Educational Technology & Society
An International Journal

Aims and Scope

Educational Technology & Society is a quarterly journal published in January, April, July and October. Educational Technology & Society seeks academic articles on the issues affecting the developers of educational systems and educators who implement and manage such systems. The articles should discuss the perspectives of both communities and their relation to each other:

- Educators aim to use technology to enhance individual learning as well as to achieve widespread education and expect the technology to blend with their individual approach to instruction. However, most educators are not fully aware of the benefits that may be obtained by proactively harnessing the available technologies and how they might be able to influence further developments through systematic feedback and suggestions.
- Educational system developers and artificial intelligence (AI) researchers are sometimes unaware of the needs and requirements of typical teachers, with a possible exception of those in the computer science domain. In transferring the notion of a 'user' from the human-computer interaction studies and assigning it to the 'student', the educator's role as the 'implementer/manager/user' of the technology has been forgotten.

The aim of the journal is to help them better understand each other's role in the overall process of education and how they may support each other. The articles should be original, unpublished, and not in consideration for publication elsewhere at the time of submission to Educational Technology & Society and three months thereafter.

The scope of the journal is broad. Following list of topics is considered to be within the scope of the journal:


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Reviewer: Vive(k) Kumar
A Collective Case Study of Online Interaction Patterns in Text Revisions

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ABSTRACT

Learning happens through interaction with others. The purpose of this study is to investigate how online interaction patterns affect students' text revisions. As a sample, 25 undergraduate students were recruited to play multiple roles as writers, editors, and commentators in online text revisions. In playing different roles, they chose to read peer writers’ texts, edit peer writers’ errors, evaluate peer editors’ suggestions and corrections, and finally rewrite their own texts. Students’ choices of actions in the system to interact with their peers for the common goal of text improvement were identified as interaction patterns in this study. Results of this study revealed significant differences in students’ interaction patterns and their final texts. The interaction pattern of students who made both local (grammatical corrections) and global (the development, organization, and style of texts) revisions was an extensive and reciprocal process. The interaction pattern of students who made only local revisions was almost a one-way process. Based on these interaction patterns, we suggest that teachers encourage low-participating students to engage in interactions with their peers by showing the benefits of peers’ text revisions in the final drafts. Providing necessary assistance and guidance to low-participating students is essential, given their difficulties in writing texts, editing peer writers’ texts, and evaluating peer editors’ suggestions.

Keywords

Interaction pattern, Collaborative learning, Trace result, Text revision, Peer review

Introduction

Learning can be more effective when students are able to discuss with peers their ideas, experiences, and perspectives (Gonzalez-Lloret, 2003; Jonassen, Davison, Collins, Campbell, & Bannan Haag, 1995; Pena-Shaff & Nicholls, 2004). Through interaction, students are provided with opportunities to engage in a process of meaning construction in which they share ideas and try to create meanings from new experiences (Jonassen et al., 1995). That is, individuals may bring divergent ideas, experiences, and perspectives into collaborative learning (Hoadley & Enyedy, 1999; Stahl, 2002). How individuals move from seemingly divergent perspectives to shared understandings and then to a new construction of meaning is considered a significant aspect in collaborative learning (Puntambekar, 2006; Reeves, Herrington, & Oliver, 2004). In collaborative learning, a student entering a discussion with his/her own understanding may take away a more in-depth or broader comprehension of a topic through collaborative interaction.

The process of collaborative interaction is also important in the development of students’ writing skills. Students usually use the writing products of others to assist them in the construction of meanings. They may also collaborate and converse with others to exchange information and rewrite their texts. Results of DiGiovanni and Nagaswami’s (2001) and Heift and Caws’ (2000) studies indicated that students had better writing (or cognitive) development under the assistance from mature peers or experts.

Collaborative revision is considered a scaffold because it helps students improve their writing. Scaffolding is a temporary support for students that aids them in bridging the gap between what they can do and what they need to do (Graves, Graves, & Braaten, 1996). In the process of collaborative revision, novice writers gain assistance from capable peers to improve their texts. Similarly, expert writers' metacognitive ability grows by editing texts and providing feedback to novice writers. That is, both novice and expert writers benefit from the process of collaborative revision.

According to Pena-Shaff and Nicholls (2004), the meaning-making or meaning-construction process “can become even more powerful when communication among peers is done in written form, because writing, done without the immediate feedback of another person, as in oral communication, requires fuller elaboration in order to successfully convey meaning” (p. 245). Collaborative interaction via the written medium is particularly important for college students who learn English as a foreign language (EFL) in Taiwan because they are required to read English
textbooks and write academic essays. However, in both reading and writing classes, they have less interaction with their peer learners and teachers due to very limited time in language instruction (Chi, 2001).

To foster interaction among students, computer-supported collaborative learning (CSCL) is proposed as an alternative (Martindale, Pearson, Curda, & Pilcher, 2005; Loard & Lomicka, 2004; Kinnunen & Vauras, 1995). CSCL has been claimed to be time and space independent (Huffaker & Calvert, 2003; Warschauer, 1997). The teacher and students can exchange messages from different places at different times. In the process of text revision, students can take peers as scaffolds to read peer writers’ texts and correct peers’ errors in order to help themselves construct meanings. That is, they collaborate with peers or the teacher to negotiate meanings and reconstruct their own texts.

**Background of this study**

To help EFL students revise their texts, an online system was built in this study that allowed students to play multiple roles. As writers, students posted their texts into the system for their peers to read. As editors, they read and edited their peers’ texts. When playing the role of a commentator, they evaluated peer editors’ suggestions and corrections (Fig. 1). That is, students were free to choose their actions in the system as they assumed each role in a writing cycle (write-edit-evaluate-rewrite). In taking different actions to play multiple roles, students acquired information from and contributed information to peers. Meaning arose as students created interpretations of their peers’ suggestions and corrections to construct and reconstruct their own texts (Leahey & Harris, 1989).

![Figure 1. The writing cycle and role-switching in the system](image)

This study is different from the related research in the field of collaborative revision in two main aspects. First, the role-switching of students in the system results in online interaction with peers through reading and writing. Online interaction occurs when writers, editors, and commentators post their texts or comments on peers’ texts. Students are free to change their roles as they take different actions such as reading peers’ texts, editing peers’ texts, and evaluating peer editors’ corrections in the system. They are also reminded to make choices and decisions to accept or reject peer editors’ correct and incorrect revisions. Second, most previous studies (e.g., DiGiovanni & Nagaswami, 2001; Heift & Caws, 2000) considered collaborative revision as an instructional intervention for students without paying attention to individual students’ progress in information acquisition and contribution. In most of the previous studies, the decreasing rate of grammatical errors in the final drafts was considered to indicate the students’ progress in text revisions. However, the quantitative data of the decreasing rate neither disclosed how students made such revisions nor revealed their progress in text reorganization.

This study not only recognizes collaborative revision as an instructional intervention but also emphasizes individual progress in text improvement. Each student’s interactive process was recorded in the trace result of the system to indicate how individuals revise their texts through online interaction to acquire and contribute information in improving their final drafts. In other words, students’ choices of actions in the system to interact with their peers for the common goal of text improvement are defined as interaction patterns in this study (Liu & Tsai, 2008; Reisslein,
Seeling, & Reisslein, 2005). Students’ first and final drafts were further analyzed and compared to illustrate the influence of interaction patterns on text revisions.

The purpose of this study is to investigate how online interaction patterns affect students’ text revisions. Because students are free to choose their actions in the interactive process to improve their texts, their interaction patterns may reveal significant instructional implications for teachers. Two research questions are addressed in this study: (1) What are students’ interaction patterns in online text revisions? and (2) How do the interaction patterns affect students’ text revisions in their final drafts?

Method

Participants

An EFL writing class was randomly selected from a university of science and technology in central Taiwan. In this class, the 25 students were common in two aspects: (1) they all passed the intermediate level of the General English Proficiency Test, a nationwide screening test administered by the university in the selection of students who wish to major in English, and (2) they had taken the same writing class for two years in this university and were in the third year of their studies.

The objective of this writing class was to develop students’ writing skills via online interaction that led to a reconstruction of their original texts based on the feedback received from peer editors. That is, students attempted to achieve their common goal in text improvement and their improvement was examined by comparing the differences between their first and final drafts. In addition to in-class instruction, students were expected to finish each text in a writing cycle (write-edit-evaluate-rewrite) within three weeks and spend three to four hours per week doing so. They were randomly assigned a user identifier in the system in order to be anonymous in the writing cycle when they posted their reaction essays, edited peers’ writing errors, evaluated peer editors’ corrections, and finally reconstructed their texts.

Procedures of data collection

The present study was conducted between October 1, 2007, and January 14th, 2008. A total of 25 undergraduate students were asked to revise their texts by interacting with their peers online both during and after class. Peer editors chose the error types and stated the reasons behind their choices so that each student was able to read the revised essay and the comments by moving the mouse on the icons in the text (Fig. 2). These corrections or comments helped writers reflect on their errors. In addition, revisions were indicated by Diff Engine, which highlighted newly added words and crossed out deleted words.

Figure 2. Commenting on corrections
Next, the original student writers provided comments to evaluate editors’ suggestions. For example, a commentator (a student writer) might click a “triangle” icon to read peer editors’ corrections or suggestions. He then might or might not write his response to each correction or suggestion. The commentator evaluated the peer editor’s correction by giving two stars on a five-star scale in the “evaluation” column. He then explained his evaluation in the “reasons for evaluation” column. An example is shown in Figure 3.

Students’ interactive processes with peers in text revision were recorded in the trace result. Two kinds of data were included in the trace result: an action log and personal statistics. The action log records students’ every single action in the system, such as reading, posting, editing, and evaluating. When students log in to the system, the recording function is activated. The trace module can record various operating actions that students adopt within the system, for example, read, post, revise, suggest, and evaluate. The action logs are listed in tables (see Fig. 4). By clicking the “view” button, the teacher was able to ascertain which student, which text, and which correction or suggestion the student interacted with.

“Personal statistics” shows the number of texts each student posts, the number and the type of errors that each student makes. “Post records” include (a) the number of new essays posted, (b) comments on peers’ essays, and (c) the topics of essays that the student has revised. For example, the peer editors select the type of errors, and the number of errors in a text is automatically counted as personal statistics in the system.
According to the report, students nowadays feel stressful during their school life. To my surprise, the report also mentions that junior high students feel more stressful than senior high students do. It is not difficult to find out the reason, which is related to our social values.

**Figure 5. Student A, information acquired from peers**
Procedures of data analysis

The main challenge of data analysis in this study involved the integration of cases, methods, and datasets to produce compelling analytic conclusions. In this collective case study, data analysis within each case, between cases, within each method, and between methods took place alongside the data collection and processing (Lim & Barnes, 2005). Data were analyzed in terms of each student’s actions in the trace result and each student’s first and final drafts along with peer editors’ suggestions and corrections collected in this study. First, in order to observe interactions among students and their peers through reading and writing, the action logs in the trace result were examined. Second, students’ interaction patterns were identified based on the actions that students took in the system.

Finally, students’ first and final drafts were analyzed and compared in terms of local and global revisions. “Local revision” refers to student writers’ corrections with respect to grammatical errors such as redundant words, misuse of punctuation, and incorrect subject-verb agreement. “Global revision” refers to student writers’ corrections concerning the organization, development, or style of a text. Both local and global revisions are important for students to improve their texts (Cho & Shunn, 2007; Li, 2006). In other words, an individual student’s text improvement was assessed by the comparison between his first and final drafts in terms of local and global revisions. The inter-rater reliability of the students’ local and global revisions in their first and final drafts ranged from 0.75 to 0.86 among 25 participants. The disagreement between two raters was resolved by discussion. Data analysis using this research method is presented in the following sections.

Results

In this study, revision is defined as the changes that students make to a writing product to improve it. Revisions are indicated in the system by Diff Engine, which highlights newly added words and crosses out deleted words. In order to illustrate the differences in student writers’ final drafts and interaction patterns, we selected two sample students. Whereas student A is an example of a student that made both local and global revisions, student B made only local revisions in the final draft. The statistics concerning the 25 participants’ actions, as recorded in the trace result and corrections on their peers’ texts, is also discussed.

Student A’s and B’s interactive processes with their peers

Student A’s interactive processes are shown in Figure 5. In tracing student A’s actions, we found that he acquired information by reading different peer writers’ texts on November 6, 2007. He then read and reread his own text and further corrected his errors to perfect the text. In interacting with his peers, he received various corrections and suggestions from different peer editors. Based on these corrections and suggestions, student A revised his text. As shown in Figure 5, student A read various suggestions and corrections from peer editors on December 4, 2007. After reading, he rewrote his text based on peer editors’ suggestions and corrections. He then published his final draft on January 5, 2008. From the trace result, it was found that student A read not only the suggestions that peer editors provided to him but also peer editor 1’s suggestions on peer writer 2’s essay (December 4, 2007).

Apart from acquiring information from peers, student A also contributed information to his peers. As shown in Figure 6, he edited a peer writer’s text and made some suggestions on December 29, 2007. In the process of information acquisition and contribution, student A served as a scaffold for others, and vice versa.
In Figure 6, student A actively participated in collaborative interactions with his peers through, for example, editing and making suggestions with respect to his peers’ essays. While student A interacted with peers, reading and providing suggestions to peers helped him revise his own text.

Similar to Student A, Student B acquired information by reading his peers’ essays (see Fig. 7). However, he sometimes published new essays without reading his peers’ essays. That is, student B used his prior knowledge to compose essays without interacting with peers in the system. When student B revised his essay, he only read few or even none of the corrections and suggestions provided by his peers. For instance, there were 74 comments (action 4) in his text. Student B only read one of the 74 comments in the text (action 5). Actions 6 to 10 indicate that none of the comments in the different versions of the essay were read by him. He read the corrections from peers without evaluating the reasons (comments) why the corrections had been made.

Students A’s and B’s interaction patterns

Based on students’ actions recorded in the trace result, students A’s and B’s interaction patterns were identified (Liu & Tsai, 2008; Reisslein, Seeling, & Reisslein, 2005). These patterns referred to how a student published new essays, read peer writers’ texts, edited peers’ errors, and provided suggestions to peer writers. Based on the actions that student A took and recorded in the trace result, the interaction patterns of student A are shown in Figure 8.
Six types of interactions are shown in Figure 8. In information acquisition, student A read peer editors’ local and global revisions as well as peer writers’ texts. In information contribution, he edited peer writers’ texts, provided suggestions to peer writers, and published texts for peers to read. In the system, almost everyone is someone else’s scaffold in the collaborative interaction of text revisions. As an individual, student A frequently acquired and contributed information to peers in assuming each role.

Figure 8. Interaction patterns of student A

A closer look at student A’s information acquisition showed that student A had read the suggestions provided by peers 1 and 3 (Fig. 9). He also read the suggestions that were provided by peer 1 to peer 2. Student A was not just passively acquiring information from peer editors. Instead, he actively searched for and read other resources such as peer 1’s suggestions on peer 2’s essay.

Figure 9. Student A’s acquisition of information from peers

With respect to information contribution (see Fig. 10), student A edited peer 1’s essay and stated the reasons why the corrections had been made. In addition to editing peers’ essays, student A also made suggestions on peer 2’s text concerning the organization and development of the text. After acquiring and contributing information in collaborative interactions, student A finally published a new essay for his peers to read.
In contrast to student A, student B had much simpler interaction patterns. In Figure 11, student B’s acquisition of information involved reading peers’ suggestions and peer writers’ essays only. He had acquired little information because he had read only the suggestions provided by peers to himself (see Fig. 12).

**Figure 10. Student A’s contribution of information**

**Figure 11. Student B’s interaction pattern**

**Figure 12. Student B’s acquisition of information**
In information contribution, student B edited peer 1’s essay and published his own essay (see Fig. 13). Different from student A’s interaction patterns, student B’s action in “suggesting global revision to peers’ essay” was missing. Student B could only edit peers’ essays for grammatical errors. He did not provide suggestions regarding the style, organization, and development of his peers’ essays.

![Diagram](image)

**Figure 13.** Student B’s contribution of information to peers

The influence of student A’s and B’s interaction patterns on text revisions

The excerpt of the editor’s suggestions and corrections on student A’s text is shown in Table 2.

| Table 2. Excerpt of the editor’s suggestions and corrections on student A’s text |
| (1) After seeing the movie, the most impressive statement in my mind is “If you focus on the problem, you can not see the solution. Never focus on the problem!” | (1) After seeing the movie, the most impressive statement in my mind is “If you focus on the problem, you can not see the solution. Never focus on the problem!” |
| (2) As one of the teachers of general education said “People often commit an error because of the habitual train of thought and do not jump out the circle.” | (2) As one of the teachers of general education said “People often commit an error because of the habitual train of thought and do not jump out the circle.” |
| (3) Because we always believe that the thing we see is true. | (3) Because we always believe that the thing we see is true. |
| (4) Such as the patients in the movie, they do not lose their mental balance, but most of people even doctors think they are mentally disordered psychiatric patients and nobody is willing to realize them. | (4) Such as the patients in the movie, they do not lose their mental balance, but most of people even doctors think they are mentally disordered psychiatric patients and nobody is willing to realize them. |

Analyzing student A’s first and final drafts, we found that student A did both local and global revisions (see Table 3). Student A did not accept all the corrections or suggestions that his peers provided; instead, he selectively accepted some suggestions and corrections in his final draft. For example, in sentence 2, 3, and 4 (see Table 3), student A did not revise the sentences exactly as the peer editor suggested. Instead, he rewrote the sentence to express his ideas more clearly and precisely. He further integrated sentences 5 and 6 in his final draft, a global revision. The meaning of sentences 5 and 6 was, thus, changed according to the reorganization of the text.

<p>| Table 3. Analysis of student A’s first and final drafts |</p>
<table>
<thead>
<tr>
<th>First draft</th>
<th>Final draft</th>
<th>Type of revision</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) After seeing the movie, the most impressive statement in my mind is “If you focus on the problem, you can not see the solution. Never focus on the problem!”</td>
<td>(1) After seeing the movie, the most impressive statement in my mind is “If you focus on the problem, you can not see the solution. Never focus on the problem!”</td>
<td>Local revision</td>
</tr>
<tr>
<td>(2) As one of the teachers of general education said “People often commit an error because of the habitual train of thought and do not jump out the circle.”</td>
<td>(2) As one of the teachers of general education said “People often commit an error because of the habitual train of thought and do not jump out the circle.”</td>
<td>Local revision</td>
</tr>
<tr>
<td>(3) Because we always believe that the thing we see is true.</td>
<td>(3) Because we always believe that the thing we see is true.</td>
<td>Local revision</td>
</tr>
<tr>
<td>(4) Such as the patients in the movie, they do not lose their mental balance, but most of people even doctors think they are mentally disordered psychiatric patients and nobody is willing to realize them.</td>
<td>(4) Such as the patients in the movie, they do not lose their mental balance, but most of people even doctors think they are mentally disordered psychiatric patients and nobody is willing to realize them.</td>
<td>Local revision</td>
</tr>
</tbody>
</table>
(5) Doctors also just use medication in compliance with the formulation and ignore the patient’s feelings. (6) It is no futile effort that cures the problem only on the physiology.

Furthermore, I think it is useless that the doctors just use medication but ignores the patient’s feeling.

Global revision

(13) The leading role finally proved his concepts and his ways are correct at the end of this movie. (14) N/A

(13) The final result is that Patch proved his concepts and his ways are correct at the end of this movie.

Local revision

Table 4 shows the excerpt of the editor’s corrections and suggestions on student B’s text.

<table>
<thead>
<tr>
<th>Table 4. Excerpt of the editor’s corrections and suggestions on student B’s text</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) “Patch Adams” is was a wonderful, wonderful, I touching, was and really enjoyable moved movie by and the I movie. Am it really was moved very by touching it and enjoyable—(2)All emotions run were running high during this whole movie. (3) The sadness level rises, the happiness level rises, and the overall entertainment through this whole movie. (4) &quot;Patch Adams&quot; delivers a powerful message. Which it is about the old saying—laughter saying that goes &quot;laughter is the best medicine.&quot;&quot;.(5)In He Adams's knew opinion, in he his think heart that all the patients need needed to laugh. And Laughter the is laughter after is all the best medicine anyone could ask for. (6) Adams discovers that a clown nose can accomplish more than any pill in many cases and sets to work amusing patients. (7) By communicating with patients, he discovers that by helping others makes he him helps help himself, himself. too.</td>
</tr>
</tbody>
</table>

The peer editor provided many corrections and suggestions to student B, but only four out of ten sentences were revised in student B’s final draft (see Table 5). Referring back to student B’s actions in the trace result, we found that student B had few interactions with peers, such as reading very few or none of the suggestions from peers. Passive interaction in the system resulted in student B’s limitations in revising his final draft. The types of text revisions were constrained to local revisions.

Table 5. Analysis of student B’s first and final draft

<table>
<thead>
<tr>
<th>First draft</th>
<th>Final draft</th>
<th>Type of revision</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) “Patch Adams” was wonderful.</td>
<td>(1) “Patch Adams” was wonderful.</td>
<td>N/A</td>
</tr>
<tr>
<td>(2) I was really moved by the movie.</td>
<td>(2) I was really moved by the movie.</td>
<td>N/A</td>
</tr>
<tr>
<td>(3) All emotions were running high during this whole movie.</td>
<td>(3) All emotions were running high during this whole movie.</td>
<td>N/A</td>
</tr>
<tr>
<td>(4) The sadness level rises, the happiness level rises, and the overall entertainment through this whole movie.</td>
<td>(4) The sadness level rose, the happiness level rose, and the overall entertainment through this whole movie rose.</td>
<td>Local revision</td>
</tr>
<tr>
<td>(5) “Patch Adams” delivers a powerful message.</td>
<td>(5) “Patch Adams” delivers a powerful message, which is an old saying that goes “laughter is the best medicine.”</td>
<td>Local revision</td>
</tr>
<tr>
<td>(6) It is about the old saying that goes “laughter is the best medicine.”</td>
<td>(7) He knew in his heart that all patients needed to laugh.</td>
<td>Local revision</td>
</tr>
<tr>
<td>(8) Laughter is after all the best medicine anyone could ask for.</td>
<td>(8) Laughter is after all the best medicine anyone could ask for.</td>
<td>N/A</td>
</tr>
<tr>
<td>(9) Adams discovers that a clown nose can accomplish more than any pill in many cases and sets to work amusing patients.</td>
<td>(9) Adams discovered that a clown nose could accomplish more than any pill in many cases, and then set to amuse patients.</td>
<td>Local revision</td>
</tr>
<tr>
<td>(10) By communicating with patients, he discovers that by helping others he helps himself, too.</td>
<td>(10) Through communicating with patients, he discovered that by helping others he helped himself, too.</td>
<td>Local revision</td>
</tr>
</tbody>
</table>
Differences in participants’ text revisions

Of the 25 participants in this study, nineteen conducted only local revisions in their final drafts, while six participants made both local and global revisions (see Table 6). Some differences could be detected in these two groups. First, the number of actions that the members of the two groups took was different (see Table 6).

A t-test was conducted to examine whether there were significant differences between these two groups of students in actions and revisions. The result showed that the differences were significant with $p$ values less than .01. The mean frequency of students’ actions indicated that the students who made global revisions took many more actions of reading, posting, editing, and evaluating than those students who made only local revisions. In other words, the more students interacted online, the more they did both local and global revisions in the texts. The effects of interaction on students’ texts could also be noticed from the rate of sentence revisions. Within a text, students who made both local and global revisions revised 90% of their sentences, whereas students who made only local revisions revised 41% of their sentences.

<table>
<thead>
<tr>
<th>Participants</th>
<th>Number of students</th>
<th>Mean frequency of students’ actions</th>
<th>Mean of sentence revision rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group A: Local and global revisions</td>
<td>6</td>
<td>862 **</td>
<td>90%%**</td>
</tr>
<tr>
<td>Group B: Local revision</td>
<td>19</td>
<td>198.6 **</td>
<td>41%%**</td>
</tr>
</tbody>
</table>

Second, some actions were missing in the interaction pattern of students who made local revisions only. For instance, six types of interaction patterns were found in students who made both local and global revisions, whereas only four of them were found in students who made local revisions. The missing actions were (1) reading suggestions from peers, (2) making suggestions to peers’ essays. Third, it was we found that students who made only local revisions focused on the suggestions that peers provided to them and ignored or rarely read the suggestions of their peers. This decreased students’ opportunities to learn from peers. Fourth, students who made only local revisions had difficulties finding and correcting peer writers’ errors. They only focused on grammatical errors without providing suggestions in terms of style, development, and organization of texts.

Fifth, from student A’s interaction patterns, we found that his collaborative interaction with peers was not a one-way process. Instead, it was a reciprocal process of sharing and constructing meaning. In the reciprocal process, he not only acquired information from his peers but also contributed information to them. He was connected with his peers to accomplish their common goal of text revision. He also served as a scaffold to his peers in the process of achieving this goal. The interaction patterns of students who made both local and global revisions are illustrated in Figure 14.
Finally, from student B’s information acquisition and contribution, the interaction patterns of students who made only local revisions was almost a one-way process (Fig. 15). For instance, student 2 acquired information from student 3 but he did not contribute information to student 3. The process of interaction became a one-way process. In addition, when student 4 contributed information to student 2, student 2 did not read student 4’s information. As a result, student 4’s contribution of information could not benefit student 2 in text revision.

**Figure 15. Interaction pattern of students who made local revisions only**

**Discussion**

From the results of this study, we were able to identify a interaction framework to explain how online collaborative interactions influenced students’ text revisions (see Fig. 16). This framework indicates how students go from their first drafts (unshared information) to their final drafts (newly constructed meanings of texts) by interacting with peers.

**Figure 16. The interaction framework of students’ text revisions**

In text revision, students went through different stages by interacting with peers, namely, information acquisition, negotiation of meaning, and information contribution. In each stage, students might have taken several actions in order to achieve their goals of revising or rewriting their texts. In this study, students received suggestions and corrections from peers in the process of revision after posting their first drafts. They also read different peer writers’ essays on the same or different topics to imitate their writing styles and skills. In reading, student writers might encounter the conflicts between their prior knowledge and peer editors’ corrections and suggestions.
In encountering conflicts, a student writer negotiated the meanings with his/her peers through reading and writing. The student writer could compare his prior knowledge with the information he received. Negotiation of meanings led to agreement or disagreement of peer editors’ corrections and suggestions. It was important for a student writer to clearly express his agreement or disagreement, which represented his evaluation of peer editors’ corrections and suggestions. Without negotiating the meanings, a student writer would be unable to identify what had been done right or wrong.

Through agreement or disagreement with peer editors’ corrections and suggestions, a student writer revised his text. Integrating peer editors’ corrections and suggestions helped one construct new meanings and publish a new essay. In the construction of new meanings, a student writer might have played another role as editor or commentator. He needed to be equipped with the ability to help others revise their texts by providing corrections and suggestions. With the investigation of information acquisition and contribution in collaborative revision, students’ progress in the process of writing could be observed in this study. Different from previous studies (e.g., DiGiovanni & Nagaswami, 2001; Heift & Caws, 2000) that focus on the evaluation of students’ final drafts, this study emphasizes the importance of students’ writing process in text improvement.

Based on the framework proposed in this study, we suggest that the instructor explain the benefits of peer reviewing and make students aware of the importance of peer reviewing. For instance, the teacher can provide students with examples of peers’ first and final drafts. This comparison will clearly show students’ improvement in their final drafts. The comparison between first and final drafts is particularly important for low-participating students since they were found to ignore peer editors’ corrections and suggestions in this study. Through monitoring low-participating students’ progress in revisions, the teacher should also provide necessary assistance to them as they may have difficulties in writing texts, editing peer writers’ texts, and evaluating peer editors’ suggestions. Since reading and writing are important interactions in the process of peer review, the teacher should encourage students to play different roles and take responsibility for each role in the collaborative interaction and learning process.

Some limitations were also found in this study. First, the sample size was not big enough to generalize students’ collaborative interaction patterns, since only 25 participants took part in this study. The result of this study might not be able to fully illustrate the interaction patterns in EFL classes. Second, the teacher’s and students’ perceptions of writing development in the system should be further explored. An interview could be conducted to investigate their perceptions toward the impact of the system on peer review.

Acknowledgement

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References


Comparison of Two Analysis Approaches for Measuring Externalized Mental Models

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ABSTRACT

Mental models are basic cognitive constructs that are central for understanding phenomena of the world and predicting future events. Our comparison of two analysis approaches, SMD and QFCA, for measuring externalized mental models reveals different levels of abstraction and different perspectives. The advantages of the SMD include possibilities for statistical testing of single criteria and big groups. Its disadvantages include a comparatively low pedagogical expressiveness of the more formal criteria. An analysis of single cases with the help of QFCA avoids imprecision by virtue of many steps of analysis and seems more significant on a qualitative level. The main limitation of QFCA is that comparisons are possible for small groups or knowledge sections only. The content-based results open various possibilities for comparing mental-model representations by single cases or groups with different pedagogical implications.

Keywords

SMD, QFCA, Mental model, Assessment, Analysis

Introduction

Mental models are basic cognitive constructs that describe complex learning and problem-solving processes. Generally speaking, a person constructs a mental model in order to explain or simulate specific phenomena of objects or events if no sufficient schema is available. Thus, mental models organize domain-specific knowledge in such a way that phenomena of the world become plausible for the individual. Compared to that of a novice, a domain expert’s mental model is considered to be more elaborate and complex. Therefore, we argue that mental models mediate between an initial state and a desired final state in the learning process. Accordingly, there is an immense interest on the part of researchers to analyze a novice’s mental model and compare it with an expert’s in order to identify the most appropriate ways to bridge the gap.

Over the past years, several possible solutions to the analysis problems of mental models have been discussed (e.g., Clariana & Wallace, 2007; Ifenthaler, 2008; Johnson, Ifenthaler, Pirnay-Dummer, & Spector, 2009). Therefore, it is worthwhile to compare analysis approaches for measuring externalized mental models systematically in order to test their advantages, disadvantages, strengths, and limitations. Johnson, O’Connor, Spector, Ifenthaler, and Pirnay-Dummer (2006) set up a series of pair-wise comparative studies in order to determine the strength, unique characteristics, and collective viability of different assessment and analysis methods. A total of six studies compared the methods ACSMM (analysis constructed shared mental models; Johnson et al., 2009), SMD (surface, matching, deep structure; Ifenthaler, 2010), MITOCAR (model inspection trace of concepts and relations; Pirnay-Dummer & Ifenthaler, 2010), and DEEP (dynamic evaluation of enhanced problem solving; Spector & Koszalka, 2004). Through study of their methodologies, the authors hope to better quantitatively and qualitatively represent individual and team mental models and better understand mental model development by comparing individuals and experts (Johnson et al., 2006). However, the above-mentioned study only focussed on conceptual differences of the analysis approaches and did not use empirical data.

In addition to the above-described comparative study by Johnson et al. (2006), our current study compares two analysis approaches, using identical data: qualitative and formal concept analysis (QFCA) and surface, matching, deep (SMD) structure. Accordingly, the aim of our comparative study is to determine conceptual and empirical strengths and limitations of two different approaches for analyzing externalized mental models. Our comparison framework is laid out as follows. First, both analysis approaches are introduced. Second, we present the empirical study. Third, we report the results analyzed with both approaches, QFCA and SMD. Forth, on the basis of our results, we compare both analysis approaches. Finally, we conclude by determining how the two approaches could be used in conjunction in further mental model research.
Analysis approaches

A mental model is always content related and the assessment (elicitation) and analysis (measurement of elicitation) should allow a psychological and content-based interpretation. However, the yet-unsolved question is how to accurately diagnose mental models. Some issues that have yet to be resolved include identifying reliable and valid ways to elicit mental models and the actual analysis of the externalized models themselves (Ifenthaler & Seel, 2005; Kalyuga, 2006). However, the possibilities of assessment (elicitation) of mental models are limited to a few sets of sign and symbol systems (Seel, 1999), which are characterized as graphical and language-based approaches. Graphical approaches include the structure formation technique (Scheele & Groeben, 1984), pathfinder networks (Schvaneveldt, 1990), mind tools (Jonassen & Cho, 2008), and the test for causal models (Al-Diban, 2008). Language-based approaches include thinking-aloud protocols (Ericsson & Simon, 1993), cognitive task analysis (Kirwan & Ainsworth, 1992), and computer linguistic techniques (Seel, Ifenthaler, & Pirnay-Dummer, 2009). However, not all of these elicitation methods interact with available analysis approaches. Therefore, we identified two analysis approaches (QFCA and SMD) which interact well with the graphical assessment method test for causal models (TCM).

Analysis I: Qualitative & formal concept analysis (QFCA)

As a first step of the QFCA, the amount of assessed data (graphical or natural language-based) will be reduced semi-automatically with help of coders, which look for semantic similarities, synonyms, and metaphors and build hierarchies of concepts and propositions. Second, the data is imported into Cernato (Navicon, 2000). This program is based on the lattice theory (Birkhoff, 1973) and allows content-based comparisons of individual mental model representations. Figure 1 shows an example of the results of an analysis. The figure presents a comparison of the preconceptions of 12 participants on the level of generic concepts. In the third step of the analysis the problem of structure isomorphism occurs, which usually prevents content-based comparisons of simple concept-mapping methods (see Nägler & Stopp, 1996). This problem consists of the possibility that any number of identical concepts can be connected in the factorial number of arrays. This makes it nearly impossible to make content-based comparisons of entire model representations. With the help of formal concept analysis (Ganter & Wille, 1996) all objects (here participants) can be systematically structured according to the entirety of all true attributes (here, concepts or propositions).

Figure 1. QFCA analysis of the rainbow phenomenon

Accordingly, the formal concept analysis follows the following procedure: (a) Since the data is preserved for the most part in natural language, it is possible to reconstruct incorrect or missing concepts in the preconceptions of the participants (e.g., decomposition of light instead of color dispersion; a biological reflex instead of a physical reflex)
and then discover any exceptional concepts that participants used. (b) The whole of semantic surface features are preserved and can be compared. This allows us to, for example, distinguish between participants with a low and high amount of prior knowledge. (c) Since concept volume is defined by all objects that can be reached by downward lines (see Figure 1), we are able to reconstruct which participants used, for example, the concept “raindrop” (only 9 of the 12 participants). (d) We are able to analyze special questions (sections) in detail, for example, what characterized the preconceptions of the participants who used the concept “rainbow figure”: two used “refraction” (RSS, CMA) and one also used “reflection” (RSS). However, no one used “dispersion,” “perception,” “sensibility for light,” or “solar radiation.”

Research designs with more than one point of measurement would allow very interesting content-based comparisons of changes.

**Analysis II: Surface, matching, deep (SMD) structure**

The advent of powerful and flexible computer technology enabled us to develop and implement a computer-based analysis approach that is based on the theory of mental models and graph theory (Chartrand, 1977). SMD uses three core measures for describing and analyzing externalized mental models (Ifenthaler, 2010). Additional measures are applied for an in-depth analysis (Ifenthaler, Masduki, & Seel, 2011). SMD requires the assessed data to be stored pair-wise (vertex-edge-vertex) for further analysis procedures. If the required data format is available (see Table 1), the raw data can be stored on an SQL (structured query language) database and the automated analysis procedure can be initiated by the researcher.

<table>
<thead>
<tr>
<th>ID</th>
<th>vertex 1</th>
<th>vertex 2</th>
<th>edge</th>
<th>subject number</th>
</tr>
</thead>
<tbody>
<tr>
<td>001</td>
<td>Licht</td>
<td>Ausbreitung</td>
<td>!</td>
<td>912abz3</td>
</tr>
<tr>
<td>001</td>
<td>Licht</td>
<td>Spalt</td>
<td>-</td>
<td>912abz3</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

As a result, SMD generates three core measures, additional measures, and standardized graphical re-representations of the previously externalized mental models. These re-representations are concept-map-like images with named nodes and named links (Figure 2).

![Figure 2. SMD re-representation of data shown in Table 1](image)

The core measures are composed of three levels: surface, matching, and deep structure. The surface structure measures the size of the externalized model, computed as the sum of all propositions (vertex-edge-vertex). It is defined between 0 (no propositions) and $n$. The computed surface structure of the re-represented model in Figure 2 would result in $\theta = 3$. The pedagogical purpose is to identify additions or removals of vertices (growth or decline of the graph) as compared to previous knowledge representations and track change over time.

In order to analyze the complexity of an externalized model, Ifenthaler (2010) introduced the *matching structure* $\mu$. It is computed as the diameter of the spanning tree of an externalized model and can lie between 0 (no links) and $n$. The complexity indicator of the re-represented model in Figure 2 would result in $\mu = 2$. The pedagogical purpose is to identify how broad (complex) the learner’s understanding of the underlying subject matter is.

Whereas the two above-described measures focus on analyzing the organization or structure of an externalized model, the deep structure measures its semantic content. It is computed with the help of the similarity measure (Tversky, 1977) as the semantic similarity between an externalized model and a reference model (e.g., expert
The measure is defined between 0 (no similarity) and 1 (full similarity). The pedagogical purpose is to identify the correct use of specific propositions (concept-link-concept), that is, concepts correctly related to each other. Additionally, misconceptions can be identified for a specific subject domain by comparing known misconceptions (as propositions) to individual knowledge representations.

In addition to the core measures, further graph-theory-based indicators are applied to more precisely describe the externalized mental models. With regard to analyzing the organization of the externalized models, Ifenthaler and colleagues (2011) introduced the measures of connectedness, ruggedness, cyclic, average degree of vertices, density of vertices, and structural matching.

The indicator “connectedness” analyses how closely the nodes and links of the externalized model are related to each other. The connectedness measure of the re-represented model in Figure 2 would result in $\phi = 1$ (it is possible to reach every node from every other node). From an educational point of view, a strongly connected knowledge representation could indicate a subjective deeper understanding of the underlying subject matter. Ruggedness indicates whether non-linked vertices of an externalized model exist, and if they do, it computes the sum of all submodels (a submodel is part of the externalization but has no link to the “main” model). The pedagogical purpose is to identify possible non-linked concepts, subgraphs, or missing links within the knowledge representation that could point to a lesser subjective understanding of the phenomenon in question. The cyclic measure is an indicator for the closeness of associations of the vertices and edges used. A cycle is defined as a path returning back to the starting vertex of the starting edge of an externalized model. A cycle in the re-represented model in Figure 2 would be: Licht – Ausbreitung – Spalt – Licht. The “average degree of vertices” measure is computed as the average degree of all incoming and outgoing edges. The “density of vertices” indicator describes the quotient of concepts per vertex within a graph. Graphs that connect only pairs of concepts can be considered weak models; medium density is expected for most good working models. The structural matching measure compares the complete structures of two graphs without regard to their content. This measure is necessary for all hypotheses that make assumptions about general features of structure (e.g., assumptions that state that expert knowledge is structured differently from novice knowledge). The pedagogical purpose of these measures is to identify the strength of closeness of associations of the knowledge representation. Knowledge representations that connect only pairs of concepts can be considered weak; medium density is expected for most good working knowledge representations. The additional semantic indicator “vertex matching” analyzes the use of semantically correct single concepts compared to a reference model. This measure is also used in the classic MITOCAR analysis procedure (see Pirnay-Dummer & Ifenthaler, 2010). The pedagogical purpose is to identify the correct use of specific concepts (e.g., technical concepts). The absence of a great number of concepts with regard to a reference representation indicates a less elaborate domain-specific knowledge representation.

For an in-depth qualitative analysis, SMD automatically generates standardized re-representations. Figure 3 shows examples of a reference (1), learner (2), cutaway (3), and discrepancy (4) re-representations, which also function as
Various experimental studies on different subject domains have confirmed the high reliability and validity of the SMD (see Johnson et al., 2006). Ifenthaler (2010) reports test-retest reliability for SMD measures as follows: surface structure, \( r = .824 \); matching structure, \( r = .815 \); and deep structure, \( r = .901 \). Also convergent and divergent validity have been successfully tested (see Ifenthaler, 2010).

### Comparative study

This initial comparative study determines conceptual and empirical strengths and limitations of the above-described approaches for analyzing the externalized mental models QFCA and SMD. In order to have identical data available, we conducted a study (pre-post design) in physics and theology with high-school students. This section introduces briefly the study’s methodology.

### Subjects

The 12 participants (9 female, 3 male) of the reported pilot study were students in the 10th grade from a traditional high school in Europe. Their mean age was 15.25 years (\( SD = .45 \)), mean score CFT 20-R intelligence test = 106.92 (\( SD = 9.89 \)). There were nine members of religious communities among the participants. Eight were active in their communities and eleven had religious interests. The participants volunteered in response to an advertisement posted at their school. After finishing the study each participant was given a reward of 20 Euros.

### Materials

The overall design (see Figure 4) included an assessment of the preconceptions of the participants in physics and theology, which began with a free-association test with scenic pictures of rainbows (physics) and tsunami (religion) which served as ice-breakers for the topics. This was followed by word problems with written text protocols and a dependant measure of the same problems from the test of causal models (TCM, Al-Diban, 2008). The participants were assessed according to relevant traits like intelligence with the standardized test of intelligence CFT 20-R (Weiß, 2006). The culture-fair test measures the fluid intelligence factor with figural material, which is a substantial indicator for inductive reasoning and flexibility of thinking. Relevant learning strategies were assessed with LIST (Wild, 2000). Additionally, we used the standardized Neo-FFI test (Borkenau & Ostendorf, 2006) to examine general self-concept, self-perceived self-efficiency (Schwarzer & Jerusalem, 1999), and personality. Furthermore, the assessment contained a test on domain-specific declarative knowledge in physics and religion. Demographic data of the participants were documented in an informal questionnaire.

### Assessment: Test for causal models (TCM)

This assessment instrument was developed to realize the postulated theoretical functions of mental models, such as high individuality, phenomenon relatedness, situational permanence, reduction of complexity, and knowledge gain (Al-Diban, 2008). The standardized TCM is a combination of the structure formation technique (Scheele & Groeben, 1984) and causal diagrams (Funke, 1990), and is a practical method for discovering structure that is in line with the theory of mental models. The participants have to transform their answers into subjectively relevant causal sequences of if/then relations or cause/consequence relations of the problem and its preconditions. The connections between single concepts represent the subjective causal thinking in a broad sense (van der Meer & Schmidt, 1992). A guided practice session in which participants construct an example is provided to improve their competence in using the TCM. For the data-assessment phase we used the computer-based software MaNET (Mannheim network elaboration technique, Reh, 2007) to enhance the usability for the participants and to allow a standardized data processing for the subsequent analysis process. Additionally, we used the purpose-built graph to context interface (GTC, Al-Diban & Stark, 2007) to export the assessed data and make them available to both analysis approaches, QFCA and SMD.
Procedure

All participants visited a learning lab at a European university on two consecutive days. The assessment procedure took three hours each day. The first part of the assessment consisted of a free-association test, a demonstration of slides with photographs of rainbows and life-threatening diseases. The participants had to write down all concepts they were spontaneously able to remember. All concrete problems, three in physics and three in religion, were measured twice: first as an open problem with transcribed text protocols from the teach-back interview and second as a dependent measure that was constructed around these answers with the TCM. The test was conducted on laptops using the software MaNET. The working time was limited to 20 minutes. Participants had the task of depicting their answers with the help of a test of causal models (TCM) comprised of concepts and causal relations. The other traits measured in this test are shown in Figure 4.

<table>
<thead>
<tr>
<th>Demonstration free association</th>
<th>Teach-back interview</th>
<th>Test for causal models</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Physics</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I Rainbow</td>
<td>General explanations</td>
<td>Concrete explanations:</td>
</tr>
<tr>
<td>II Crack experiment</td>
<td></td>
<td>Why can we see a rainbow?</td>
</tr>
<tr>
<td>III Light electrical effect</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Biology and religion</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IV Disease situation</td>
<td>General explanations</td>
<td>Concrete explanations:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Why do people fall ill?</td>
</tr>
<tr>
<td><strong>Traits</strong>: Intelligence, learning strategies, emotions, self concept, interests, attitudes</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

On the one hand, the two different topics — light models in physics and disease models in biology in combination with religion — were oriented toward the curriculum and the courses of instruction. On the other hand, these topics represent two very different knowledge domains. This allows us to compare the mental model representations of the same persons in very different knowledge domains. It should be emphasized that the results of this initial study are descriptive single cases only and not valid for a greater population group and general educational implications.

Results

The data collected in our study were analyzed with QFCA and SMD separately. Therefore, we describe our results in two separate sections and then compare the results of both analysis approaches. The “expert models” and “correct model concepts” applied to evaluate the semantic criteria of objective plausibility were developed with the help of specialists in physics education and theology. The expert models resulted in a rainbow (11 propositions), crack experiment (12 propositions), light electrical effect (10 propositions), and disease situation model (18 propositions). The correct model concepts represented key concepts and were a precondition for understanding each phenomenon correctly. In all cases, the criteria of objective plausibility were dependent on the semantic correspondence of the student model to the propositions of the expert model.

As far as the measured traits were concerned, there was a negative correlation $r = -.625^*$ between the trait of agreeability (Neo-FFI) and knowledge on the level of concepts in physics, but no significant correlation with concepts concerning the disease problem. The objective plausibility of all three model representations to physical problems together (sum of all the physic problems) and the learning strategy “critical thinking” shows a high and significant correlation, $r = .869^{**}$, such as with “openness for new experiences,” $r = .707^*$. This result might indicate that the objective plausibility of the investigated physical problems is associated with intensive “critical thinking” learning strategies and a high personal “openness for new experiences.”

Qualitative & formal concept analysis (QFCA)

The QFCA analysis approach includes five quantitative structural measures (count of concepts, count of propositions, depth of connectivity, intensity of connections, ruggedness) and an in-depth content-based investigation. Table 2 shows the results of the five quantitative structural measures. On a descriptive level, there are remarkable differences among the four problems for the measures count of concepts and count of propositions. The other structural measures, intensity of connections and ruggedness, show almost equal values with comparable
standard deviations. The majority of the mental model representations of all problems have a low depth of connectivity, a low intensity of connections, and are not rugged. Additionally, the standard deviations show high interindividual differences in the crack experiment (II) and the disease problem (IV) for the measures count of concepts and the count of propositions.

**Table 2. QFCA structural measures**

<table>
<thead>
<tr>
<th>DOMAIN</th>
<th>M</th>
<th>SD</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>count of concepts</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>7.08</td>
<td>2.64</td>
<td>4</td>
<td>13</td>
</tr>
<tr>
<td>II</td>
<td>5.91</td>
<td>3.05</td>
<td>3</td>
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<td>IV</td>
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<td>count of propositions</td>
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<td>1.50</td>
<td>3</td>
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</tr>
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<td>IV</td>
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<td>5</td>
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<tr>
<td>depth of connectivity</td>
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<td></td>
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<td>I</td>
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<td>0.16</td>
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<td>0.33</td>
<td>0.83</td>
</tr>
<tr>
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<tr>
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<td>1.25</td>
<td>0.45</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>II</td>
<td>1.27</td>
<td>0.65</td>
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<td>3</td>
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<td>III</td>
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<td>0.16</td>
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</tr>
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<td>IV</td>
<td>1.00</td>
<td>0.00</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Note: DOMAIN: I = rainbow experiment (N = 12), II = crack experiment (N = 10), III = electrical effect experiment (N = 9), IV = disease situation (N = 12)

In the next step, we analyzed the results for generic concepts and propositions and determined to what extent they corresponded to the expert models (see Table 3). Focusing the averages of the match with the expert models - relative and absolute objective plausibility - can be called small in general. The minimum of most semantic criteria represents the mental models to the physic problem (III) “light electrical effect”. This problem seems to be most difficult for the participants. The solutions to the biology & theology problem “disease situation” were slightly more competent. The use of correct model concepts is very low for all problem solutions, too. This indicates that the participants did not possess sufficient concept knowledge, which is a precondition for mental models with high objective plausibility.

**Table 3. Content-based similarity measures between participant and expert solutions**

<table>
<thead>
<tr>
<th>DOMAIN</th>
<th>M</th>
<th>SD</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>relative objective plausibility [propositions in %]</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>51.09</td>
<td>19.65</td>
<td>22.2</td>
<td>80</td>
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<tr>
<td>II</td>
<td>33.70</td>
<td>38.22</td>
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<td>100</td>
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<tr>
<td>III</td>
<td>28.94</td>
<td>23.58</td>
<td>0</td>
<td>66.7</td>
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<tr>
<td>IV</td>
<td>45.8</td>
<td>26.70</td>
<td>5.2</td>
<td>100</td>
</tr>
<tr>
<td>absolute objective plausibility [prop., max.11/12/10/18]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>3.08</td>
<td>1.24</td>
<td>2</td>
<td>6</td>
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<tr>
<td>II</td>
<td>1.20</td>
<td>1.03</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>III</td>
<td>1.44</td>
<td>1.24</td>
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<td>4</td>
</tr>
<tr>
<td>IV</td>
<td>4.50</td>
<td>1.45</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>correct model concepts [6/7/8/20]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>1.17</td>
<td>0.94</td>
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<td>3</td>
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<td>3.50</td>
<td>1.17</td>
<td>2</td>
<td>5</td>
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</table>
A further step of the QFCA approach was concerned with the in-depth content-based analysis. We compared all participants on the level of original concepts. Figure 5 shows the whole sample with all concepts occurring in the rainbow-experiment problem (I). Each participant is represented by a rectangle, including an individual study code (e.g., CSS, SIM, AMN, MPS, LSM, RSS, AEN, PMM, CHS, SAC, and CKJ). The upper rectangles include used concepts, and the lines show connections between participants and used concepts. Points within the figure represent overlaps of participants’ use of concepts.

![Figure 5](image)

**Figure 5.** Comparison of participants for domain-specific problem (I)

It is easy to see which of the correct model concepts from the expert model are present and which are absent. Basically, the preconceptions are based solely on the radiation model. The absent correct concepts are diffraction, dispersion, light rays, and a constant color spectrum in contrast to the simple concept of colors. These mental model representations contain no elements to explain the color spectrum. Instead, some participants worked with the rainbow figure and tried to find explanations for this.

In addition, QFCA allows content-based comparisons of the single cases with small groups (see Figure 6). Clearly, the participants CKJ and CMA show more knowledge than do participants LSM and CHS. Moreover, this method displays the data in such a way that the content becomes obvious. In a comparison of participants CHS and CMA, there is empirical evidence that they share all five concepts used by CHS. But CMA was able to supplement his preconceptions with adequate concepts such as the intensity of light and refraction and also spent time thinking about the rainbow figure, “observer,” and the colors blue, green, and red.

In summary, QFCA can be a useful tool for making empirically based conclusions about mental model representations for single cases and small groups. It makes the content-based quality of preconceptions and special areas of interest easy to evaluate. With the help of data from more than one measurement point, conceptual changes become better and more accurately observable too.
Figure 6. Four single-case domain-specific problems (I)

Table 4. Structural SMD measures

<table>
<thead>
<tr>
<th>DOMAIN</th>
<th>M</th>
<th>SD</th>
<th>Min</th>
<th>Max</th>
<th>KS-Z</th>
<th>p</th>
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<td>surface structure</td>
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<td></td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>I</td>
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<td>1.00</td>
<td>26.00</td>
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<td>.998</td>
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<td>.692</td>
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Table 5. Semantic SMD measures

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<td>.778</td>
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<td>.693</td>
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<td>18.00</td>
<td>.78</td>
<td>.579</td>
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</tbody>
</table>

Note: DOMAIN: I = rainbow experiment (N = 12), II = crack experiment (N = 10), III = electrical effect experiment (N = 9); IV = disease situation (N = 12); KS-Z = Kolmogorov-Smirnov one-sample test; * p < .05; ** p < .01

Surface, matching, deep (SMD) structure

The automated analysis procedure of SMD generates the above-described quantitative measures. The results for the three physics domains and the biology & religion domain are presented in Tables 4 and 5. As can be seen by the frequencies and the Kolmogorov-Smirnov one-sample tests, we found no interindividual differences among the subjects, except for the measures connectedness and ruggedness in the first physics domain (rainbow experiment), and for the measure cyclic in the biology & religion domain (disease situation).

Table 6. SMD similarity measures (structure) between participant and expert solutions

<table>
<thead>
<tr>
<th>DOMAIN</th>
<th>M</th>
<th>SD</th>
<th>Min</th>
<th>Max</th>
<th>KS-Z</th>
<th>p</th>
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<tbody>
<tr>
<td>surface structure</td>
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<td>.260</td>
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<td>.109</td>
<td>.23</td>
<td>.62</td>
<td>.711</td>
<td>.692</td>
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</table>
In order to locate differences among the four domains, we computed conservative Kruskal-Wallis H-Tests. The frequencies of the surface structure among the domains were significantly different, $\chi^2(3, N = 43) = 11.40, p > .05$. We also found significant differences for the measures structural matching, $\chi^2(3, N = 43) = 14.80, p > .05$, vertex matching, $\chi^2(3, N = 43) = 19.42, p > .001$, and propositional matching, $\chi^2(3, N = 43) = 11.36, p > .01$. However, we found no significant differences for the remaining measures.

Besides the descriptive measures (see Tables 4 and 5), SMD compares the individual representations with an expert representation (see Tables 6 and 7). The comparisons are described with the help of the Tversky similarity ($0$ = no similarity; $1$ = total similarity). Our analysis revealed interindividual differences in the three physics domains for the measure of propositional matching. For all other measures, we found no interindividual differences among our subjects (see Table 6 and 7). Regarding the differences among the subject domains, the Kruskal-Wallis H-Test revealed significant differences among the measures of surface structure, $\chi^2(3, N = 43) = 10.26, p > .05$, structural matching, $\chi^2(3, N = 43) = 20.53, p > .001$, and vertex matching, $\chi^2(3, N = 43) = 19.37, p > .001$.

In addition to the above-reported quantitative measures, SMD enables us to automatically create cutaway and discrepancy re-representations for qualitative analysis. These standardized re-representations could be used for an in-depth analysis of the individual re-representations (see Figure 7). The quite elaborated cutaway re-representation in Figure 9 includes all vertices and edges of the subject. Compared to the reference re-representation (expert solution of the crack experiment question) seven vertices are semantically correct (vertices as circles). However, there are also seven vertices that are incorrect compared to the expert solution. Additionally, the cutaway re-representation reveals that the students understanding of the phenomenon in question is not fully connected (two submodels). Furthermore, the upper submodel re-representation includes three circles. However, the submodel includes incorrect concepts (e.g., *farben-rot-regenbogen*).
Pedagogical implications

The primary purpose of this initial study was to compare the methodological range of QFCA and SMD. However, we briefly discuss the results from an educational point of view. Results from both analysis approaches show that the structural and semantic measures highlight important changes of the assessed knowledge representations. The structural measures of QFCA (e.g., count of concepts) and SMD (e.g., surface structure) show remarkable differences among the four subject domains. For the electrical effect experiment, we found significantly fewer concepts in the subjects’ representations. The semantic measures (QFCA: correct model concepts; SMD: vertex matching, deep structure) show that learners are farther away from using correct concepts than are experts. Hence, the subjects of this initial study are still in their initial stage of the learning process. Instructional intervention would focus on missing concepts or misconceptions found in the individual re-representation (see Figure 7) and/or structural characteristics (e.g., many submodels).

Comparison of QFCA and SMD analysis approaches

Using the same set of data, we were able to conduct an in-depth investigation of both analysis approaches. Minor differences in the results are caused by the transformation of the participants’ data into a raw data file. Hence, further studies should also focus on various assessment techniques and available interfaces to analysis approaches to identify their strength and weaknesses. Although both analysis methods work quite well and produce a lot of indicators, there are several difficulties and differences to report.

The first point concerns the placement (classification) of the indicators in relation to the mental model results. This is essential not only to compare the empirical results of different indicators but also to compare results of different studies. A precondition for this point is to find arithmetic similarities among the analysis indicators (see Table 8). Although the quantitative measures should be equal, the values differ. After intensive checking we found that the export function of the assessment technique was not accurately exporting the raw data. Therefore, the quantitative measures differ minimally. The QFCA method used the assessed data directly; the SMD used the imprecise exported data.
Second, the scientific quality criteria of objectivity, reliability, and validity should be checked and reported. The analysis step of qualitative restructuring of data in QFCA to find generic concepts and propositions is not wholly objective and is characterized by degrees of freedom.

A third point is concerned with the areas of application for research and practice. These areas are limited in QFCA and almost unlimited in SMD. This great advantage of SMD is bought at the price of limitations in precision and in the pedagogical information value of the highly aggregated criteria. Due to its automated analysis, SMD is especially at an advantage for applications in pedagogical practice, where results are needed as quickly as possible. The QFCA results were analyzed with the help of coders, which was time consuming.

**Conclusion and future developments**

We have not answered essential questions of a reliable and valid diagnosis of mental models completely (see Ifenthaler, 2008). This article focuses on the quality of two analysis approaches, a matter in which there is a major lack of systematic research and in which one seldom finds scientific criteria like objectivity, reliability, and validity (see Johnson et al., 2006). There is a lack of stochastic modelling concerning the analysis methods of the mental models approach, especially for content-based data.

| Table 8. Comparison of indicators, scientific quality, and exploratory power of both analysis approaches |
|-----------------------------------|-----------|-----------------|---------------------------------|
|                                   | QFCA      | SMD             |
| Quantitative measures            |           |                 |
| • count of concepts & propositions | structural measures |
| • ruggedness                     | semantic measures |
| • structural measures            | various graph theory measures (e.g., ruggedness, cyclic) |
| Qualitative measures             |           |                 |
| • relative objective plausibility | standardized re-representations |
| • absolute objective plausibility | cutaway and discrepancy re-representations |
| • correct model concepts         |           |                 |
| Objectivity                      |           |                 |
| • semi-automated analysis        | automated analysis of predefined raw data structure |
| • raw-data-based algorithms      |           |                 |
| Reliability                      | partly tested (see Al-Diban, 2002) | tested (see Ifenthaler, 2010) |
| Validity                         | not tested | tested (see Ifenthaler, 2010) |
| Areas of application             |           |                 |
| • limited comparisons            | unlimited comparisons |
| • single-case analysis           | single-case analysis |
| • small-group analysis           | large-group analysis |
| • stochastic analysis            | stochastic analysis |
| Advantages and limitations       |           |                 |
| • semi-automated analysis        | automated analysis |
| • structural decomposition into five formal categories | structural decomposition into three key categories |
| • recomposition into three content-based criteria | recomposition into “re-representations” |

Future research with bigger samples should focus on (a) the comparison of available assessment and analysis approaches, and (b) on the observation of processes of learning-dependent change (see Ifenthaler et al., 2011). In this way, different types of subjective mental models could be identified and classified. When more is known about the modes by which mental model representations change, it will become possible to increase the individual specificity and efficiency of instructional designs (see Ifenthaler, 2008). Both described analysis approaches, QFCA and SMD, are applicable to different knowledge domains. Disadvantages of QFCA might be its capacity for no more than about small groups, or its inability to analyze complex knowledge-representation contents. Hence, the approach is labor intensive and there is a need for further service interfaces. In contrast, SMD proved to be highly economical due to its automated process. The integration of the SMD analysis features into a new web-based research platform, HIMATT (highly integrated model assessment technology and tools) with graphical and text-based assessment and analysis techniques is a consequent and forward-looking approach (see Pirnay-Dummer, Ifenthaler, & Spector, 2008).
2010). A further development of HIMATT could also include the QFCA approach. These future developments will open up new opportunities for continuing research on mental models and lead to new instructional implications.

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Ifenthaler, D., Masduki, I., & Seel, N. M. (2011). The mystery of cognitive structure and how we can detect it. Tracking the development of cognitive structures over time. *Instructional Science, 39*(1), 41–61.


Facilitating Learning from Animated Instruction: Effectiveness of Questions and Feedback as Attention-directing Strategies

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ABSTRACT
The purpose of this study was to investigate the relative effectiveness of different types of visuals (static and animated) and instructional strategies (no strategy, questions, and questions plus feedback) used to complement visualized materials on students’ learning of different educational objectives in a computer-based instructional (CBI) environment. Five hundred eighty-two \(N = 582\) undergraduate students enrolled in an eastern university in the United States participated in the study. Students were randomly assigned to treatments and after interacting with their respective treatments, they received four individual criterion posttests to measure achievement of different educational objectives. Data analysis consisted of two phases. The first analyzed data that included all items in the four criterion posttests (80 items) plus a composite score. The second phase analyzed only the 34 enhanced items complemented by different instructional strategies and animation. Results indicated that students who received the animated visual treatment scored significantly higher on all criterion posttests than those who received the static visual treatment consistently for both phases of analysis. For the instructional strategy, students who received questions plus feedback or questions in their treatment scored significantly higher than those who received no strategy on selective criterion measures.

Keywords
Visualization, Animation, Questions, Feedback

Introduction
Recent technological advances have made possible individualized learning opportunities that integrate multiple ways of combining such media devices as audio, varied types of visuals, graphics, and sounds. There has been a long history of using visualization to complement textual material (Feaver, 1977; Slythe, 1970; Anglin, Vaez, & Cunningham, 2004). Research findings have generally supported the proposition that human beings remember pictures better than words (Anglin et al., 2004). Human memory is composed of two interdependent types of memory mode to process and store information — the verbal and nonverbal modes. Paivio (1990) has indicated that the dual coding of pictures both in its verbal and nonverbal forms is more likely to occur than words, which are more likely to be encoded verbally only. This hypothesis is presented to explain the superior effect of pictures to words when used in instruction.

Animation has been used in various disciplines to deliver instructional material that is hard to present alone using static visuals or that contains content that is highly abstract or invisible to human eyes. Animation, presented as pictures in motion, is analogous to a subset of visual graphics (Weiss, Knowlton, & Morrison, 2002). In a computer-based instructional (CBI) environment, animation is typically used due to its inherent characteristics that facilitate the instructional and learning processes. Animation also has the potential to provide feedback in various forms that may be both entertaining and motivating to learners striving for the correct response.

Different types of questions or questioning strategies can be used to engage learners in deeper cognitive information processing and therefore enhance their learning. King (1992) indicated that having students ask and answer high-level questions facilitates their comprehension of the text material by engaging them in tasks such as “... focusing attention, organizing the new material, and integrating the new information with existing knowledge” (p. 304).

The importance of feedback in the learning process has long been recognized, and feedback has been a variable of interest in educational research. During a learning process, feedback generally plays a role as a motivator or incentive to encourage accurate performance or as an information confirmer that learners can use to judge the correctness of a previous response. In terms of its purpose, feedback has both reinforcing and informational attributes. It is believed that letting learners know how well they are performing a task and that giving them the opportunity to monitor or assess their learning progress can result in a better learning effect (Kulhavy & Wager, 1993).
Dynamic visualized materials created in an interactive learning environment always depend on “learners’ actions” and “. . . active learner engaged processing of learning materials . . .” (Kalyga, 2007, p. 387). Cognitive load theory (CLT) originated in the 1980s, heavily relies upon theories drawn from cognitive architecture and the memory system of human beings. It provides instructional designers with theory-based guidelines for designing instructional materials. Researchers conducting studies on effectiveness of animation or simulation-based instruction recognized and discussed their findings mostly from a cognitive load perspective, especially when the cognitive load was associated with the level of interactivity of learners engaged in the learning process (Paas, Van Gerven, & Wouters, 2007; de Koning, Tabbers, Rikers, & Paas., 2007; Moreno, 2007; Lusk & Atkinson, 2007). These studies have used this framework to establish the conditions and methods for enhancing the effectiveness and efficiency of animated instruction (Kalyga, 2007). Major findings of animated instruction design employing a cognitive load approach included examinations of the learner differences and design principles to optimize the effect of animated instruction. For example, Cohen and Hegarty’s study revealed that accuracy of mental representation of animated visuals greatly depends on learners’ spatial abilities. Students with high-level spatial ability are more likely than their low-level counterparts to interpret animated visuals more correctly and efficiently (Cohen and Hegarty, 2007).

Design principles of animated instruction have also focused on techniques to reduce cognitive load. Techniques that have been discussed in previous studies include the employment of learner control of the pace of instruction rather than a system-paced instruction (Hasler, Kersten, & Sweller, 2007). Research has also suggested that attention cueing in the animation and embedded animated pedagogical agents, designed to direct students’ attention to relevant visual information, also reduced extraneous cognitive load (Ayres & Paas, 2007; de Koning et al., 2007). Guided-discovery principle is another design principle that has been utilized to develop animated instruction (De Jong, 2005; Plass et al., 2009). Questions and feedback embedded in a computer-based animated instruction is one example that follows guided-discovery principle. Moreno (2004) and Moreno and Mayer (2005) indicated that corrective feedback is less effective than explanatory feedback in supporting retention and far transfer. The former simply informed users whether they were right or wrong, and the latter provided relevant explanations (Plass, Homer, & Hayward, 2009).

In this paper, the author draws on cognitive load theories and guided-discovery principle to design both static and animated visualized materials. By inserting questions and feedback into segments of the visualized materials, the study further compared the relative effectiveness of such strategies in enhancing learning from both types of visualized materials.

Statement of the problem

Although there is increasing interest in conducting animated visual research, there has been little work done to precisely specify what educational objectives animated visuals are most effective in facilitating. There is a need to specify the levels of learning outcomes that animated visuals are most effective in improving due to the high cost associated with the development of animated instruction. Furthermore, a series of previous studies has shed light on factors that may have undermined the effectiveness of animation (Owens & Dwyer, 2005; Wilson & Dwyer, 2001; Rieber & Boyce, 1990; Lin, Kidwai, Munyofu, Swain, Ausman, & Dwyer, 2005). Researchers indicated that learners, when presented with animated instruction, were not able to “. . . effectively attend to the animation” or were “. . . distracted by the combination of visual and verbal information presented to them” (Rieber, 1990, p. 81). Owens & Dwyer (2005) also found that learners failed to focus on critical aspects of the animation that depicted important concepts.

Furthermore, unlike studies that employed animated visuals alone to examine their effects with different designs, this study incorporated a comparison group using static visuals. As Ayres and Paas (2007) have argued, the effectiveness of static visuals could be enhanced and therefore might be more effective than animation when additional techniques are used. Based on previous research findings and suggestions, this study employed varied instructional strategies to accompany animated and static visuals instruction to scaffold students. The primary purpose of this study was to investigate the effect of varied types of visuals (static and animated) on students’ learning of different educational objectives in a CBI environment. The study also investigated the relative effectiveness of using varied instructional strategies (questions and feedback) used to complement static and animated visualization on students’ learning.
Methods

Participants

The participants of the study consisted of 582 undergraduate students enrolled in an eastern university in the United States. They were recruited from a number of classes and majored in different disciplines, such as education, engineering, physics, statistics, etc. Among them, 324 participants were female and 258 male. The components of the participants were as follows: 13% freshmen \( n = 77 \); 29% sophomores \( n = 169 \); 35% juniors \( n = 202 \); and 23% seniors \( n = 134 \). Participation was voluntary, and students received course credits for their participation.

Research design

This study employed a posttest only, a 2 x 3 factorial experimental design. The two independent variables were visual type and instructional strategy. The dependent variables were four criterion posttests measuring differences in subjects’ understanding of the materials after being exposed to the learning materials. The first independent variable, that is, visual type, consisted of two levels: static visuals or animated visuals. The second independent variable, that is, instructional strategy, was comprised of three levels: no strategy, questions, and questions plus feedback. Figure 1 describes the research design employed in the study.

![Figure 1. 2 x 3 factorial-posttest-only research design](image)

Computer-based instructional module

The instructional material used in this study, originally presented in print material, was modified into a computer-based format. The instructional module consisted of five units dealing with physiological knowledge of the human heart. Content for each unit was presented in texts supported by either static or animated visuals. Enhancement strategies, that is, questions or questions plus feedback, were integrated within each frame to facilitate learning. The total number of instructional frames for the module was 20.

Pilot study

A pilot study employing the identical criterion measures and material was conducted using participants with similar background as the main study. The purpose of the pilot study was to effectively develop animated visuals that would facilitate the students’ learning and comprehension of the treatment instructional material. Based on the result of the
pilot study, difficult and complex concepts presented in the material were identified by item analyses and were later on complemented by questions and feedback.

**Respective treatment groups**

*Group One: Animation alone.* Participants assigned to this treatment group received instructional material that contained text and animated visuals in selective frames. In total, 14 animation sequences, developed to address 34 difficult items, were embedded in these frames. Students in this treatment group were instructed to first read the text carefully and then interact with the animation. Each animated sequence was developed to complement a portion of the text and to facilitate understanding of complex concepts that were found in the pilot studies to be difficult to comprehend with static visuals only. Figure 2 provides a screenshot of the instructional frame containing an animated visual.

![Figure 2. Instructional frame containing an animation sequence](image)

*Group Two: Animation + questions.* Participants assigned to this treatment group received instructional material that contained text, animated visuals, and questions in selective frames. Students in this treatment group received exactly the same instructional material as did the “animation alone” group; however, 32 questions addressing 34 difficult items were embedded after the 14 frames to reinforce students’ comprehension and acquisition of the difficult knowledge contained in previous frames.

*Group Three: Animation + questions + feedback.* The instructional material used for the treatment group contained the text, animated visuals in 14 frames, questions following these 14 frames, and corresponding feedback. After viewing the animation, students proceeded to a frame that contained a question. Participants needed to make an overt response to each question. In addition, after a response was submitted, feedback on the correctness of the response was displayed as either “incorrect” or “correct.” A short sentence elaborating upon the correct answer was provided as well.

*Group Four: Static visuals alone.* The instructional module received by participants in this treatment group consisted of text and static visuals used to complement the text. In total, there were 20 static visuals in this module, with one static visual accompanying each instructional frame. The 20 visuals matched those in the previously described treatments, with all being static in this treatment. Figure 3 provides a screenshot of the instructional frame that contained an animated visual.

*Group Five: Static visuals + questions.* Participants in this treatment group received exactly the same instructional material as that received by the “static visuals alone” treatment group; however, an additional instructional strategy was embedded in the instructional module. Questions following the same 14 instructional frames as those in the animated visual treatments were provided to students in this group. Students were required to read the question
carefully, recall what they had learned from previous frames, and choose a correct answer. There was no feedback in regard to the correctness of the submitted response.

Group Six: Static visuals + questions + feedback. The instructional module received by this treatment group was exactly the same as that received by the “static visuals + questions” group; however, the students received feedback on their responses immediately after submission. The feedback, presented in the same format and with the same amount of information as the “animated visuals + questions + feedback” treatment group, first assessed the students’ submitted responses as either correct or incorrect, then provided a simple elaboration of the correct response.

Criterion measures

Four criterion measures developed by Dwyer (1972) were used to assess students’ understanding and achievement of the instructional material. These four criterion tests measured different learning outcomes in educational technology area, such as facts, concepts, rules/procedures, comprehension, and problem solving. Each criterion test consisted of 20 items. All but the drawing test, terminology, and comprehension tests consisted of 20 multiple-choice questions. Cronbach’s alpha coefficients (α) were calculated to establish the reliability and internal consistency of the dependent variables in this study. A detailed description of the criterion measures is summarized below.

Drawing Test (α = .98). The purpose of the drawing test was to measure students’ overall understanding of the instructional material as well as their ability to “...reproduce the parts of the heart in their appropriate context...” (Dwyer, 1994, p. 391). This criterion test was developed to assess specifically the level of intellectual skills/concept learning regarding the instructional module according to the types of learning outcomes developed by Gagne (1985). Each student was provided with a blank piece of paper on which they were required to draw a simple diagram of the human heart.

Identification Test (α = .87). The purpose of the identification test was to assess the students’ ability to identify parts of the human heart. The level of knowledge measured in this test was verbal information based on Gagne’s types of learning outcomes (1985). In this test, a diagram of the human heart with 20 numbered arrows was provided to students, who had to then choose the corresponding letter to the numbered arrow from four possible answer choices.

Terminology Test (α = .84). The terminology test measured several levels of learning including verbal information, concepts, and rules/procedures. The students’ knowledge of specific terms of the human heart and their association with various functions of the human heart were assessed.
Comprehension Test ($\alpha = .84$). The test measured a higher-level learning outcome; the mastery of this learning outcome would require the students’ competent acquisition of knowledge concerning facts, rule/procedures, concepts, and problem solving pertaining to the instruction.

Total Composite Score ($\alpha = .96$). Two composite scores were calculated. One composite score was calculated by adding the separate scores of all items on the drawing, identification, terminology, and comprehension tests. Another total composite score was calculated by adding the separate score of enhanced items only on the drawing, terminology, and comprehension tests.

Data analysis

Two phases of analyses were conducted in the study to answer the research questions. The data analysis in the first phase investigated the effectiveness of respective treatments by comparing the participants’ achievement scores on all 80 items contained in the four criterion posttests and a composite score based on these 80 items. The second phase of analysis focused on the 34 enhanced items, nine (9) items in the drawing test, none (0) in the identification test, twelve (12) in the terminology test, thirteen (13) in the comprehension test was identified in the pilot study as difficult. The latter analysis aimed to assess students’ achievement in those portions of the instructional module in which animated visuals, questions, and feedback were included.

Analysis based on 80 enhanced items

The drawing test (number of items = 20). ANOVA source data indicated that the interaction between the visual type and instructional strategy was not statistically significant: $F = .352$, $df = 2/576$, $p = .704$. The main effect of the visual type was significant, $F = 25.452$, $df = 1/576$, $p = .000$. Participants receiving the animated visual treatment ($M = 11.66$; $SD = 5.80$) scored significantly higher in the drawing test than did participants receiving the static visual treatment ($M = 10.22$; $SD = 5.89$). However, the main effect of the instructional strategy was not significant, $F = .991$, $df = 2/576$, $p = .372$.

The identification test (number of items = 20). ANOVA conducted on the identification test indicated that the interaction between the visual type and instructional strategy was not statistically significant: $F = .655$, $df = 2/576$, $p = .520$. The main effect of the visual type was significant, $F = 20.716$, $df = 1/576$, $p = .000$. However, the main effect of instructional strategy was not significant, $F = .154$, $df = 2/576$, $p = .857$. Participants receiving the animated visual treatment ($M = 14.51$; $SD = 4.71$) scored significantly higher in the identification test than did participants receiving the static visual treatment ($M = 12.70$; $SD = 4.85$).

The Terminology Test (number of items = 20). The interaction between the visual type and instructional strategy was not statistically significant: $F = 2.026$, $df = 2/576$, $p = .133$. However, the main effects for both the visual type and the instructional strategy were significant, for the visual type, $F = 4.706$, $df = 1/576$, $p = .030$, and for the instructional strategy, $F = 5.969$, $df = 2/576$, $p = .003$. An inspection of the means for the static visual and the animated visual treatment groups indicated that animated visual ($M = 12.09$; $SD = 4.80$) significantly outperformed static visuals ($M = 11.25$; $SD = 4.66$). For the main effect of the instructional strategy, post hoc tests indicated that the “questions + feedback” treatment ($M = 12.30$, $SD = 4.88$) significantly outperformed the “no strategy” treatment ($M = 10.74$, $SD = 4.49$), and the difference is significant at the .003 level. In addition, the “questions” treatment ($M = 11.97$; $SD = 4.74$) also significantly outperformed the “no strategy” treatment ($M = 10.74$; $SD = 4.49$), and the difference was significant at the .026 level. The observed differences between the “questions + feedback” and the “questions” treatments were not significant at the .05 level.

The Comprehension Test (number of items = 20). The interaction between the visual type and the instructional strategy was not statistically significant: $F = 1.685$, $df = 2/576$, $p = .186$. However, the main effects for both the visual type and the instructional strategy were significant, for visual type, $F(1,576) = 8.789$; $p = .003$, and for the instructional strategy, $F = 4.154$, $df = 2/576$, $p = .016$. An inspection of the means for the static visual and the animated visual treatment groups indicated that animated visual ($M = 11.63$; $SD = 4.64$) significantly outperformed static visuals ($M = 10.47$; $SD = 4.81$). For the main effect of the instructional strategy, post hoc tests indicated that the “questions + feedback” treatment ($M = 11.66$; $SD = 4.64$) significantly outperformed the “no strategy” treatment.
The composite score (number of items = 80). The interaction between the visual type and the instructional strategy was not statistically significant: $F = 1.063, df = 2/576, p = .346$. However, the main effect for the visual type was significant, $F = 17.235, df = 1/576, p = .000$. The main effect for the instructional strategy was not significant, $F = 1.388, df = 2/576, p = .250$. An inspection of the means for the static visual and the animated visual treatment groups indicated that animated visual ($M = 50.89; SD = 18.33$) significantly outperformed static visuals ($M = 44.64; SD = 18.03$).

Summary of results

Table 1 presents a summary of results for the data analysis of the learning achievement of all items based on visual type. As indicated, differences on all criterion tests between static and animated visuals were significantly in favor of animated visuals.

<table>
<thead>
<tr>
<th>Measures</th>
<th>Static (S)</th>
<th>Animated (A)</th>
<th>Result</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drawing</td>
<td>10.22(5.89)</td>
<td>12.66(5.80)</td>
<td>A &gt; S</td>
<td>.000***</td>
</tr>
<tr>
<td>Identification</td>
<td>12.70(4.85)</td>
<td>14.51(4.71)</td>
<td>A &gt; S</td>
<td>.000***</td>
</tr>
<tr>
<td>Terminology</td>
<td>11.25(4.66)</td>
<td>12.09(4.80)</td>
<td>A &gt; S</td>
<td>.030*</td>
</tr>
<tr>
<td>Comprehension</td>
<td>10.47(4.81)</td>
<td>11.63(4.64)</td>
<td>A &gt; S</td>
<td>.003**</td>
</tr>
<tr>
<td>Composite</td>
<td>44.64(18.03)</td>
<td>50.89(18.33)</td>
<td>A &gt; S</td>
<td>.000***</td>
</tr>
</tbody>
</table>

* Mean score. a Value in the parentheses is the standard deviation.
* $p < .05$. ** $p < .01$. *** $p < .001$.

Table 2 summarizes the results of the first phase analysis based on instructional strategies. As indicated, both “questions” and “questions + feedback” were significantly more effective than “no strategy” in the terminology test, and “questions + feedback” was significantly more effective than “no strategy” in the comprehension test.

<table>
<thead>
<tr>
<th>Measures</th>
<th>NO*</th>
<th>QS</th>
<th>QF</th>
<th>Result</th>
<th>Sig.</th>
</tr>
</thead>
</table>
| Drawing        | 11.56(5.91) | 10.97(6.06)| 11.78(5.93)| ns
d | .372  |
| Identification | 13.72(4.78) | 13.46(4.97)| 13.64(4.85)| ns    | .857  |
| Terminology    | 10.74(4.49) | 11.97(4.74)| 12.30(4.88)| QF > NO | .003**|
|                |      |       |      | QS > NO | .026* |
| Comprehension  | 10.30(4.72) | 11.18(4.84)| 11.66(4.64)| QF > NO | .005**|
| Composite      | 46.33(17.97)| 47.59(18.79)| 49.39(18.48)| ns    | .250  |

* NO = No Strategy. QS = Questions. QF = Questions + Feedback.
* Mean score. a Value in the parentheses is the standard deviation.
* $p > .05$ * $p < .01$. ** $p < .01$.

Analysis based on 34 enhanced items

The second phase of the data analysis was focused on the items for which the instructional strategy and animation were particularly designed to improve achievement. As with the first phase of data analysis, a two-way ANOVA was conducted to compare the mean scores of the enhanced items in each dependent variable among the treatment groups.

The drawing test (number of items = 9). ANOVA results indicated that the interaction between the visual type and the instructional strategy was not statistically significant: $F(2/576) = .042, p = .959$. However, the main effect of the visual type was significant, $F = 38.328, df = 1/576, p = .000$. The main effect of the instructional strategy was not
significant, \( F = 1.147, df = 2/576, p = .318 \). Participants receiving the animated visual treatment (\( M = 5.10; SD = 3.04 \)) scored significantly higher on the enhanced items in the drawing test than did the participants receiving the static visual treatment (\( M = 3.57; SD = 2.92 \)).

The terminology test (number of items = 12). The interaction between the visual type and the instructional strategy was not statistically significant: \( F = 1.392, df = 2/576, p = .249 \). However, the main effects for both the visual type and the instructional strategy were significant: for the visual type, \( F = 4.140, df = 1/576, p = .042 \), and for the instructional strategy, \( F = 7.603, df = 2/576, p = .001 \). An inspection of the means for the static visual and animated visual treatment groups indicated that the animated visual (\( M = 6.67; SD = 3.13 \)) significantly outperformed the static visuals (\( M = 6.16; SD = 3.05 \)). For the main effect of the instructional strategy, post hoc tests indicated that the “questions + feedback” treatment (\( M = 6.87; SD = 3.26 \)) significantly outperformed the “no strategy” treatment (\( M = 5.73; SD = 2.84 \)), and the difference was significant at the .001 level. In addition, the “questions” treatment (\( M = 6.64; SD = 3.08 \)) also significantly outperformed the “no strategy” treatment (\( M = 5.73; SD = 2.84 \)), and the difference was significant at the .01 level.

The comprehension test (number of items = 13). The interaction between the visual type and the instructional strategy was not statistically significant: \( F = .863, df = 2/576, p = .423 \). However, the main effect for both the visual type and the instructional strategy was significant: for the visual type, \( F = 6.215, df = 1/576, p = .013 \); and for the instructional strategy, \( F = 3.397, df = 2/576, p = .034 \). An inspection of the means for the static visual and the animated visual treatment groups indicated that the animated visual (\( M = 6.87; SD = 2.81 \)) significantly outperformed the static visuals (\( M = 6.29; SD = 2.87 \)). For the main effect of the instructional strategy, post hoc tests indicated that the “questions + feedback” treatment (\( M = 6.91; SD = 2.80 \)) significantly outperformed the “no strategy” treatment (\( M = 6.18; SD = 2.84 \)), and the difference was significant at the .02 level.

The composite score (number of items = 34). The interaction between the visual type and the instructional strategy was not statistically significant: \( F = .863, df = 2/576, p = .423 \). However, the main effects for both the visual type and the instructional strategy were significant: for the visual type, \( F = 6.189, df = 1/576, p = .000 \); and for the instructional strategy, \( F = 3.569, df = 2/576, p = .029 \). An inspection of the means for the static visual and the animated visual treatment groups indicated that the animated visual (\( M = 18.64; SD = 7.88 \)) significantly outperformed the static visuals (\( M = 16.01; SD = 7.64 \)). For the main effect of the instructional strategy, post hoc tests indicated that the “questions + feedback” treatment (\( M = 18.34; SD = 7.91 \)) significantly outperformed the “no strategy” treatment (\( M = 16.25; SD = 7.61 \)), and the difference was statistically significant at the .021 level.

Summary of results

Table 3 presents a summary of results for the data analysis of the learning achievement of enhanced items based on visual type. As indicated, the differences on all criterion tests between the static and animated visuals were significantly in favor of the animated visuals.

<table>
<thead>
<tr>
<th>Measures(^a)</th>
<th>Static (S)</th>
<th>Animated (A)</th>
<th>Result</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drawing</td>
<td>3.57(2.92)</td>
<td>5.10(3.04)</td>
<td>A &gt; S</td>
<td>.000**</td>
</tr>
<tr>
<td>Terminology</td>
<td>6.16(3.05)</td>
<td>6.67(3.13)</td>
<td>A &gt; S</td>
<td>.042*</td>
</tr>
<tr>
<td>Comprehension</td>
<td>6.29(2.87)</td>
<td>6.87(2.81)</td>
<td>A &gt; S</td>
<td>.013*</td>
</tr>
<tr>
<td>Composite</td>
<td>16.01(7.64)</td>
<td>18.64(7.88)</td>
<td>A &gt; S</td>
<td>.000***</td>
</tr>
</tbody>
</table>

\(^a\) Maximum score for the drawing test, 9; terminology test, 12; comprehension test, 13; composite score, 34. \(^b\) Mean score. \(^c\) Value in parentheses is the standard deviation. \(p < .05. \quad **p < .01. \quad ***p < .001.\)

With regard to learning achievement on the enhanced items, based on the instructional strategy, Table 4 indicates that “questions + feedback” was a significantly more effective instructional strategy than “no strategy” in facilitating achievement in the terminology, the comprehension test, and the composite test.
Table 4. Results of enhanced items based on instructional strategy

<table>
<thead>
<tr>
<th>Measures</th>
<th>NO*</th>
<th>QS</th>
<th>QF</th>
<th>Result</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drawing</td>
<td>4.35 (3.15)</td>
<td>4.10 (3.05)</td>
<td>4.56 (3.03)</td>
<td>ns&lt;sup&gt;e&lt;/sup&gt;</td>
<td>.318</td>
</tr>
<tr>
<td>Terminology</td>
<td>5.73 (2.84)</td>
<td>6.64 (3.08)</td>
<td>6.87 (3.26)</td>
<td>QF &gt; NO</td>
<td>.001**</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>QS &gt; NO</td>
<td>.010*</td>
</tr>
<tr>
<td>Comprehension</td>
<td>6.18 (2.84)</td>
<td>6.66 (2.88)</td>
<td>6.91 (2.80)</td>
<td>QF &gt; NO</td>
<td>.028*</td>
</tr>
<tr>
<td>Composite</td>
<td>16.25 (7.61)</td>
<td>17.39 (7.97)</td>
<td>18.34 (7.91)</td>
<td>QF &gt; NO</td>
<td>.021*</td>
</tr>
</tbody>
</table>

<sup>a</sup> NO = No Strategy. QS = Questions. QF = Questions + Feedback.
<sup>b</sup> Mean score. <sup>c</sup> Value in the parentheses is the standard deviation.
<sup>d</sup> The maximum score for the drawing test, 9; terminology test, 12; comprehension test, 13; composite score, 34.
<sup>e</sup> *p*>=.05 * *p*<.05. ** *p*<.01.

Discussions

General findings

The major interest of this study concerned whether the provision of question and feedback would optimize students’ learning in visualized instruction. The results of the study, however, indicate that questions with or without feedback were equally effective in students’ learning from visualized instruction. This finding may suggest that the use of feedback as simple as the one used in the study was not an effective instructional technique for increasing student achievement of different types of learning objectives when accompanying visualized instruction.

Related work

Previous research has shown that embedded questions designed to focus student attention effectively reinforced relevant learning cues. By responding to the embedded questions inserted before or after the text, students may activate their prior knowledge, engage in deeper information processing, and therefore enhance their recall and retention of the instructional material (Anderson & Pearson, 1984). The type of questions and feedback employed in this study to enhance learning from visualized instruction are easy to construct in a CBI environment and, consequently, the instructional effect that can be expected is minimal. Other types of questions and more elaborate feedback may be used to produce more desirable learning effects. As Anderson and Biddle (1975) have indicated, “... higher order questions consistently increased both recall and application of information ...” (p. 122). In this study, the provision of feedback to responses that students made to inserted questions seems not to have produced a satisfactory instructional effect, which can be seen from both phases of the data analysis, which consistently showed that the “questions + feedback” group did not significantly outperform the “questions” group in any posttests. This finding was consistent with previous studies that found the no-feedback condition to be equally effective as providing feedback of some type (Clariana, Ross, & Morrison, 1991; Clark & Dwyer, 1998; Pridemore & Klein, 1995; Kulhavy & Stock, 1989).

However, the finding also contradicted previous research that supported that providing some kind of feedback is superior to no feedback at all (De Klerk & De Klerk, 1978). As suggested from research on feedback, many factors contributed to the effectiveness of feedback. The type of feedback investigated in this study was analogous to the combination of KCR and KOR. Learners were informed as to the correctness of their submitted responses as well as a statement of the correct response. This kind of feedback is simple in nature and easy to construct in a CBI environment. It is also associated with low cost in terms of instructional design and development. However, the study found out that this type of feedback did not help students in the acquisition of even the simplest factual knowledge, as reflected in their performance of the drawing and identification tests, which measured lower-level learning outcomes. Other types of feedback, which are more dedicated and complex in nature and developed to accompany visualization instruction to maximize students’ learning, may be more effective.

In regard to the effects of visual types, the findings of the study suggested the superior effectiveness of animated visuals compared to static visuals. Students receiving the animated instructional treatment outperformed significantly on all criterion posttests across both phases of the analysis than did students who received static visuals. The findings were encouraging and consistent with previous studies that found significantly superior effects with animation than...
with static visuals (Kaiser, Proffitt, & Anderson, 1985; Rieber, 1989; Rieber, Boyce, & Assad, 1990). Indeed, no other studies conducted positioned treatments via item analysis. Animation, at its core nature, has attention-gaining and entertaining features, which is believed to motivate student learning. Rieber (1990, 1991) indicated that the most powerful and effective application of animation is in presenting instructional materials rather than focusing learners’ attention or for its cosmetic function. The animation used in the study complemented textual material. The findings of this study also contradicted previous studies that suggested that animation was no more effective than static visuals (Caraballo, 1985; King, 1975; Moore, Nawrocki, & Simutis, 1979).

Conclusion

Mirzoeff (1998), as cited by Jeffers (2002), indicated that visual culture resides in everyday life and that to explore visual culture, we need to understand how visuals have shaped our society, including how we visualize things and how we learn visually. Anderson and McRorie (1997) further indicated that visual culture is determined by the context in which visuals were made and used (Jeffers, 2002). Visuals have been well recognized in terms of their function in facilitating knowledge construction and in shaping, reflecting, and representing our society. People in post-modern society learn visually and most of the time, need to learn to “visualize” things that are not visual-based, since visuals have occupied almost every aspect of our society and everyday life (Jeffers, 2002, p.157). Visuals have dominated most instructional materials that we use and, therefore, instructional designers need to understand general instructional principles that apply to all graphic materials. Rieber (2000) has suggested conditions that need to be taken into consideration when designing graphics or visuals based instructional materials. First, the purposes that graphics serve and the specific type of instructional objective each graphic is designed to achieve must be determined prior to the design process and evaluated throughout the process. Second, the selection of the types of graphics depends on the needs and the types of learner, the content to be delivered, and the characteristics of the learning task. Thirdly, graphics should be designed to present a meaning context through which students can achieve the predetermined learning objectives as well as feel highly motivated in the learning process. One important design principle that Rieber (2000) pointed out that is especially relevant to this study is “. . . the important relationship between attention-gaining and presentation principles associated with graphics . . .” (p. 222). As was revealed in previous studies, students might not attend to relevant parts of a graphic presentation due to selective attention. Therefore, “. . . direct and overt directions to actively search for or use specific information in the visual . . .” should be provided to increase the chance that students would pay attention to a graphic. Such strategies also reduce extraneous cognitive load resulting from irrelevant search and free working memory space for more intrinsic learning.

Computers can be a powerful medium to design graphics for “. . . attention-gaining and presentation purposes . . .” (Rieber, 2000, p. 224). However, much of the strengths of the computer in achieving above purposes have not been explored. This study explored the effect of computer-based questions and feedback in complementing visuals (both static and animated) to examine the relative effects. The significance of the study is two-fold. First, the results provide instructional designers with empirical evidence that supports the use of varied types of visuals in a computer-based learning environment specifically to achieve designated instructional objectives. Second, although this study did not intend to explore the effects of different types of feedback in learning, it examined a basic issue — the provision (or not) of feedback, specifically in a computer-based learning environment that used varied visuals. That is, this study examined the notion that providing feedback to the responses would enhance learning from the visualized instruction, especially with regard to animated visualized instruction.

The results of this study were affected by a particular system in which the author tested the hypothesis that questions or questions plus feedback can be used to optimize learning from visualized instruction, in particular, animated instruction. The learning outcomes of visualized materials integrated with questions or feedback are not superior to those of visualized materials not integrated with questions or feedback. One plausible explanation might be that simple textual feedback on the correctness of a submitted response was not effective in conveying information for visualized materials. Another possible explanation might be that well-designed visualized materials, such as those in this study, are self-contained and therefore no additional aids were necessary in conveying meanings.

Furthermore, this study found no effect of questions and feedback in facilitating student learning specifically from animated visualization. Future research may investigate other types of cueing strategies such as advance organizers, narrations, audios, or chunking. In addition, new and emerging technology has been becoming increasingly available
to offer more advanced types of instructional strategies that involve sounds, digital images, audio, and more. Feedback certainly can be constructed combining these new advanced technology features. Future research on the relative effectiveness of these multisensory instructional strategies is warranted.

References


Integrating Annotations into a Dual-slide PowerPoint Presentation for Classroom Learning

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ABSTRACT
This study introduces a learning environment integrating annotations with a dual-slide PowerPoint presentation for classroom learning. Annotation means a kind of additional information to emphasize the explanations for the learning objects. The use of annotations is to support the cognitive process for PowerPoint presentation in a classroom. The construction of the learning environment is based on cognitive theory of multimedia learning so as to figure out the impact of using annotation in classroom learning. PowerPoint materials and their corresponding multimedia annotations can be simultaneously displayed in the environment. While teaching the current PowerPoint slide, it is displayed through one channel (or projector) and the related annotation or its previous slide is exhibited through the other channel (or the other projector). This manner can scaffold learners' coherent mental representations so as to enhance their learning performance. In this study, an exploratory method was conducted with 170 sophomore and junior students ranging in age between 18 and 21 years. Survey results indicated that the proposed system based on cognitive theory can effectively help students in the experimental group to have better learning efficacy for lectures with dual-slide PowerPoint presentation than that of the conventional group.

Keywords
Annotation, Cognitive load, Multimedia instruction, PowerPoint

Introduction

The use of computers in today's multimedia-based instruction is being widely applied in the blended learning environment to improve learning (Liao, 2007; Mayer, 2001). The multimedia learning environment uses several types of representation including text, audio, graphs, photographs, animation, or video. The multimedia teaching content is readily and effectively communicated between teachers and learners using popular presentation devices such as monitors or projectors (Bartsch & Cobern, 2003; Russell, 1998). In recent years, many researchers have focused on constructing multimedia instructional environments such as electronic classrooms (Leidner & Jarvenpaa, 1993), virtual classrooms (Hiltz & Wellman, 1997), and interactive multimedia environments (Armstrong & Curran, 2006). The projector is a common component of these multimedia instructional environments. It is easy for teachers to use projectors to present the visual information of their lectures. This method, of simply projecting a lecture onto a screen in front of a classroom has shown to provide excellent results. Multimedia teaching contents can be easily made using Microsoft PowerPoint, and has a high potential for reinforcing students' learning (Apperson, Laws, & Scepansky, 2008). As a result, the way teachers utilize projectors to display their PowerPoint created lectures on a screen has become an essential component of the multimedia instrumental environment of today's learning classroom (Susskind, 2008; Szabo & Hasting, 2000).

In the past decade, giving a lecture using PowerPoint has become a more convenient presentation method than writing on a whiteboard or using transparencies and an overhead projector (Savoy, Proctor, & Salvendy, 2009; Susskind, 2005). The convenience lies in the fact that teachers now spend less time in writing, changing transparencies, or maintaining lecture contents. A PowerPoint presentation makes a lecture flow easier and smoother, and provides structure to the presentation (Pippert & Moore, 1999). In other words, teachers that employ PowerPoint produce their lectures slides in the appropriate sequence and pace. In addition, PowerPoint makes it easy to present clear summaries (Lowry, 1999; Susskind, 2005). The use of PowerPoint in a lecture has shown that it can improve the note-taking ability of students while they study the teaching materials (Frey & Birnbaum, 2002). In addition, PowerPoint presentations can be effective for students’ self-efficacy and attitude towards learning (Susskind, 2008).

Although PowerPoint lectures can emphasize the key points of the teaching material, many studies demonstrate that there is no increase in the learning performance of students for using PowerPoint lectures (Apperson, Laws, &
Scepansky, 2006; Bartsch & Cobern, 2003; Susskind, 2005; Tufte, 2006). Generally, teachers should decide what the message is they want to communicate. The message should be kept simple on the screen, and each slide should have no more than 6 lines of texts or one-to-two pictures (Dodds, 2004). On the other hand, some researchers are of the opinion that students may have difficulty understanding every slide if they only contain some simple content and some key information. Some studies concluded that PowerPoint presentations do not promote the learning performance of students (Frey & Birnbaum, 2002; Susskind, 2005; Szabo & Hastings, 2000). This seems to be due to the fact that the teacher presents the teaching materials without applying the spatial or temporal contiguity principles of multimedia learning (Reed, 2006). More specifically, students often fail to understand the contents conveyed by the lecture because they have difficulties reconstructing their referential links between the visual and verbal information, thereby degrading the relevance and coherence of the mental model (Erhel & Jamet, 2006).

When a teacher presents a PowerPoint slide that includes several related learning objects, it can cause two problems: information load and presentation holding (Mayer & Moreno, 2003). An information load problem is where a PowerPoint slide contains too many learning objects. In order to overcome this problem, learning objects are distributed over two or more slides. This in turn creates a presentation holding problem where the slide presentation does not follow spatial and temporal cognitive principles. For example, a textual description is presented in the present slide and its corresponding explanations (annotations) are presented in the next slide. Therefore, students must hold the information represented by the textual description in their working memory while reading the corresponding explanations. If they don’t, their referential links between the textual description and the explanations will decrease, thereby degrading their learning performance. Consequently, either one of these problems reduce the students’ abilities to solve problems, think, and reason (Allen, 2000; Mayer & Moreno, 2003).

Moreno’s study (2004) showed that simply presenting information does not promote a student’s understanding of a particular knowledge in a certain context. Thus, there is a need to integrate annotations into a PowerPoint presentation. Annotations refer to the additional data, information or knowledge in the form of explanations for a specific part of the content (Verhaart & Kinshuk, 2006). Previous research reported that in general the use of annotations is helpful to improve learning (Jones & Plass, 2002; Wallen, Plass, & Brünken, 2005; Yeh & Lo, 2009). However, other reports found that supplemental information may increase a learner’s information load, thereby reducing his/her learning performance (Plass, Chun, Mayer, & Leutner, 2003). The above mentioned studies focused mainly on the web-based learning environment, and only a few of them focused on how to integrate annotations in a PowerPoint presentation for the physical classroom. Therefore, this study focused on two issues. First, how can a learning environment using a PowerPoint presentation accompanied by annotations be constructed so as to help students to comprehend their learning material? Second, what are the perceptions of students that find themselves in the PowerPoint accompanied by Annotations Presentation (PPAP) learning environment?

The construction of the PPAP learning environment, based on cognitive theory of multimedia instruction, was applied to present the contents of the courses, “Introduction to the Art”, “Calculus”, and “Management Mathematics”. Furthermore, an exploratory study was conducted with 170 sophomore and junior students ranging in age between 18 and 21 years to figure out the impact of annotation in the classrooms. The rest of this paper is organized as follows. Section 2 briefly reviews cognitive theory of multimedia instruction. Section 3 describes the PPAP learning environment. Section 4 shows the survey results. Finally, Section 5 draws conclusions.

Background

Cognitive theory of multimedia learning

Multimedia learning is defined as learning from verbal and visual information (Mayer & Moreno, 2003). The verbal information includes the written form of printed words and the oral form of spoken language. The visual information can be represented by pictorial forms such as illustration, coordinate, diagram, photo, animation, and film. Mayer (2001) proposes a cognitive theory of multimedia learning, as shown in Figure 1, to explain how to learn from verbal and visual information. These critical processes are proposed for multimedia learning. The first cognitive process called selecting, which is applied to collect relevant verbal and visual information and then construct a text based and image based representations. The second process called organizing, which is applied to organize the selected verbal information into a coherent verbal mental model and the selected visual information into a coherent visual mental
model. The third process called integrating, which is applied to integrate the newly built verbal and visual models by creating connections between prior knowledge and corresponding events in visual and verbal models.

![Figure 1. The multimedia learning system](image)

### Cognitive load during learning

The learning process occurs in the working memory and imposes a cognitive load which is essential for learning (Baddeley, 2002; Chandler & Sweller; 1991; Plass, Chun, Mayer, & Leutner, 2003). The cognitive load is related to the human information processing capacity. According to the properties of the task being performed, the cognitive load can be divided into three categories, intrinsic, germane, and extraneous (Sweller, 1999). The intrinsic cognitive load refers to the burden imposed on the learner to construct a semantic context required for a particular learning task. In a teaching context, a lesson cannot take place without two elements: the content knowledge to be taught in the lesson and the pedagogy itself (Feldon, 2007). The germane cognitive load refers to the learning activities that are related to schema acquisition and automation, such as asking students to compare solution procedures in structurally similar but contextually different situations (Kalyuga, 2007). On the other hand, the extraneous cognitive load stands for the ineffective structure or semantic contents that occupy the working memory, thereby reducing the capacity of working memory available for learning activities.

The intrinsic cognitive load can not be altered during learning. An appropriate instructional design increases the germane cognitive load but decreases the extraneous cognitive load (Hasler, Kersten, & Sweller, 2007). An increased extraneous cognitive load is the result of poor instructional design. For example, if the presentation of the teaching materials with PowerPoint is artificially separated in space and/or time, it will lead to the related learning elements not being processed simultaneously to allow understanding of the instructional information. In addition, many new learning elements are selected too quickly to be successfully transferred into the semantic knowledge of the long-term memory. Finally, novice students do not have the appropriate prior knowledge to deal with this rapid introduction of new learning elements, and in addition the instructions do not provide sufficient external guidance. A high extraneous cognitive load will cause novices to use random search procedures, resulting in a poor learning performance (Hasler, Kersten, & Sweller, 2007; Kalyuga, 2007).

### The principles of multimedia instruction

Multimedia includes different formats such as text, graphic, image, video, and sound. Nowadays, teaching materials with multimedia can increasingly provide richer instruction. Multimedia instruction can be regarded as a computer-based narrated animation that illustrates how a causal system works such as how pumps work or how the human respiratory system works (Mayer & Moreno, 2003). A way of using multimedia presentation can build referential connections between written and pictorial information. Several articles indicated the way multimedia can improve students’ learning effects (Mayer & Anderson, 1991; Muthukumar, 2005). Most important principles being considered in the design of multimedia instruction are: (a) multimedia principle (students learn better from words and pictures than from words alone); (b) modality principle (students learn better from animation and narration than from animation and on-screen text); (c) spatial contiguity principle (students learn better when corresponding words and pictures are presented near rather than far from each other on the page or screen); or (d) temporal contiguity principle (students learn better when corresponding words and pictures are presented simultaneously rather than successively) (Astleitner & Wiesner, 2004; Reed, 2006). Following the instruction, Mayer’s experiment results show
that students possess better retention, understanding, and inference capabilities (Mayer & Moreno, 2003; Reed, 2006).

Multimodal learning environment

Recently, the multimodal learning environment is being employed in the construction of the learning environment. The multimodal learning environment uses two different modes, verbal (e.g., printed words, spoken words) and non-verbal (e.g., illustrations, photos, videos, and animations), to represent the content knowledge (Moreno & Mayer, 2007). The large-display, which is shown in Figure 2(a), presents more visible information to the students and is more comfortable to read due to the size of the display area (Tan, Gergle, Scupelli, & Pausch, 2006). Students can comfortably view two or more different documents in a side-by-side fashion. Tyndiuk et al. (2004) examined an experiment involving 40 high-school students and found that the large-display effectively assisted in tasks with difficult interaction. In addition, Tan et al. (2006) examined an experiment and found that an advantage could be obtained by applying a 3D navigation presentation on a large-display. However, setting up a large-display system results in high cost, and as a result, its use has been limited. In addition, there are several problems with the traditional large-display system as listed below (Czerwinski et al., 2006; Robertson et al., 2005).

- Task management problem: users have to operate or control more complex tasks, and therefore require better task management mechanisms.
- Window management problem: leads to notification and window-creation problems. Windows and dialog boxes pop up in unexpected places.
- Losing the cursor: hard to keep track of the cursor.
- Bezel principle: visual distortions are introduced in switching windows and when shifting the cursor.
- Configuration problem: the user display interface is complex and difficult to use. At present it is difficult to deal with the heterogeneity of the monitors, such as different size or pixel density.

Dual-display refers the presentation of documents using two physical display devices such as monitors or projectors. This means that more visual information can be displayed than on a single monitor. The dual-display is less expensive and is easier to control than a single large-display. One kind of dual-channel display is the span-display, as shown in Figure 2(b). It shows a document which can be enlarged and can be shown across two monitors. However, when a document crosses two monitors, it creates a reading problem. In addition, it is necessary that the two monitors are set up with the same span-display settings, such as resolution, color, and refresh rate. The other dual-channel display is called the extended-display, as shown in Figure 2(c), and allows for different settings of the two monitors. It presents two documents on two individual monitors, respectively.
Constructing a PPAP learning environment

The acronym PPAP means PowerPoint accompanied by Annotations Presentation. Figure 3 shows the PPAP learning environment consists of a notebook/PC, two projectors, and the context display management (CDM) system. In the environment, the current screen shows the slide the teacher presents at that moment. The other screen is called the annotation screen which displays the corresponding previous slides or annotations.

The CDM system

The CDM system (as shown in Figure 3) was developed and applied for the PPAP learning environment. Here consistent with previous studies on text annotations, the current slide and the relevant annotations are presented close to each other so as to avoid splitting the attention of the student, (Plass et al., 2003). The CDM system provides a flexible and useful presentation by offering two functions, the authoring and the presenting functions for creating a presenting sequence for instruction in the use of PowerPoint files. Two main components of the authoring function are the Conceptual Association Component and the Annotation Component. The presenting function is divided into three parts: Mouse Control, Switch Cursor, PowerPoint Presentation, Handwriting, Window Control, and Panel Control. These components are addressed in the following context.

The authoring functions of the CDM system

Conceptual Association Component allows teacher to build the conceptual association map (CAM) among slides. An example is shown in Figure 4. Teacher can edit and view the CAM which displays presentation structure of slides through the graphical user interface. Teachers use the component to edit the displaying chains for teaching units. This way can help teachers to present the related learning elements simultaneously. This is helpful to reduce student’s extraneous cognitive load (Kalyuga, 2007; Hasler, Kersten, & Sweller, 2007). Besides, when the related textual and pictorial learning elements are presented simultaneously, students can keep the visual and verbal mental
representations simultaneously (Bartsch & Cobern, 2003; Cavanaugh et al., 2008; Jones & Plass, 2002). That is, the referential connections between the visual and verbal mental representations can be built for the teaching contents by using Conceptual Association Component. Therefore, while displaying teaching contents, teachers can easily present materials for students so as to help them to build the coherent mental representations corresponding to materials.

Annotation Component allows teachers to insert various kinds of multimedia annotations in each slide of teaching materials. Annotations, including text, image, handwriting, video, and audio, are extra explanations to key terms in slides of a PowerPoint file. The purpose of using annotations is to offer students with different cognitive functions such as remembering, thinking, and clarifying (Koroghlanian & Klein, 2004; Verhaart & Kinshuk, 2006). Many researches have shown that a slide, which includes the media annotations, is better comprehended that without them (Kennewell & Beauchamp, 2007; Jones & Plass, 2002). Therefore, the CDM system provides an edit function to add various formats of annotations in slides.

The CDM system offers synchronous and asynchronous presentations. The synchronous annotations can be displayed and disappeared at arranged steps during a predefined time period and the asynchronous annotations can be popped up anytime. Whenever an annotation is no longer needed, the instructor can immediately make them
invisible. Here, teachers can use the CDM system to present PowerPoint slide in one of the two projectors and pop up those annotations in the other projector. This way can offer sufficient external guidance (Feldon, 2007) and also avoid the situation that small annotations for instructional texts are jammed in a slide (Erhel & Jamet, 2006; Sakar & Ercetin, 2005). For instructors, this situation can provide instructional hints for teaching references while lecturing. Figures 5 and 6 show the operation control panel and an example of an arranged annotation sequence, respectively.

**The presenting functions of the CDM system**

Using the control panel of the CDM system, teachers easily operate the mouse moving and window displaying in a large display (three monitors) or dual-channel display (two monitors) learning environment. Figure 7 shows the control panel of the CDM system. The components of the presentation functions of the CDM system are as follows.

- **Mouse Control**: Lock the working area of the cursor in the designated working window.
- **Switch Cursor**: Transfer the working priority of the cursor to the current screen.
- **PowerPoint Presentation**: Presents two or more different PowerPoint files simultaneously or two slides from a PowerPoint file, into the screen assigned by the user.
- **Handwriting**: Writing, editing, or operating the handwriting tool and then synchronously or asynchronously display them onto the assigned screen selected by the user.
- **Window Control**: Displays the window into the assigned screen and calls the window back from one of the two screens to the current screen.
- **Panel Control**: Hides, shows, anchors, and closes the panel.

![Figure 7. The control panel of the CDM system](image)

**A comparison for the three display modes**

Using the CDM system, instructors can easily control the displayed window in the annotated learning environment. Table 1 shows a comparison of Microsoft solution and the CDM system for the large-display mode, span-display mode, and extended-display mode.

<table>
<thead>
<tr>
<th>Problems</th>
<th>Microsoft</th>
<th>CDM system</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Large-display</td>
<td>Span-display</td>
</tr>
<tr>
<td>Cost</td>
<td>High</td>
<td>Middle</td>
</tr>
<tr>
<td>Cursor moving</td>
<td>Difficult</td>
<td>Difficult</td>
</tr>
<tr>
<td>Bezel principle</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Management problem</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

**Method**

**Participants**

The students from six classes, using three faculty members in a technology college in Taiwan participated in this experiment. They totaled 170 sophomore and junior students (94 males and 76 females). Each faculty agreed to teach two classes using the same instructor and the same course. Each of the two classes for each faculty was randomly matched to either the experimental group or the conventional group. The experimental group (three classes, 87
students) was lectured using the PowerPoint presentation accompanied by annotation screen for displaying the previous slides or annotations. The conventional group (three classes, 83 students) was lectured without using the annotation screen. The two groups were lectured with the same teaching materials. The courses were “Introduction to the Arts”, “Calculus”, and “Management Mathematics” and they ran for four months. The PowerPoint materials were to supplement these three courses which were designed as face-to-face courses. The classes met three times a week for 50 minutes each session. Although this type of design does not completely follow a randomized selection and assignment design, it is often necessary in educational settings because classes are often intact and already formed before the research is begun (Gall, Gall, & Borg, 1999).

Materials

The responses from the students regarding their learning perceptions from lectures with PowerPoint presentation were obtained at the end of the semester. The purpose of the questionnaire assessed their general attitudes, interest, efficacy, and taking notes across their learning experience for the PowerPoint presentation. This was a 16-item survey using a 7-point Likert-type scale (with 1 being Strongly Disagree and 7 being Strongly Agree). The items in the survey were similar to those contained in previous surveys (Apperson, Laws, & Scepansky, 2006; Loyd & Gressard, 1986; Susskind, 2008). All items are presented in Table 2. Internal consistency reliability of the questionnaire was assessed by Cronbach's alpha ($\alpha = .83$). The significance level, $p$ value, was taken as 0.05. Since the items included positive and negative statements, the values of the negative statements were reorganized prior to grouping them. Thus, in explaining the survey result, the higher scores indicate more positive learning perceptions toward the PowerPoint presentation. After the experiment, the experimental group was asked to provide open-ended comments about the lectures using the PowerPoint presentation accompanied by CDM and annotations.

According to Bloom’s revised taxonomy, the achievement test was designed to measure the students’ factual knowledge, their conceptual comprehension, and higher-level understanding on the taxonomy levels of evaluation, synthesis, and creation (Wallen, Plass, & Brünken, 2005). First, a pretest was designed to assess the students’ prior knowledge, and then two learning achievement tests (a formative test and a summative test) were designed to measure the students’ learning outcomes.

Instructional content preparation

Figure 8 shows the operation procedure for instruction content preparation involving the CDM system. The procedure of authoring teaching contents is summarized as follows.

Step 1. PowerPoint creation: Instructor creates a PowerPoint file.
Step 2. Project creation: Instructor creates a new CDM project or opens an existing project by using Project Manager in main menu. An example is illustrated in Figure 9.
Step 3. Slide management: Instructor uses Conceptual Association Component to edit the tree structure for PowerPoint slides. The operation in the Conceptual Association Component includes adding, deleting, and modifying nodes. Also, the Conceptual Association Component offers instructor to make a link between two slides and then forms the tree structure of slides for easily presenting sequence followed by the spatial and temporal cognitive principles (Kester, Lehnen, Van Gerven, & Kirschner, 2006; Mayer & Moreno, 2003). The operations can be easily performed through graphic use interface (see Figure 4).
Step 4. Annotation management: Instructor uses Annotation Component to add, delete, edit, and arrange the sequence of the digital annotations in the PowerPoint slides (see Figure 10).

Step 5. Instruction rehearsal: Instructor uses the control panel of the presentation function of the CDM system (see Figure 7) to rehearse the PowerPoint materials before instruction.

![Figure 9. Instructor creates a new project](image1.png)

![Figure 10. Instructor edits the annotations](image2.png)

Procedures

In order to verify the learning perceptions of the PowerPoint presentation complete with CDM and annotations, an exploratory study was conducted. The experimental procedure is described as follows.

(1) The first period of the semester: Before starting the course, the students' prior knowledge was assessed. For the first four weeks of the semester, all students were taught via a traditional lecture method where the instructors lectured course-related contents and wrote notes on a whiteboard. The instructors encouraged students to ask and discuss the questions about the contents of the lecture during the class.

(2) Assignment: At the beginning of the fifth week, classes with the same course title were randomly assigned to either the experimental group or the conventional group. The two groups were lectured with the same teaching materials. A major difference of the learning environment between the experimental group and the conventional one is that the experimental group was lectured with annotation screen for displaying the previous slides or annotations. In contrast, the conventional group was lectured without using the annotation screen.

(3) The remainder of the semester: From the fifth week of the semester onwards, students were taught by the same instructors. The instructors encouraged students to ask and discuss questions about the contents of the course during the class.

The experimental group was taught using PowerPoint presentation complete with CDM for annotations. Instructors used the CDM system to edit and manage the slides and the annotations and to control the presentation of the materials in the PPAP learning environment. By using the CDM system, instructors assisted students with annotations with coherent references that enhanced their cognitive development. Instructors presented the current slide and simultaneously displayed the annotations in the other monitor (Figure 11 (a)). For example, when the information content of the current slide is not sufficient to allow for processing the information, the instructors supported it with annotations to facilitate learning. The instructors presented textual or pictorial annotations to construct mental representations in a coherent episode (Baddeley, 2002). Instructors presented handwriting annotation to lead students into deeper understanding similar to the traditional method where the instructors wrote on the whiteboard. Moreover, if there were any cross-references between the information presented on the current slide and the previous slide, the instructors would simultaneously present both slides (Figure 11 (b)). Students, who possess low prior domain knowledge, can hold the presented slide in their working memory in order to organize and integrate its contents while the following slide is being taught (Kalyuga, 2007; Mayer & Moreno, 2003). This is positive because it prevents presentational holding. Students have enough time to learn the contents, take notes, and
obtain a conceptual understanding of the previous slide. The conventional group was taught via a traditional PowerPoint lecture method where the instructors presented course-related contents to students but without the annotation screen. Most of the PowerPoint slides contained texts that described equations or taught concepts. In addition, some of the contents were images, pictures, and tables for conveying concepts.

(4) Post-test: A formative test was conducted immediately after class and a summative test was done at the end of the course, respectively. Students were asked to complete the Learning Perception Survey and provide some open-ended comments at the end of the semester.

(5) Data analysis: The questionnaire was given to all students in both groups and 170 completed questionnaires were received. The questionnaire data were analyzed using an analysis of variance (ANOVA).

![Figure 11. The CDM presentation](image)

Results

Learning Perception Survey

Analysis of Variance (ANOVA) and the effect size analyses (Cohen’s $d$) were conducted to assess the effects of the annotation presentation on the 16 survey items related to the learning perceptions. Table 2 shows the results of the experimental analysis, which indicate that students in the experimental group thought that the instructor puts key terms and their corresponding explanations and annotations on the display, $F(1, 168) = 18.81, p < 0.001, d = 0.67$. It may be that students can get additional information from the annotation screen. They also thought that the presentations promote their understanding of the learning contents, $F(1, 168) = 6.47, p < 0.05, d = 0.39$. It may be that the annotations can support the cognitive processes of slide, with a function to aid either the process of selecting relevant information, organizing the information in memory, or integrating information with prior knowledge. They felt the multimedia presentations were helpful in increasing learning in the classroom, $F(1, 168) = 3.94, p < 0.05, d = 0.30$.

According to the modality of instructional design (Moreno & Mayer, 2007; Mayer, 2001), the mixed-modality presentations that combined verbal and non-verbal representations of the knowledge are the most effective learning environments. They found that visual elements (e.g., pictures, charts, graphics, or tables) were helpful in presentations, $F(1, 168) = 7.13, p < 0.01, d = 0.41$. It may be that the annotation presentation keeps students actively involved in the learning process rather than focusing solely on printed texts or spoken words. According to the cognitive theory of multimedia learning (Mayer, 2001), students learn better from words and pictures than from printed or spoken words alone. The slides usually presented continguously and simultaneously corresponding words and pictures, $F(1, 168) = 12.42, p < 0.01, d = 0.54$. According to the spatial and temporal contiguity principles of multimedia learning (Astleitner & Wiesner, 2004; Reed, 2006), the students well received the relevant verbal (e.g., printed words, spoken words) and non-verbal (e.g., illustrations, photos, video, and animation) annotations (Mayer & Moreno, 2007). They took more notes, $F(1, 168) = 4.97, p < 0.05, d = 0.34$. It may be that the annotation display is helpful to make meaning, so they enhance students’ note-making.
Students provided open-ended comments about the presentation in the learning environment. Some of students’ positive opinions are given as follows: I can simultaneously read two slides for cross-reference; I can clearly understand the solution while simultaneously displaying the mathematical question and its background knowledge in the annotated learning environment; teacher can offer the corresponding annotations while lecturing; and I can compare the contents in the current display with those in the annotation one.

Achievement Test

A one-way analysis of covariance (ANCOVA) was conducted on the achievement test, with the pretest scores as prior knowledge used as a covariant. Table 3 shows the means (M) and standard deviation (SD) of the learning achievement test scores. Here the prior knowledge is regarded as a covariant in order to exclude the factor of prior knowledge by the students. This factor affects the assessment of the students’ learning achievement. An ANCOVA was performed after confirming the requirement of homogeneity of within-cell regressions, \( F(1, 166) = 0.015; p > 0.05 \). The results of the ANCOVA revealed a statistically significant difference for the formative test, \( F(1, 167) = 4.918, MSE = 183.87, p < 0.05 \). The finding indicates that students in the experimental group had a higher formative test than those in the conventional group. It was found that the PPAP learning environment facilitates student learning in class. However, there was no significant difference between the two groups on the summative test, \( F(1, 167) = 0.249, MSE = 93.78, p > 0.05 \). This may be due to the ceiling effect because both groups studied very hard and spent sufficient time in learning for the summative test (final examination) no matter what kind of tools were provided.

| Table 2. The analysis on Learning Perception Survey for experimental group (EG) and conventional group (CG) |
| --- | --- | --- | --- |
| Item | EG \( (N = 87) \) | CG \( (N = 83) \) | \( F \) | Effect size |
| The lectures were more organized. | 4.49(1.45) | 4.23(1.36) | 1.51 |  |
| The lectures were effective in maintaining students’ interest. | 4.46(1.24) | 4.34(1.48) | 0.35 |  |
| I felt easily hitting important concept more. | 5.05(1.13) | 5.07(1.06) | 0.03 |  |
| I can focus on the teaching material. | 4.52(1.27) | 4.76(1.57) | 1.22 |  |
| The instructor put key terms with explanations and annotations completely well on PowerPoint slides. | 5.13(1.16) | 4.37(1.10) | 18.81 \( ^{'b} \) | 0.67 |
| The presentations promote my understanding of the learning contents. | 4.23(1.33) | 3.76(1.07) | 6.47 \( ^{a} \) | 0.39 |
| The presentations were clear. | 3.85(1.03) | 4.04(1.23) | 1.14 |  |
| The multimedia presentations were helpful in increasing learning in the classroom. | 5.52(1.17) | 5.23(1.20) | 1.74 |  |
| I generally found visual elements (e.g., pictures, charts, graphics, or tables) helpful in presentations. | 4.24(1.20) | 3.84(1.41) | 3.94 \( ^{a} \) | 0.30 |
| The slides usually presented contiguously and simultaneously corresponding words and pictures. | 4.95(1.35) | 4.39(1.42) | 7.13 \( ^{b} \) | 0.41 |
| I generally felt slides that only provided key phrase outlines of the lecture material. | 4.80(1.35) | 4.06(1.40) | 12.42 \( ^{b} \) | 0.54 |
| I can easily make notes. | 4.39(1.36) | 4.49(1.49) | 0.22 |  |
| I took more notes. | 4.75(1.60) | 4.19(1.64) | 4.97 \( ^{a} \) | 0.34 |
| I have more time to organize notes. | 4.52(1.24) | 4.24(1.53) | 1.69 |  |
| My notes were easier to understand. | 4.32(1.29) | 4.35(1.31) | 0.02 |  |
| My notes were more useful for exams. | 4.07(1.28) | 4.02(1.36) | 0.50 |  |

\( ^{a} p<.05, \ ^{b} p<.01, \ ^{c} p<.001 \)

| Table 3. Learning achievement test scores |
| --- | --- | --- | --- | --- | --- |
| Achievement test | EG | CG |
| --- | --- | --- | --- | --- | --- |
| Pre-test | n \( = 87 \) | M(\( SD \)) | n \( = 83 \) | M(\( SD \)) |
| Formative test | 87 | 35.71(11.22) | 83 | 33.73(9.53) |
| Summative test | 87 | 61.52(12.93) | 83 | 56.92(14.11) |
Discussion and Conclusion

Students in our case study pointed out that PowerPoint presentations complete with CDM and annotations is helpful in the classrooms. The findings of this study are consistent with Mayer’s (2001) cognitive theory of multimedia learning, and we extended this theory to the PowerPoint presentation complete with CDM and annotations. Three points are evident from this experiment. First, the annotations, with a more skilled presentation, could facilitate learning. The instructors continguously and simultaneously presented the written words and the corresponding pictures. According to Mayer’s (2001) cognitive theory of multimedia learning, students who selected from words annotated in both pictorial and written modes were able to build more referential connections between the verbal and visual mental representations. In addition, different students learn efficiently but in different ways. Therefore, multimedia environments that provide annotations may be most effective for students because then the students can select the annotations that best fit their needs and preferences, thereby reinforcing their learning (Jones & Plass, 2002). Thus, the PowerPoint presentation accompanied by CDM and annotations will help students to acquire more information and remember more ideas from the pictorial and written annotations than if there were no annotations.

Second, a good presentation for students means being coherent, explicit, and systematic. This is suitable for a low rate of information transfer (Tufte, 2003). The PPAP learning environment facilitates students’ learning in class. For example, an instructor needed two or more slides to contain the handwriting solution to a mathematical question. Students reflected that they clearly understood the solution as a result of the simultaneous display of the mathematical question and its background knowledge in the annotated learning environment. In the traditional PowerPoint display environment, students needed to vacate the contents of the previous slide in the working memory after a certain time, to make room for the next slide. Sometimes instructors may not roll slides back and forth while explaining two successive slides. This may result in reducing a student’s capacity to solve a particular problem. In the PPAP learning environment, students can simultaneously read two slides for building coherent references, thereby helping the cognitive process in the comprehension of the content being taught (Hasler, Kersten, & Sweller, 2007; Wallen, Plass, & Brünken, 2005).

Finally, the PPAP environment helps students to see two sequential slides simultaneously. This situation can present clear and large words and graphs and also display the slides display for a longer time period. This makes students have sufficient time to take notes, thinking, and reasoning. Some results of this study were similar to the traditional PowerPoint presentation. For example, the students indicated that they found that the lectures were well organized and that the key points were emphasized with the use of the PowerPoint presentation in the classroom (Susskind, 2008). Some results also were similar to the results of Apperson, Laws, and Scepansky (2006). Students preferred the fact that instructors added visual elements such as pictures, graphics, charts, or tables in their PowerPoint Presentations.

The following conclusions can be drawn from this paper. This study utilized the CDM system to construct an annotated learning environment to promote the positive effects of the dual-slide PowerPoint presentation in classroom learning. The PPAP is suitable for the learning situations which include very large groups of students, one teacher and a large room. Within traditional teacher-centered instructional designs, this kind of technical solution improves the students’ ability to actually construct learning, rather than that merely becomes learning objects for transmission. To students a good presentation means being coherent, explicit, and a clear structure. An optimal presentation requires the right amount of context overlap, and slides with coherent annotations that stimulate the students’ active inference. The CDM system can simultaneously display PowerPoint slides and annotate corresponding multimedia materials to assist the students with their learning efficacy in an instructional environment. An advantage of this environment is that the presentation sequence of the PowerPoint slides and their annotations can be edited beforehand. The ability to simultaneously display the current slide and its corresponding annotation is helpful to support cognitive processing (Hasler, Kersten, & Sweller, 2007). Therefore, while lecturing in this environment, students have a better chance to understand the learning contents. In addition, this learning environment is suitable for those students who need more time to understand the slides presented. In addition, this learning environment allows students to create more cognitive paths to facilitate the construction of referential links and mutual references between two channel representations. Consequently, the proposed learning environment can scaffold learners to construct coherent mental representations. Finally, the survey results of this study have shown that the proposed system, which is based on cognitive theory and the congruity principle of multimedia learning can effectively help students to reach a better learning performance of lectures employing a dual-slide PowerPoint presentation.
Like in any study, this study also has a few limitations. First, it was necessary to limit the number of annotations to obtain a reliable and valid measure. Second, we do not know the actual levels of the cognitive load because it was not measured directly. Finally, participants were not randomly grouped. Students were enrolled in a class and the group equivalence was not possible like in a study using quasi-experimental research. The students posed different questions and discussion opinions, so the contents slightly differed in each class. In the future, this study could further apply the CDM system to other courses taught, or apply it to other cultures. The PPAP environment is suitable for illustrated courses such as engineering drawing, program design, and video game programming. The teacher can present the program on one screen and its result on the other screen simultaneously. Moreover, future study could investigate the integration of the interactive whiteboard with the multimodal learning environment.

Acknowledgements

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References


Students’ Acceptance of Tablet PCs and Implications for Educational Institutions

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ABSTRACT
This research develops and empirically tests a factor model for understanding college students’ acceptance of Tablet PC (TPC) as a means to forecast, explain, and improve their usage pattern in education. The analysis involved more than 230 students from a regional Midwestern institution. Overall, our model exhibited a good fit with the data and provided satisfactory explanatory power for students’ acceptance of TPC in an educational setting. Analysis of the results suggests a number of implications to educational institutions. Most notably are the need for programs aimed at influencing students’ attitudes and perceptions towards TPC, creating an environment of a positive image surrounding the use of TPC on campus, and facilitating the use of TPC.

Keywords
Education, Tablet PC, College students, Technology acceptance

Introduction
Tablet PC’s extend the mobility provided by laptops by providing the ability to capture handwriting using a magnetic pen. Since the introduction of the first commercial Tablet PC in fall 2002, TPC have been steadily gaining market share with sales expected to reach 14 million by 2009 (Ozok, Benson, Chakraborty, & Norcio, 2008). The portability and ease of note taking made possible by TPC have attracted users from various sectors including healthcare, construction, government, and education.

In education, the application of computer technology in collegiate classroom can improve teaching when used appropriately (Barak, Lipson, & Lerman, 2006). Accordingly, with the proliferation of mobile computing initiatives across campuses, evaluation of such initiatives becomes the logical next step. The evaluation ultimately centers on the students’ learning and teaching effectiveness. Yet for such initiatives to improve students’ learning and teaching effectiveness, these initiatives must be accepted by students and faculty alike. In that regard, the objective of this research is to understand the factors influencing students’ acceptance of TPC as a means to forecast, explain, and improve usage pattern. The research builds on prior technology acceptance research to develop a factor model to assess various factors driving acceptance within the context of students’ acceptance of TPC technology. The research contributes to a better understanding of the introduction and management of information technology (IT) based initiatives in education with a particular emphasis on TPC.

The next section provides a brief overview of relevant prior research followed by a detailed depiction of our research model. The research model identifies relevant factors and captures dependency relationships among these factors in the form of a number of hypotheses to be tested in this research. Next, we describe the methodology employed highlighting the study design, data collection, and data analysis. We then summarize the results obtained with respect to measurement validity and model testing results followed by a discussion of implications for educational institutions. We conclude with a summary of research contributions, limitations, and venues for future research.

Related Work

Technology acceptance

The technology acceptance literature documents a rich collection of models and theories that could be used to explain the adoption of information technology innovations (Venkatesh, Davis, & Morris, 2007; Venkatesh, Morris, Davis, & Davis, 2003). With respect to individual (as opposed to organizational) acceptance of technology these models use intention or usage as a dependent variable. Examples of some of the most influential models include the
theory of reasoned action (TRA) (Fishbein & Ajzen, 1975); the theory of planned behavior (TPB) (Ajzen, 1991), the technology acceptance model (TAM) (Davis, 1989); along with modifications of these models.

The theory of reasoned action (TRA) (Fishbein & Ajzen, 1975) is anchored in social psychology and particularly in expectancy-value analysis and has been used extensively to study technology acceptance. According to TRA, an individual’s acceptance of technology can be explained by his/her intention. This in turn is determined by the individual’s positive or negative feelings towards the target behavior (attitude) and the individual’s perception that most people who are important to him/her think he/she should exhibit the behavior under consideration (subjective norm). The theory of planned behavior (TPB) (Ajzen, 1991) extends TRA by including perceived behavioral control as an additional determinant of behavioral intention. Perceived behavioral control represents the ease or difficulty of performing the target behavior. Similar to TRA, TPB has been used to predict intention and behavior in a wide variety of setting (Ajzen, 1991).

The technology acceptance model (TAM) is built from TRA and is intended to predict information technology acceptance across diverse technologies, user groups, and organizational contexts. TAM postulates that an individual’s acceptance of a technology can be captured by behavioral intention which can be explained by the individual’s perception of the usefulness and ease of use of the technology. According to Venkatesh (2008), as of December 2007 there are over 1,700 citations in the Social Science Citation Index and 5,000 citations in Google Scholar to the two journal articles (Davis, 1989; Davis, Bagozzi, & Warshaw, 1989) that introduced TAM. TAM thereby emerged as the most widely employed model for IT adoption and use. Empirical support for TAM has been favorable (Venkatesh, et al., 2007). In a meta-analysis study, King (2006) found that TAM’s measures of perceived usefulness, perceived ease of use, and behavioral intent were highly reliable in a variety studies. Both King (2006) and Schepers (2007) agree that perceived usefulness has a higher correlation with acceptance than perceived ease of use.

However, TAM has been criticized for parsimony that hampers its use for guiding systems design and technology management practices that are aimed at enhancing users’ acceptance of technology (Hu, 2005). Similar concerns are echoed by Mathieson (1991) and Venkatesh and Davis (1996) indicating that there is a need for a better understanding of key acceptance determinants that allow organizations to devise intervention strategies to improve acceptance of new technology. In that regard, efforts to address the parsimoniousness of TAM included adding key antecedents of perceived usefulness (Venkatesh, 2000), key antecedents of perceived ease of use (Venkatesh, 2000), and integrating key concepts from TPB, TRA, and other relevant theories (Chau & Hu, 2002).

Nevertheless, a review of the literature indicates that TAM has been used as a theoretical underpinning for developing generalized models as well as models targeting specific user acceptance contexts. For example, in an attempt to evaluate and integrate concepts from various models, Venkatesh et al. (2003) conducted a comparison of eight models and their extensions to propose a unified theory of acceptance and use of technology (UTAUT). In this model, performance expectancy (perceived usefulness), effort expectancy (perceived ease of use), social influence, and facilitating conditions are key determinants of user intention and usage behavior. Overall, the results indicate that TAM and its extensions compared favorably to other models with three constructs of TAM (and its extensions) being part of the proposed UTAUT model.

Technology acceptance in education

In education, the use of technology acceptance prediction models to study technology acceptance situations would be a useful tool for understanding and managing technology initiatives. Examples of such studies include Gao (2005) who states that “technology acceptance models can serve the purpose of evaluating competing products such as text books and technology systems” and provide a valuable tool to educators. TAM has also been used to examine students’ perception of usage, usefulness, and ease of use of web-enhanced instruction (WEI) using Blackboard (Landry, Griffeth, & Hartman, 2006). Moreover, Davis and Wong (2007) use TAM and the flow model to develop an integrated perspective to analyze students’ participation and engagement with an eLearning system. Also in the context of eLearning, Saadé (2007) proposes and demonstrates the utility of an expanded TAM to distinguish between the influences of the three proposed dimensions of perceived usefulness, namely, performance-related outcome expectations, personal-related outcome expectations while Kiraz and Ozdemir (2006) incorporates TAM constructs with six different educational ideologies and conclude that different educational ideologies may have
different effects on teachers’ technology acceptance. Gong et al. (2004) recognize the increasingly important role of information technology in modern education and proposes a framework comprised of a combination of TAM and social cognitive theory (SCT) to evaluate IT acceptance by teachers. Meso and Liegle (2005) uses TAM to assess the suitability and fit of .NET, as a pedagogical tool for teaching a technical information system (IS) course. The study suggests the effectiveness of the technology acceptance theory as an approach for assessing the pedagogical fit and suitability of specific IT for teaching specific IS courses.

With respect to the TPC, Anderson et al. (2006) evaluate faculty acceptance of TPC using the Unified Theory of Acceptance and Use of Technology (UTAUT). Their findings suggest that performance expectancy and voluntariness are the most salient drivers of acceptance for business faculty. Others have underscored the potential for TPC to allow faculty to focus more on the students (Lindsey, 2003). In another study, Anderson (2007) proposes a distributed system that leverages TPC in the classroom to facilitate sharing of digital ink on electronic slides. The purpose is to enhance students’ engagement in class. Moreover, Weitz et al. (2006) evaluates the usefulness of TPC for faculty in the context of a pilot study. The results indicate that while participating faculty were convinced of the potential of TPC to meaningfully impact learning, overall, only a fraction were motivated to use the TPC and only one third opted for replacing their notebook with a TPC. In a corporate setting, Garfield (2005) reports on acceptance of the Tablet PC. The study identifies a number advantages and disadvantages related to the use of TPC. Most notable advantages were the ability to multi-task, increased information accessibility, and improved image (as a tech-savvy organization). Disadvantages includes challenges with data input (difficulty with using the stylus), and potential for intimidation (possibly due to fear of being recorded) (Garfield, 2005).

Despite the proliferation of TPC in education and the richness of the technology acceptance literature, the literature is limited when it comes to understanding general students’ acceptance of Tablet PC in an education context. It is the objective of this study to examine the factors influencing students’ acceptance with an emphasis on the implications for educational institutions.

The Research Model and Hypotheses

Figure 1 depicts the research model. The model leverages TAM, TRA, TPB, and UTAUT as a theoretical foundation and incorporates important factors pertaining to the target technology, user group, and organizational context. Following Chau and Hu (2002), our research model hypothesizes that students’ acceptance of TPC can be explained by a number of factors which can be organized into technological, individual, and organizational factors.
With respect to technological factors, the research model identifies performance expectancy (PE), and effort expectancy (EE) as key factors. In this study, performance expectancy refers to the degree to which a student believes that using the TPC will help her improve her performance in school, i.e., consider the TPC to be useful. On the other hand, effort expectancy refers to the degree of ease associated with the use of TPC, i.e., the degree to which a student considers the use of TPC to be free of effort. Consistent with TAM and UTAUT, the model suggests that performance expectancy is a key determinant affecting students’ acceptance of TPC. Consistent with TAM, performance expectancy and effort expectancy are intrinsically related. Specifically, a student’s perception of performance expectancy is positively influenced by his or her perceptions of effort expectancy. Therefore, we tested the following hypothesis:

H1: The degree to which a student believes that TPC will help him or her to attain gains in school performance (Performance expectancy) has a positive effect on his/her intention to use TPC.

H2: The degree of ease of use (Effort expectancy) associated with the use of TPC as perceived by a student has a positive effect on the degree to which a student believes that TPC will help him or her to attain gains in school performance.

The model identifies students’ attitude towards TPC as a critical determinant of their acceptance of the technology. In this study, attitude reflects a student’s feelings of favorableness or unfavorableness towards using TPC. In effect, according to TAM, TRA, and TPB, individuals with a positive attitude towards a technology are more likely to accept a technology than those not showing such an attitude. However, Venkatesh et al. (2003) indicate that attitude represents an interesting case where it has shown to be a significant determinant of acceptance in some studies while not being significant in other studies. The study further attributes the results to a possible relationship between attitude on one side and performance expectancy and effort expectancy on the other. The explanation is based on the observation that attitude seems to be significant only when specific cognitions such as performance and effort expectancies are not included in the model. Nevertheless, in a recent quantitative meta-analysis of previous research on TAM, Schepers and Wetzels (2007) confirm the TAM relationships (including the mediating role of attitude as a determinant of behavioral intention. Accordingly, and given the considerable autonomy of students, our model retains attitude together with performance and effort expectancy resulting in the following hypothesis:

H3: The degree to which a student believes that TPC will help him or her to attain gains in school performance has a positive effect on his/her attitude towards TPC.

H4: The degree of ease of use (Effort expectancy) associated with the use of TPC as perceived by a student has a positive effect on his/her attitude towards TPC.

H5: The attitude of a student towards TPC has a positive effect on his/her intention to accept TPC.

Organizational factors captured in the model include social influence and facilitating conditions. In this model social influence refers to the degree to which a student perceives that important others such as faculty, advisors, and peers believe he or she should use TPC. In this model, we hypothesize that social influence will have a positive and significant effect on both performance expectancy and intention to accept the technology resulting in the following hypothesis:

H6: A student’s perception of the usefulness of TPC (performance expectancy) will be positively influenced by his or her perception on how important others perceive them having used the technology (social influence).

H7: A student’s acceptance of TPC will be positively influenced by his or her perception on how important others perceive them having used the technology (social influence).

Facilitating conditions are the degree to which a student believes that an organizational and technical infrastructure exists to support his or her use of TPC. According to Ajzen (1991), perceived behavioral control involves internal factors such as self-efficacy, as well as external conditions such as facilitating conditions. Taylor and Todd (1995) further demonstrate the role of external aspects of perceived behavioral control while Venkatesh (2000) highlight the importance of resource availability in user acceptance. In the context of this study, we hypothesize that facilitating conditions such as the TPC help desk, computing services TPC support center, and user training would play a positive role in students’ acceptance of TPC. In effect, we tested the following hypothesis:

H8: A student’s acceptance of TPC will be positively influenced the availability and access to support mechanisms (facilitating conditions).
Methodology

Participants

The study is conducted at a Midwest public university which has implemented a Tablet PC computing initiative. By the spring of 2006 all students at this university had their own TPC. As a relatively early adopter of the TPC technology and with the pervasiveness of TPC on the campus, the institution provides an environment for studying students’ adoption of TPC. The participant pool consists of 360 students enrolled in courses in a college of business and information systems. All participants have a TPC and used the device in classroom environments. The length of use varied among participants.

Instrument

The survey instrument is based on technology acceptance constructs validated in prior research (Davis, Bagozzi, & Warshaw, 1992; Venkatesh, et al., 2003) and adapted to the context of this study. The variables measured include; performance expectancy, effort expectancy, social influence, facilitating conditions, behavioral intent, and usage. The survey instrument collected additional information such as gender, age, and major. All questionnaire items were measured using a 7-point Likert scale ranging from “strongly agree” to “strongly disagree”.

Data collection

The survey instrument was delivered using the Web to ease participation and data acquisition. All participants were enrolled in courses on-campus and used the Tablet devices to take the survey. The survey was conducted during normal class sessions during the last ten minutes of class.

Data analysis

The statistical analysis method used for this study was partial least squares (PLS), a second generation statistical technique for conducting structural equation modeling (SEM) based analysis. The utility of PLS is detailed elsewhere (Falk & Miller, 1992). With respect to technology acceptance, a number of recent studies utilized PLS including (but not limited to) (Al-Gahtani, 2001; Hu, 2005; Venkatesh, et al., 2003).

PLS allows for evaluating the psychometric properties of the scales (indicators) used to measure a variable (construct) (the measurement model), and the estimation of the direction and strength of the relationships among the model variables (the structural model). In effect, PLS includes two sets of equations: the measurement model (outer model) comprised of equations representing the relationships between indicators and the variable they measure, and the structural model (inner model) comprised of equations representing the paths among variable (constructs). PLS calculates weights and loading factors for each item in relation to the construct it was intended to measure. The weights calculated by PLS are used to calculate latent variable scores for the constructs, which reflect the contribution of each variable to its construct.

Evaluating the measurement model includes estimating the internal consistency for each block of indicators and evaluating construct validity. Internal consistency is evaluated using composite reliability (CR) and the average variance extracted (AVE). Both CR and AVE are calculated using the loading factors for each item in relation to the construct it was intended to measure (Chin, 1998). Compared to Cronbach’s alpha, CR does not assume that all indicators are equally weighted thereby providing a closer approximation when the parameters are accurate. Cronbach’s alpha tends to be a lower bound estimate of reliability (Chin, 1998). Nunnally’s (1978) guidelines were used to evaluate the composite reliability obtained for each variable. According to Fornell (1981) AVE should be greater than 0.5 indicating that 50% of the amount of variance in an item that its corresponding variable explains relative to the amount due to measurement error (Chin, 1998).

Construct validity refers to the degree which a variable measures what it was intended to measure (Cronbach, 1951). Construct validity is comprised of convergent and discriminate validity. Convergent validity is degree which similar
constructs are related; while discriminate validity is the degree that different constructs are different from each other. Following Gefen and Straub (2005) convergent validity of the variables is evaluated by examining the t-values of the outer model loadings. A t-value greater than 1.96 indicates that the particular indicator is explained by the linear regression of its variable and its measurement error (Gefen & Straub, 2005). Discriminate validity is the degree to which any single construct is different from the other constructs in the model. Discriminate validity is evaluated by examining item loadings to variable correlations and by examining the ratio of the square root of the AVE of each variable to the correlations of this construct to all other variables (Chin, 1998; Gefen & Straub, 2005).

For the structural model, path coefficients are interpreted as regression coefficients with the t-statistic calculated using bootstrapping (200 samples), a nonparametric technique for estimating the precision of the PLS estimates (Chin, 1998). To determine how well the model fits the hypothesized relationship PLS calculates an $R^2$ for each dependent construct in the model. $R^2$ represents the proportion of variance in the endogenous constructs which can be explained by the antecedents (Chin, 1998). The tool used for the analysis was PLS Graph.

Results

Sample size and characteristics

According to Cohen (1988) a sample of at least 175 participants would be needed to achieve 95% confidence. One of the benefits of using PLS-Graph is that it can resample the initial data set, effectively enlarging it and thus reducing overall sample requirements. Guidelines provided with PLS-Graph recommend a sample size equal to the larger of two possibilities: (1) ten times the number of indicators on the most formative construct, in this study ten times the ten indicators of performance expectancy or one hundred participants, or (2) ten times the largest number of antecedent constructs used to determine a dependent variable, in this study ten times six, the number of constructs used to determine behavior intent.

Data was collected from students in all the sections of courses thought to be most likely enrolled in by students in their first year of TPC use. The available participant pool was about 360 individuals enrolled in the selected courses. Several survey submissions were disqualified due to incomplete submissions. Overall, a total of 232 (n=232) usable responses were included in data analysis representing 64% of the participant pool and exceeding the required sample size. The general demographics of the survey participants are illustrated in Table 1.

<table>
<thead>
<tr>
<th>Table 1: Survey Sample Characteristics</th>
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</thead>
<tbody>
<tr>
<td>Participant’s demographics</td>
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<tr>
<td>----------------------------------------</td>
</tr>
<tr>
<td>Number of participants</td>
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<tr>
<td>Average age</td>
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<tr>
<td>Gender</td>
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<tr>
<td>Male</td>
</tr>
<tr>
<td>Female</td>
</tr>
<tr>
<td>NA</td>
</tr>
<tr>
<td>Class placement</td>
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<td>Freshman</td>
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<tr>
<td>Sophomore</td>
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<td>Junior</td>
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<tr>
<td>Senior</td>
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<td>College major</td>
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<td>Business&amp; Info Sys</td>
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<tr>
<td>Education</td>
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<tr>
<td>Other</td>
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<tr>
<td>First use of computers</td>
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<tr>
<td>Elementary</td>
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<tr>
<td>Middle</td>
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</table>
Table 2: Construct item values and standard deviation

<table>
<thead>
<tr>
<th>Construct Item</th>
<th>Measured Value</th>
<th>Calculated Value</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>PE1</td>
<td>5.85</td>
<td>1.07</td>
<td></td>
</tr>
<tr>
<td>PE3</td>
<td>5.46</td>
<td>1.17</td>
<td></td>
</tr>
<tr>
<td>PE5</td>
<td>5.91</td>
<td>1.07</td>
<td></td>
</tr>
<tr>
<td>PE10</td>
<td>5.83</td>
<td>1.03</td>
<td></td>
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<tr>
<td>Performance Expectancy</td>
<td>5.75</td>
<td>0.89</td>
<td></td>
</tr>
<tr>
<td>EE1</td>
<td>5.98</td>
<td>1.06</td>
<td></td>
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<tr>
<td>EE2</td>
<td>5.78</td>
<td>1.06</td>
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<tr>
<td>EE3</td>
<td>5.85</td>
<td>0.99</td>
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<tr>
<td>EE4</td>
<td>5.77</td>
<td>1.03</td>
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<tr>
<td>EE5</td>
<td>5.94</td>
<td>0.97</td>
<td></td>
</tr>
<tr>
<td>EE6</td>
<td>6.03</td>
<td>0.95</td>
<td></td>
</tr>
<tr>
<td>Effort Expectancy</td>
<td>5.88</td>
<td>0.87</td>
<td></td>
</tr>
<tr>
<td>SI1</td>
<td>4.78</td>
<td>1.20</td>
<td></td>
</tr>
<tr>
<td>SI2</td>
<td>4.76</td>
<td>1.23</td>
<td></td>
</tr>
<tr>
<td>SI3</td>
<td>5.62</td>
<td>1.01</td>
<td></td>
</tr>
<tr>
<td>SI4</td>
<td>5.19</td>
<td>1.21</td>
<td></td>
</tr>
<tr>
<td>Social Influence</td>
<td>5.12</td>
<td>0.90</td>
<td></td>
</tr>
<tr>
<td>FC1</td>
<td>5.99</td>
<td>0.94</td>
<td></td>
</tr>
<tr>
<td>FC2</td>
<td>6.08</td>
<td>0.76</td>
<td></td>
</tr>
<tr>
<td>FC5</td>
<td>5.74</td>
<td>1.20</td>
<td></td>
</tr>
<tr>
<td>Facilitating Conditions</td>
<td>5.90</td>
<td>0.83</td>
<td></td>
</tr>
<tr>
<td>BI1</td>
<td>5.69</td>
<td>1.16</td>
<td></td>
</tr>
<tr>
<td>BI3</td>
<td>6.09</td>
<td>1.07</td>
<td></td>
</tr>
<tr>
<td>BI4</td>
<td>5.97</td>
<td>1.06</td>
<td></td>
</tr>
<tr>
<td>BI5</td>
<td>5.90</td>
<td>1.11</td>
<td></td>
</tr>
<tr>
<td>Behavioral Intent</td>
<td>5.89</td>
<td>0.83</td>
<td></td>
</tr>
<tr>
<td>ATUT1</td>
<td>5.80</td>
<td>1.05</td>
<td></td>
</tr>
<tr>
<td>ATUT 3</td>
<td>5.69</td>
<td>0.94</td>
<td></td>
</tr>
<tr>
<td>ATUT4</td>
<td>5.39</td>
<td>1.24</td>
<td></td>
</tr>
<tr>
<td>ATUT5</td>
<td>5.78</td>
<td>1.14</td>
<td></td>
</tr>
<tr>
<td>Attitude</td>
<td>5.67</td>
<td>1.13</td>
<td></td>
</tr>
</tbody>
</table>

Based on tests of univariate normality (Anderson-Darling test) none of the variables in this study were normally distributed. This phenomenon is similar to other studies of technology acceptance (van der Heijden, 2004). Nevertheless, the use of partial least squares (PLS) for data analysis is appropriate for this study because of its ability to model latent constructs under non-normal conditions (Cohen, 1988). Table 2 summarizes survey responses for each construct item. The calculated values are from PLS Graph (Chin, 1999).

**Analysis of measurement validity**

While most questions items have been validated elsewhere in the literature (Venkatesh, et al., 2003), we follow the recommendation of Straub (1989) and re-examine the survey instrument in terms of reliability and construct validity. The original thirty four variables initially included in the survey instrument were analyzed in PLS-Graph, resulting in
ten items with loading less than .70, a threshold level considered generally acceptable (Fornell & Larcker, 1981). Following the recommendations by (Hair, Tatham, Anderson, & Black, 1998), items with low loading are deleted. The process is continued until no item loading is less than 0.7. Examination of the remaining items revealed that they adequately represent the underlying construct attesting to the content validity of the instrument. Table 3 summarizes the results for the items comprising the model.

<table>
<thead>
<tr>
<th>Construct</th>
<th>Items</th>
<th>Item Loading</th>
<th>Construct CR</th>
<th>Construct AVE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance</td>
<td>PE1</td>
<td>0.7818</td>
<td>0.882</td>
<td>0.652</td>
</tr>
<tr>
<td></td>
<td>PE3</td>
<td>0.8039</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>PE5</td>
<td>0.7758</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>PE10</td>
<td>0.8436</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Expectancy</td>
<td>EE1</td>
<td>0.8259</td>
<td>0.946</td>
<td>0.744</td>
</tr>
<tr>
<td></td>
<td>EE2</td>
<td>0.9037</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>EE3</td>
<td>0.9077</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>EE4</td>
<td>0.8672</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>EE5</td>
<td>0.8362</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>EE6</td>
<td>0.8388</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Effort</td>
<td>SI1</td>
<td>0.7632</td>
<td>0.857</td>
<td>0.6</td>
</tr>
<tr>
<td></td>
<td>SI2</td>
<td>0.8103</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>SI3</td>
<td>0.7984</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>SI4</td>
<td>0.7075</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social Influence</td>
<td>FC1</td>
<td>0.8376</td>
<td>0.85</td>
<td>0.654</td>
</tr>
<tr>
<td></td>
<td>FC2</td>
<td>0.7634</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>FC5</td>
<td>0.8114</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Behavioral Intention</td>
<td>BI1</td>
<td>0.8479</td>
<td>0.922</td>
<td>0.749</td>
</tr>
<tr>
<td></td>
<td>BI3</td>
<td>0.7858</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>BI4</td>
<td>0.8983</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>BI5</td>
<td>0.9133</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attitude</td>
<td>ATUT1</td>
<td>0.8223</td>
<td>0.887</td>
<td>0.614</td>
</tr>
<tr>
<td></td>
<td>ATUT3</td>
<td>0.8401</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ATUT4</td>
<td>0.7575</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ATUT5</td>
<td>0.8431</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The results show composite reliability (CR) exceeding 0.8 as recommended by Nunnally (1978). AVE which can also be considered as a measure of reliability exceeds 0.5 as recommended by (Fornell & Larcker, 1981). Together CR and AVE attest to the reliability of the survey instrument. The t-values of the outer model loadings exceed 1.96 verifying the convergent validity of the instrument (Gefen & Straub, 2005). Calculating the correlation between variables’ component scores and individual items confirmed that intra-variable (construct) item correlations are very high compared to inter-variable (construct) item correlations attesting to the discriminate validity of the instrument. In addition, discriminate validity is confirmed if the diagonal elements (representing the square root of AVE) are significantly higher than the off-diagonal values (representing correlations between constructs) in the corresponding rows and columns (Chin, 1998). As shown in Table 4 the instrument demonstrates adequate discriminate validity as the diagonal values are greater than the corresponding correlation values in the adjoining columns and rows. Overall, the instrument has achieved an acceptable level of reliability and construct validity.

<table>
<thead>
<tr>
<th>PE</th>
<th>EE</th>
<th>SI</th>
<th>BI</th>
<th>FC</th>
<th>ATUT</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.807</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.343</td>
<td>0.863</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.343</td>
<td>0.338</td>
<td>0.775</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.521</td>
<td>0.464</td>
<td>0.513</td>
<td>0.865</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.476</td>
<td>0.669</td>
<td>0.565</td>
<td>0.661</td>
<td>0.809</td>
<td></td>
</tr>
<tr>
<td>0.536</td>
<td>0.501</td>
<td>0.524</td>
<td>0.724</td>
<td>0.624</td>
<td>0.784</td>
</tr>
</tbody>
</table>
Model testing results

Figure 2 depicts the structural model showing path coefficients and $R^2$ for dependent variables.

![Figure 2. Tablet PC structural model testing results](image)

The $R^2$ values for each dependent variable indicate that the model was able to account for 17.6% of the variance in performance expectancy, 40.1% of the variance in attitude, and 60% of the variance in behavioral intention. Bootstrap method was used in PLS-Graph to assess the statistical significance of the path coefficients (which have similar interpretation to standardized Beta values in regression analysis). Consistent with hypothesis 1 (H1), the degree to which a student believes that TPC will help him or her to attain gains in school performance (performance expectancy) has a positive effect on his or her intention to use intention to use TPC ($\beta=0.124$, $p<0.001$). Similarly, the degree of ease associated with the use of TPC as perceived by a student has a positive effect on his or her perceived usefulness of TPC consistent with hypothesis 2 (H2) with ($\beta=0.256$, $p<0.001$). Hypothesis 3 (H3) is also confirmed with the degree to which a student believes that TPC will help him or her to attain gains in school performance has a positive effect on his/her attitude towards TPC with ($\beta=0.413$, $p<0.001$). Consistent with hypothesis 4 (H4), the degree of ease of use (Effort expectancy) associated with the use of TPC as perceived by a student has a positive effect on his/her attitude towards TPC with ($\beta=0.359$, $p<0.001$). Similar to H1 and consistent with hypothesis 5 (H5), attitude of a student towards TPC has a positive effect on his/her intention to accept TPC with ($\beta=0.439$, $p<0.001$). Social influence has also proven to be a significant determinant. Consistent with hypothesis 6 (H6) and hypothesis 7 (H7), the degree by which a student perceive the importance of how significant others (such as peers and faculty) perceive him or her using the technology positively influence his or her perception of the usefulness of TPC (performance expectancy) with ($\beta=0.256$, $p<0.01$) and his or her acceptance of TPC with ($\beta=0.081$, $p<0.05$). Consistent with hypothesis 8 (H8), the availability and access to support mechanisms (facilitating conditions) positively influence students’ acceptance of TPC with ($\beta=0.281$, $p<0.01$). Overall, all structural relationships depicted in the research model are significant.
Discussion

With the proliferation of various forms of technology across educational institutions, our analysis suggests a number of findings that is of particular relevance to research and technology management in educational settings. With respect to key determinants of TPC acceptance, students’ attitude has the most direct influence followed by facilitating conditions, performance expectancy, and social influence. When considering direct and indirect influence, students’ attitude still exhibits the most influence on TPC acceptance followed by performance expectancy, facilitating conditions, effort expectancy, and social influence (Table 5).

Table 5: Direct and indirect effect of factors predicting performance expectancy, attitude, and behavior intention

<table>
<thead>
<tr>
<th>Performance expectancy (PE)</th>
<th>Attitude (ATUT)</th>
<th>TPC acceptance</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>I</td>
<td>T</td>
</tr>
<tr>
<td>EE</td>
<td>0.256</td>
<td>0.256</td>
</tr>
<tr>
<td>PE</td>
<td>0.413</td>
<td>0.413</td>
</tr>
<tr>
<td>SI</td>
<td>0.256</td>
<td>0.256</td>
</tr>
<tr>
<td>ATUT</td>
<td>0.439</td>
<td>0.439</td>
</tr>
<tr>
<td>FC</td>
<td>0.283</td>
<td>0.283</td>
</tr>
</tbody>
</table>

*: ‘D’ denoted direct effect, ‘I’ denotes indirect effect, and ‘T’ denotes total effect

While the results are not consistent with other technology acceptance findings in which performance expectancy seems to have the most influence driving technology acceptance (Schepers & Wetzels, 2007), the results emphasize the importance of managing students’ attitude towards the technology.

Accordingly, it is paramount for administrators, technology officers, and project champion to have a better understanding of factors affecting attitude and develop programs for positively influencing students’ attitude towards TPC. In this vein, our results suggest a prominent influence of performance expectancy and effort expectancy on students’ attitude towards TPC. In effect, students’ perception on the extent TPC will improve their productivity and on the degree by which TPC is easy to use (user-friendly) will positively affect their attitude towards TPC. Programs aiming at positively influencing students’ attitude (and thus acceptance) should target performance and effort expectancy.

Insofar, it is evident that while performance expectancy is not the most prominent direct driver for acceptance, it continues to play an important role directly and indirectly (through attitude) affecting students acceptance of TPC. In effect, performance expectancy does not play a prominent role as in other studies with other user groups such as law enforcement officers where efficiency gains and perceived usefulness are the single most important acceptance drivers (Hu, 2005). Further analyzing the factors affecting performance expectancy, our model and associated results suggest effort expectancy and social influence as significant determinants of performance expectancy. In effect, students’ perception of the degree of ease associated with using TPC has a positive influence on their perception of TPC usefulness. This relation further underscores the importance of developing programs for managing students’ effort expectancy as highlighted earlier. Moreover, students’ perception on how others believe they should use TPC has a similar positive effect on their perception of TPC usefulness. The latter result emphasizes the importance of cultivating a positive environment surrounding the use of TPC.

It is interesting to note that despite social influence being a determinant of performance expectancy, it has the least significant direct effect on TPC acceptance. This suggests that social influence’s significant and positive effect on TPC acceptance is mediated by other factors such as performance expectancy. In effect, students’ assessment of the usefulness of TPC will likely take into account the perception of ‘significant’ others. However, such perception may have a less direct influence on their acceptance of the technology. This is consistent with other research findings (Venkatesh, 2000; Venkatesh, et al., 2003) for mandatory adoption as well as the findings reported in the meta-literature analysis (Schepers & Wetzels, 2007). It is important to consider that even when the users perceive the system as organizationally mandated, intention to use the system may vary as some users may be unwilling to comply with the mandate (Hartwick & Barki, 1994; Venkatesh & Davis, 2000). Accordingly, the results indicate that “internalization effect” – representing the human’s tendency to interpret information from significant others as evidence about reality – is stronger than the “compliance effect” – representing the willingness of people to choose to perform an action when an important referral indicate they should. While, the significance of the “compliance
effect” is expected in the mandatory setting of this study, the prominence of the “internalization effect” further highlights the importance of programs shaping the social context of TPC roll out as noted earlier. However, our results differ when time is taken into consideration. While earlier results support declining effort of social influence with experience, the results of this study indicate that even with experienced users (more than 80% of respondents have been using TPC for more than 6 months), social influence continues to influence behavior. The results suggest that students as a user group are more susceptible to social influence over time.

Consistent with prior research (Agarwal & Prasad, 1997; Davis, 1989; Venkatesh, et al., 2003) effort expectancy is also a significant determinant of students’ acceptance of TPC (though through indirect effect through attitude and performance expectancy). However, the results suggest that the degree of ease associated with using TPC as perceived by students continues to play a major role in influencing student intention to continue to use the technology even after 80% have been using TPC for more than 6 months. The primary implication of this result is the need to continue to ensure that students continue to perceive TPC as easy to use. One approach, is for the continuous support/training beyond the initial adoption period (which is normally up to 6 months).

It is worth noting the significant and positive effect of facilitating conditions on students’ acceptance of TPC acceptance. Initiatives such as help desks and dedicated technology support services are certainly recommended as means for facilitating the use and thus students’ acceptance of TPC.

Conclusion

In this study, we employ a variation of the technology acceptance model to assess the influence of various factors driving the acceptance of TPC by college students. Overall, our model exhibited a good fit with the data and provided a satisfactory explanatory power for students’ acceptance of TPC in an educational setting. Analysis of the results suggests a number of implications to educational institutions. In effect, institutions wishing to engage in TPC initiatives need to:

- Engage in programs aimed at influencing students’ attitudes and perceptions towards TPC. Such programs should emphasize the utility of TPC to students (for school and personal use) as well as the user-friendliness of TPC.
- Create and sustain an environment of a positive image surrounding the use of TPC on campus as the results suggest that students’ as a user group are more susceptible to social influence over time.
- Institute support mechanisms such as help desks, user groups, and online support sites to facilitate the use of TPC and respond to students’ questions and concerns regarding the effective use of the technology.

We believe this study has both theoretical and practical contributions. With the proliferation of technology-based initiatives in education, studies analyzing the adoption of such initiatives complement existing attempts to evaluate students’ learning and teaching effectiveness. Specifically, evaluating the adoption of such IT-based initiatives in education provide insight regarding the factors behind the success or failure (measured in students’ learning and teaching effectiveness) of such initiatives. Based on the findings of this study, we can identify factors that induce students to adopt (buy-into) such initiative. Such insight can be used for diagnostic purposes and for the planning and management for technology-based initiatives in education. From a theoretical perspective, the research will add to the literature dealing with mandatory adoption of technical innovations. The research also contributes to the general adoption literature by studying the theoretical validity and empirical applicability of the TAM model.

Future research will need to address the limitations of this study. First, effort expectancy and social influence seem to exhibit influence that extends in time (more than 80% of the respondents have been using the TPC for more than 6 months). Further research is needed to assess the influence of these determinants over time and the causes for such extended influence over TPC acceptance compared to other determinants. As emphasized by Karahanna et al. (1999), an individual’s beliefs and attitudes towards technology or cognitive assessment is likely to evolve dynamically over time. Second, with the prominence of students’ attitude as a determinant of students’ acceptance of TPC, we suggest further research into the role of different types of attitude. As Yang and Yoo (2004) advocates, “attitude deserves more attention in IS research for its considerable influence on individual and organizational usage of IS”. Third, in this study, we employed a quantitative model to assess the influence of various factors on TPC
acceptance. A case study approach would complement the analysis presented in this research and provide useful and insightful information to TPC implementation initiative.

References


Promoting Internet Safety in Greek Primary Schools: the Teacher's Role

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ABSTRACT
The introduction of the Internet at schools has raised new pedagogical challenges facing educators trying to ensure children’s awareness of the possible dangers when surfing the Web. This article aims to investigate how teachers evaluate the possible dangers that students might face when surfing the Net for various educational or interpersonal purposes, and the teachers’ technological skills in terms of their ability to promote Internet safety awareness when supervising elementary students surfing the Web within the school premises. Using questionnaire surveys from 179 teachers in Greece, the present data showed that teachers who tended to incorporate technology in their every-day personal or professional habits were found to be more effective in promoting Internet safety issues in class such as discussions with students or teaching children moral behaviours when navigating the Net than their less technology enthusiastic colleagues. The current work strongly recommends the importance of a more systematic promotion of Internet safety awareness in primary schools as most Greek teachers seem to lack the basic pedagogical skills for exploring Cyberspace alongside their students, and giving worldly guidance and wisdom screen-by-screen.

Keywords
Teachers, Internet safety issues, elementary students

Introduction
Nowadays, one of the main goals of almost every European country is to prepare children of all ages for an increasing complex and technological world by improving the educational quality and cognitive standards of the pupils in addition to support teachers in their everyday classroom (Anastasiades, Vitalaki & Gertzakis, 2008; Chen, 2008; Reynolds, Treharne & Tripp, 2003; Plowman & Stephen, 2003). Therefore, training children on the use of the Internet as a tool to collect information or fact finding in elementary schools has become an important and challenging issue for teachers as disorientation by misleading or inappropriate information on the Web is one of the major problems that novice pupils tend to have while navigating the Internet (Dias, Gomes, & Correia, 1999). Thus, this paper focuses on the impact of the integration of computers and the Internet at school and investigates the level of the teachers’ capacity to provide safe practices and wise pedagogical guidance to elementary students when they have the opportunity to surf the Internet for various purposes (e.g. educational, recreational, interpersonal, etc.) in less regulated contexts inside or outside the school boundaries.

The first part of the article makes a brief literature review of various findings on the teachers’ attitudes towards the penetration of the Internet at schools and their challenging perspective to promote Internet safety policies with students in class. In the next sections, we provide the reader with various information about present attempt such as, a general description of the study, the methodology used, the hypotheses of the research as well as the presentation of the sample and the data analysis. Finally, a brief description of the research variables is also included. Moreover, the following part elaborates on the results of the study. On the basis of the discussion of the results we present conclusions about the significance of the teachers’ role in view of safe Internet use by elementary students and the article finishes with the researchers’ proposals for further research.

Literature Review
Promoting the Internet safety awareness to elementary students: Teachers’ Attitudes

As to, whether the Internet has a positive influence in children's lives is mostly sketchy and ambiguous, concerns have emerged from both parents and educators for the safety of students unsupervised when surfing the Web for either educational or recreational purposes (Valcke, Schellens, Van Keerand & Gerarts, 2007), as children may also be exposed to inappropriate material such as pornography, gambling games, purchases, improper information about strangers, etc. (Anastasiades et al., 2008; Vallentine & Holloway, 2001) that most adults would deprecate against it.
As schools both in England and internationally are considered to be an important factor to counter the negative side-effects of Internet use by students (Valcke, Schellens, Van Keerand, Gerarts, 2007; Wishart, 2004), most of these initiatives were concerned with technological solutions, such as filtering software (Mitchell, Finkelhor & Wolak, 2001; Hunter, 2000) that were appropriate for a single computer at home or in the classroom rather than playing a central role in developing safe Internet behaviour in their students (Valcke, et al., 2007).

Regarding the impact of school based Internet safety interventions in developing pupils’ safety attitudes when surfing the Web for various activities, Valcke, et al., (2007) concluded that there are limited evaluative studies focusing on such innovative ventures within the school context. For example, more contemporary implementation of intervention theories in the classroom deal with online role play activities in order to motivate and enable children to discuss and learn about internet safety by increasing pupils’ involvement in existing online activities (Wishart & Morris, 2007; Ingram, Hathorn, and Evans, 2000; Harasim, Starr, Teles, & Turoff, 1995). Particularly, Wishart et al.’s (2007) intervention programme for teaching Internet awareness to 9–12 year old students in three UK schools found that 34% of the pupils claimed that they had learned about Internet safety procedures and not to hand over personal details in chat rooms and 27% learned not to trust what other users say. Despite the validity of the implementation of such Internet safety intervention in class, the “newness” of these novice attempts usually meets potential obstacles (e.g. technical issues, the amount of preparation of the pupils carried out by the teacher in charge may become a crucial factor to the success of the online role play, etc.) (Wishart et al., 2007), which may consequently lead the programme to a deadlock (Reynolds et al., 2003).

Training elementary students to use digital devices to collect information for various educational or interpersonal purposes is a challenging perspective for teachers who lack the skills for using such technological and pedagogical innovations in class (see Chen, 2008; Todman and Day, 2006; Reynolds et al., 2003; Chou, 2003; Leu, 2000) than those who are more willing to keep up with the fast development of advanced technologies and to try out innovative methods in class (Albirini, 2006; Migliorino & Maiden, 2004, Liaw, 2002). Similarly, additional studies indicated that teachers often express anxiety symptoms when they have to be involved with their students in various digital educational or interpersonal activities (Al-Fudail & Mellar, 2008; Weil & Rosen, 1997; Brod, 1984), meaning that these online education appliances may often be ignored by them (Hwang, Tsai, Tsai & Tseng, 2008; Todman & Day, 2006; Chou, 2003; Namlu & Ceyhan, 2003).

Regarding the possibility of students being exposed to various dangers through the Web (Anastasiades et al., 2008), a number of official initiatives have been launched that were designed to help educators about how to protect children when they go online (e.g. National Grid for Learning, 2002; Media Awareness Network, 2001; Children’s Charities’ Coalition for Internet Safety, 2001, et.c., see more in Wishart & Morris, 2007 and Valcke, et al., 2007). Though, acknowledging the validity of such Internet safety instructional initiatives for educators within the school context, someone might query the effectiveness of such instructions as they do not yet guarantee the amplification of teachers’ skillfulness and self-esteem for cultivating students’ critical judgement when they are triggered off by doubtful information through the Net in less controlled settings (Valcke, et al., 2007; Berson, 2002). Finally, other researchers agree that despite the various school-based interventions such as discussions between students and teachers about Internet safety matters (Berson, 2002) role play etc., although innovative, are considered to be “new” and as yet less effective to expect a direct impact on pupils’ behavioural level of safe Internet use (Wishart & Morris, 2007; Valcke, et al., 2007; Wishart, 2004).

In sum, whilst there is only a limited amount of evulative studies focusing on teachers’ involvement with students in promoting fundamental Internet awareness in or out of the school classroom, the literature itself highlights the vital role of schools in promoting and ensuring safety measures and pedagogical guidance of both pupils and parents in crucial Internet matters. Moreover, the need for providing teachers with higher technological competence (Chen, 2008; Al-Fudail & Mellar, 2008; Todman & Day, 2006; Reynolds et al., 2003; Chou, 2003; Leu, 2000) and with innovative pedagogical guidance for Internet safety issues seems immense but it is only part of the story (Wishart & Morris, 2007; Valcke, et al., 2007; Wishart, 2004). To the writers’ point of view, effective involvement of teachers is mostly associated with positive attitudes and approaches to software, their flexibility to take an approach that is relative to students’ developmental needs, beliefs and cognitive standards, to seek, to inspire, to support and facilitate children’s critical thinking while setting the scene for an Internet safety pedagogical environment in class (Wishart & Morris, 2007; Valcke, et al., 2007; Albirini, 2006; Migliorino & Maiden, 2004; Wishart, 2004; Liaw, 2002).
The Research

General Description of the Research

Recognizing the importance of teachers’ involvement in children’s safe and effective use of the Internet in and out of the school premises, this article focuses on the relations between primary teachers’ computer/Internet experience, and their effectiveness and attitudes towards regarding students’ safety when they surf the Web for various educational or interpersonal reasons in and out of the school boundaries. Particularly, the main objectives of this research were to investigate: a) teachers' attitudes towards their pupils when they have an option to use the Internet at school, b) to what extent can teachers identify risky behaviours during Internet use by students in school, c) if teachers take responsibility for promoting Internet safety issues in class and, d) if teachers currently get enlightenment on promoting pupils’ Internet Safety behaviour.

Finally, the significance of this study lies in pointing to the fundamental need of teachers to be prepared for much more than book literacy in their classrooms as they are expected to be both efficient users of the Internet technology and guides of primary students in developing adequate safe Internet skills. Furthermore, the present research emphasizes the need for training or giving directions to teachers in safety Internet issues that build on a more safe engagement of pupils in primary schools.

Methodology and hypotheses

For the needs of this study elementary students responded to a questionnaire in order to identify: a) teachers’ efficacy to use computers and the Internet, b) their attitudes towards incorporating the Internet as an educational and recreational tool in class, c) which teachers consider themselves capable enough to teach Internet Safety, in what ways, with which age groups and in which locations (urban or rural schools), d) how teachers evaluate the current Internet Safety issues for students, which are emerging and the overall importance schools assign to the topic, e) what Internet safety actions usually take place in class, and finally f) where teachers currently get advice from on Internet Safety and how they respond to that advice. More specifically, the assumptions tested here are:

a) Teachers’ technological abilities affect significantly their level of confidence when supervising children on the Internet as well as when both (students and teachers) are engaged in various learning activities too.

b) Higher technological profiles can also lead to a greater teacher evaluation of the Internet dangers and their serious effects on minors’ psycho-physical development.

c) Teachers’ technological ability is also a serious factor of keeping students away from the negative content found on the Web by promoting Internet safety behaviours in class.

d) The effectiveness of the teachers to promote Internet safety issues in class is also connected to the type of guidance they have already received.

Sample and Research Material

The research was carried out among 36 elementary schools, which 26 were urban and 10 rural in the island of Crete during the 2005–2006 academic year with the participation of 179 teachers, 55 (30.7%) male and 124 (69.4%) female in total. The school principles of the elementary schools recruited their teaching personnel from first to sixth grade to participate in the present research. Their age ranged from 25 years to 45 years old. The whole sample of teachers had received the basic university qualification on how to manipulate computers and Internet. The selected sample of elementary teachers represents all geographic areas of Crete, and also different sized school populations, from big cities to small towns and villages.

Procedure and Research Tools

To recruit teachers for this study, the researchers first contacted the principal of the school. After getting permission from the principal and teachers of each school, the survey questionnaire was delivered to teachers.
To measure elementary teachers’ attitudes and ability to promote Internet safety issues into classroom pedagogy, five tables are formed on the basis of their answers: a) **Table 1** labelled *Primary Teachers’ ability to navigate the Internet* was based on multiple-choice questions that detected the participants’ level of technological profile (e.g. teachers’ experience with computers and the Internet and their access to technology). **Table 2** labelled *Ways of being educated in computer functions* asked teachers how they obtained further information in technical functions. **Table 3** labelled *Type of Internet Activity* questioned the type of computer activities of the teachers in or out of the classroom, b) **Table 4** labelled *Emerging Internet Thoughts and Expectations* questioned the attitudes of the teachers toward their students’ opportunity to use the Internet for increasing their cognitive skills or interpersonal experiences in school settings. Finally, **Table 5**, labelled *Teachers’ Ability to Promote Internet Safety Issues according to their Technological Profile* measures teachers’ effectiveness to conduct primary students morally when the latter surf the Internet inside school. All Likert-type questions are coded 5 or 4 if the teacher’s answer is *more or less positive*, 3 and 2 for *negative or strong negative answer* and 1 for *not knowing what to answer*.

**Data Analysis**

The electronic data of the questionnaires were blueprinted and a content analysis of the text was conducted. Data analysis was performed right after the questionnaires were filled in by the teachers. All statistical analysis of the data was performed using SPSS statistical package (Howitt & Cramer, 2004). For questions collecting quantitative data, frequencies of the responses to each question were calculated and cross-tabulations of the results were made. Where appropriate the $x^2$ statistic was used to test for statistically significant associations within the cross-tabulation. Finally, where correlation between variables was calculated Spearman’s rank order correlation coefficient was preferred. Additionally, a binary logistic regression was conducted to test the reliability of the model in predicting the self-perceived teacher’s knowledge about the dangers of the Internet and their evaluation of the incorporation of the Internet usage in their classroom pedagogy regarding their tendency to promote Internet safety issues with their students. For explaining the teacher’s knowledge about the Internet dangers a logistic regression model has been obtained after one iteration of backward method as proposed by Field (2005). This model explains 70.3% of the data and with a significiation of 5%, the Hosmer and Lemeshow test shows that the model fits the sample data well. The results are reported in the following sections.

**Results**

Concerning the teachers’ level of technological profile the present study showed that almost half of the sample had the basic grasp to navigate the Internet (30.2% of the teachers were positive and 16.8% very positive) comparatively to the rest of the participants who were more skeptical about their Internet familiarity (38% of the teachers were less positive while 13.4% answered negatively) (Table 1).

<table>
<thead>
<tr>
<th>Do you use the Internet?</th>
<th>Frequency</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>More positive</td>
<td>30</td>
<td>16.8</td>
</tr>
<tr>
<td>Positive</td>
<td>54</td>
<td>30.2</td>
</tr>
<tr>
<td>Less Positive</td>
<td>68</td>
<td>38.0</td>
</tr>
<tr>
<td>Negative</td>
<td>24</td>
<td>13.4</td>
</tr>
<tr>
<td>I do not answer</td>
<td>3</td>
<td>1.7</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>179</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

In relation to the question that detected where or how the teachers got their basic skills to use computers, almost half of the sample stated “in teacher training programmes” while 12.8% stated in “private institutes”. However, it is worth mentioning that a 25.7% of the remaining sample claimed that they were “self-learners” while the rest of the participants did not give an answer (Table 2).

Finally, it was found that using the Net for preparing schoolwork for pupils (67%) and checking their e-mail (66.7%) were the two most favoured computer activities for both sexes of elementary teachers. Less than half of the teachers (39.1%) used the Internet for education and 26.3% to search for various information (Table 3).
Table 2: Ways of being educated in computer functions

<table>
<thead>
<tr>
<th>Where or how did you get the basic skills on computer functions?</th>
<th>Frequency</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>In a private institute</td>
<td>23</td>
<td>12.8</td>
</tr>
<tr>
<td>I am a self-learner</td>
<td>46</td>
<td>25.7</td>
</tr>
<tr>
<td>In teacher training programs</td>
<td>75</td>
<td>41.9</td>
</tr>
<tr>
<td>I do not answer</td>
<td>35</td>
<td>19.6</td>
</tr>
<tr>
<td>TOTAL</td>
<td>179</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Table 3: Type of Internet Activity

<table>
<thead>
<tr>
<th>Type of activity</th>
<th>Internet access (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>Mail</td>
<td>66.5</td>
</tr>
<tr>
<td>Education</td>
<td>39.1</td>
</tr>
<tr>
<td>Searching for various information</td>
<td>26.3</td>
</tr>
<tr>
<td>Preparing schoolwork for pupils</td>
<td>67.0</td>
</tr>
</tbody>
</table>

Urban primary teachers more than rural ones ($x^2=9.600$, df=2, p=.008), were found more willing to conduct pupils in technology matters. Though, pupils’ option to use the Internet for education or recreation inside the school premises, seemed a less favoured idea by both urban (53%) and rural teachers (63.4%). Apparently, using the Internet in both urban and rural schools, was an activity mainly related to the pupil’s personal choice and less for school requirements and generally for educational purposes. A closer look of Figure 1 shows that the Internet was rarely thoroughly involved in its exploitation in the classroom but mainly during the school breaks, probably consequently leading children to an accidental access to inappropriate material.

![Figure 1: Pupils’ opportunity to navigate the Internet at school](image)

In response to the questions regarding whether pupils can widen their cognitive skills through the Internet usage, most teachers applauded the idea (90.5%). Though, according to the binary logistic regression to predict teachers’ opinion about the Internet related to the reasons that students should navigate the Web as well as the teachers’ efficacy to discuss the Internet dangers in class, it was found that: a) the technologically skilled sample considered the Internet a useful educational tool for pupils ($R^2=0.79^*$) and, b) they tended to encourage pupils almost twice more to use the Internet for various educational and recreational reasons ($R^2=0.63^*$, Exp. (B)= 1.88) than their colleagues with less technical skills. Additionally, teachers with higher technological backgrounds seemed to know better the Internet hazards and considered themselves more efficient to promote Internet safety issues in class ($R^2=1.36^{***}$). Finally, the patterns in these relationships were similar for male and female educators with higher level of technological profiles. The present results are analytically presented in Table 4.
### Table 4: Emerging Internet Thoughts and Expectations

<table>
<thead>
<tr>
<th>Teachers’ Thoughts and Expectations when students navigate the Internet in class</th>
<th>95% CI for exp b</th>
<th>β (SE)</th>
<th>Lower</th>
<th>Exp. (B)</th>
<th>Upper</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-5.848 (1.25)</td>
<td>0.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The Internet offers new educational opportunities for primary students</td>
<td>0.79* (.32)</td>
<td>1.17</td>
<td>2.19</td>
<td>4.12</td>
<td></td>
</tr>
<tr>
<td>The Internet promotes students’ methodical and scientific way of thinking</td>
<td>0.63* (.27)</td>
<td>1.12</td>
<td>1.88</td>
<td>3.16</td>
<td></td>
</tr>
<tr>
<td>Teachers’ ability to discuss Internet safety issues with primary students</td>
<td>1.36*** (.30)</td>
<td>2.17</td>
<td>3.90</td>
<td>7.01</td>
<td></td>
</tr>
</tbody>
</table>

R² = 0.22 (Hosmer & Lemeshow), 0.26 (Cox & Snell), 0.35 (Nagelkerke), Model χ² (1) = 52.41
p< 0.001, * p<0.05, ** p<0.01, *** p<0.001

According to Table 5, after correlating teachers’ technological level and their effectiveness to promote Internet safety issues with pupils in class, the present data revealed that teachers with higher technological abilities were also better informed about the possible risks that elementary pupils might face on the Web (rₑ =0.27**). Also, these teachers seemed more capable of controlling pupils’ unsafe behaviours when exploring the Web (rₑ =0.36**) and they avoided less to make discussions with students about the possible Internet risks rather than their low technically skilled colleagues (rₑ = -0.16*). Moreover, teachers with higher technological level tended to inform pupils regularly about the possible negative Internet effects on their physical and psycho-social development (rₑ = 0.21**) as they knew the way compared to the teachers with lower technological profiles (rₑ = -0.28**) who did not know how to do so. Finally, an additional χ² statistical analysis between the two sexes of teachers revealed that male teachers tended to initiate Internet safety measures in class more than their female associates (p=. 018).

### Table 5: Teachers’ Ability to Promote Internet Safety issues according their Technological Profile

<table>
<thead>
<tr>
<th>Teachers’ attitudes and perceptions</th>
<th>Spearman’s Rho (rₑ) Correlations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teachers are aware of the possible dangers when students navigate the Web</td>
<td>0.27**</td>
</tr>
<tr>
<td>Teachers are qualified enough to promote Internet Safety behaviours in class</td>
<td>0.36**</td>
</tr>
<tr>
<td>Teachers make regular discussions with students about the possible Internet risks and the negative Internet effects on their physical and psycho-social development</td>
<td>0.21**</td>
</tr>
<tr>
<td>Teachers usually feel discomfort when discussing Internet hazards with pupils but it is their duty to do so.</td>
<td>-0.06</td>
</tr>
<tr>
<td>It is the school’s principle to discuss with pupils Internet hazards</td>
<td>0.14</td>
</tr>
<tr>
<td>Teachers wish they could discuss with pupils about Internet hazards but they do not know the way</td>
<td>-0.28**</td>
</tr>
<tr>
<td>Teachers absolutely trust their students when they surf the Net without their personal guidance.</td>
<td>-0.09</td>
</tr>
<tr>
<td>When pupils surf the Net at school, they are always guided by a teacher.</td>
<td>0.07</td>
</tr>
<tr>
<td>Teachers do not discuss with students about the Internet dangers in class</td>
<td>-0.16*</td>
</tr>
<tr>
<td>Teachers avoid to discuss with students about the Internet dangers even if they are asked</td>
<td>0.12</td>
</tr>
<tr>
<td>Promoting moral behaviors when children surf the Net is the parents’ and not the teachers’ obligation.</td>
<td>0.04</td>
</tr>
</tbody>
</table>

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

In response to the question if teachers are properly qualified to promote Internet Safety behaviours in class, a 54% gave a “Little” statement and 23% of the teachers were negative. Also, a 17% of the sample stated “some” while only 6% gave an absolute positive answer (Figure 2).
Finally, it was interesting to find that 39.1% of the teachers justified their avoidance of promoting Internet Safety issues with students due to the poor technologically resourced schools while a 58.7% admitted that they simply did not find any interest in incorporating technological practices along with moral behaviour development in their classroom pedagogy. Moreover, most teachers (86%) agreed that it is the States’ responsibility to provide teachers with the appropriate advice and encouragement to integrate the Internet into successful pedagogical and safe practices at school (Figure 3).

In conclusion, although most teachers are familiar with the basic functions of computers, it seems that teachers with higher Internet efficacy have a greater perceived evaluation of the possible dangers that a student may encounter on the Net. Finally, primary educators who value the various Internet applications in primary education seem more capable of incorporating Internet Safety issues into their classroom pedagogy.

Discussion and Future Research

The current study detects how teachers from urban and rural primary schools in Greece, perceive the issue of the possible dangers that students may face when surfing the Net for educational or recreational activities. Particularly, the notion of the teachers’ level of familiarity with the Internet use and their ability to promote Internet safety behaviours in class, was also investigated.
An overall review of this work showed that teachers while recognising the liberate and empowering possibilities of the internet, seemed deeply concerned about how the web should be managed and controlled safely by primary students. Thus, teachers with higher internet familiarity were more likely to incorporate the Internet technology in the students’ learning process and they were more effective to control and to promote internet safety issues as they knew better the possible risks that children may encounter in the Web.

Specifically, according to the teachers’ technological background almost half of the sample did have the basic skills to use the Internet while the others simply did not. Also, better skilled teachers seemed more comfortable to use the Internet in class while teachers with lower technological profiles tended to appreciate less the educational significance of the Web for pupils (Ertmer, 1999; Fabry & Higgs, 1997).

Regarding participants’ perceptions and attitudes towards the possible risks pupils may encounter on the Net, the present study found that teachers with higher technological profiles seemed quite worried about pupils viewing something that is out of their control inside the school environment (Wishart, 2004). Consequently, these primary teachers were more likely to promote their pupils’ Internet safety behaviours in class (Valcke, et al., 2007) and at the same time to engage students in meaningful interaction than teachers with less sophisticated Internet skills (Chen, 2008). Thus, male educators seemed more confident in promoting Internet safety behaviours in class than their female peers. This finding probably drops hints that technology practices between men and women seem to remain still a gendered space (Veckiri & Chronaki, 2008), as women are more likely to have less positive perceptions of their computer competence and are less attracted to computers than their male companions (Anastasiades, et al., 2008; Colley & Comber, 2003; Singh, 2001; Kadijevich, 2000; Durndell & Thomson, 1997; Shashaani, 1997; Whitley, 1997).

Furthermore, students’ option to navigate the Net mostly during school breaks may not only derive from the teachers’ personal inconvenience to monitor or engage with their students over the pedagogical and moral use of the internet but from other reasons too, such as technological inconveniences (e.g. poor digital appliances, network problems, lack of technological support etc.) (Anastasiades, et al., 2008; Pettersson & Carlsson, 2004; Chen & Wellman, 2004; Reynolds, Treharne & Tripp, 2003; Epper, 2001) and other personal reasons (Chen, 2008; Reynolds, et al., 2003; Solomon, 1998), such as lack of interest in technology (Spodark, 2003; Epper, 2001; Fullan, 2001; Etmer, 1999; Fabry & Higgs, 1997).

Generally, most teachers were found inefficient to be involved with students in promoting Internet awareness as 54.2% of them expressed low self-esteem to teach safe Internet practices in class while 22.3% were strongly negative in dealing with the particular subject (Chen, 2008; Hwang, Tsai, Tsai & Tseng, 2008; Valcke, et al., 2007; Wishart & Morris, 2007; Todman and Day, 2006; Wishart, 2004; Chou, 2003; Namlu & Ceyhan, 2003). Due to this, almost all of the sample identified the vital role of schools in promoting particular intervention programmes for ensuring Internet Safety (Chen, 2008; Valcke, et al., 2007).

Therefore, it is strongly recommended: a) the importance that all teachers receive full information on the dangers related to the Internet use and proper training on how to protect and guide their students on the Internet safety, b) to provide schools with teaching materials to use with pupils aimed at developing Net literacy and safe surfing practices that enable pupils to use the Internet responsibly and usefully both in and outside school, c) to involve teachers and students in interactive environments based on specific intervention programmes aimed at the development of safe Internet behaviours of young children and, d) to promote parent and family partnerships in schools, in order to guide minors to develop a critical thinking when navigating the Web for education or amusement in or out the school premises.

This study is subject to several limitations: first, the present sample is small in scale and there may be other variables that need to be included for study. Second, the research data were derived only from questionnaires. A richer data set could be based on actual observation of both teachers’ and students’ Internet use in class and teacher focus groups. However, the results presented do enable the generation of hypotheses which could usefully be tested in larger scale studies. Despite these methodological constraints, the current work strongly emphasises that additional action in Internet safety lines have to be developed and implemented in Greek primary schools.

Based on this study, future research in this area might include further examination of the factors influencing the teachers’ level of involvement with pupils in the pedagogical and safe uses of the Internet in class. Teachers’ features
such as communication style, teaching style and to what extend teachers try to assist students’ development of Internet safety awareness should be analytically examined too. Finally, actual Internet safety intervention programs taking place in class and how teachers evaluate the learning outcomes of their students in using the Internet safely should be also considered in future research.

References


Weil, M., & Rosen, L. (1997). Technostress coping with technology @ work @ home @ play. New York: John Wiley and Sons.
ABSTRACT
The purpose of this study was to explore the current state of information literacy (IL) training and to identify the strategies and methods used by Canadian public libraries in improving IL skills for their staff and patrons. Also, the study sought to identify problems associated with the development of IL training. This study employed document analysis, observations, and focus group interviews to collect research data. The focus group interview consisted of six library staff members. The research findings revealed that Canada’s public libraries valued their roles as IL training providers and paid careful attention to staff development by offering various training approaches in order to provide efficient IL instruction for the public. Another issue explored in this study is that Canadian public libraries build partnerships with other organizations to extend their IL teaching responsibilities. In addition to the financial concern, a major challenge, based on the research findings, is that public libraries need to let their staff understand the learning theories associated with IL education and adult learning in order to enhance the quality of this training. This study also proposes four guidelines for developing effective IL trainings at public libraries.

Keywords
Information literacy, Public library, Adult education, Lifelong learning

Introduction
In recent years, the issue of the digital divide has drawn remarkable attention from most developed and developing countries. “Digital divide” generally refers to unequal access to information and communication technology (ICT) and the gap between those who are “information-haves” and those who are “information have-nots” has raised great social problems of inequality (Hersberger, 2003; NTIA, 1995, 1998, 1999, 2000; Tien & Fu, 2008). In addition to the disparities of accessing information and communication technology, peoples’ lack of adequate computer knowledge and skills is also an important dimension that causes the digital divide (Tien & Fu, 2008). In 2000, the Group of Eight (G8) industrial summit issued a report. The report illustrated the serious problems related to this discrepancy in the world because the knowledge gap produced by the digital divide can cause an educational divide (Costello, 2000). Canada, a member of the G8 countries, has made efforts to bridge the digital divide within the country by developing advanced ICT infrastructure and providing information literacy programs to the public through libraries and schools (Whitehead & Quinlan, 2003). Under the policy of “Connecting Canadians”, a policy framework designed to make Canada the most connected country in the world, Canadian public libraries serve as appropriate sites to provide free computer access and to facilitate the development of Canadians’ information skills (Julien & Anderson, 2002; Julien, 2003). Public libraries in Canada play a significant role in bridging the digital divide and have brought positive influence to the country regarding the ever important issue of accessing both current and past information since any given decision or learning is directly influenced by the information base used to produce it.

Information literacy (IL) is generally defined as the set of skills to access, evaluate, organize, and use information from a variety of sources (Association of College and Research Libraries, 2000) and the emergence and prevalence of the Internet has made IL a necessary competency in the knowledge economy era. Resnick (2002) articulated that IL skills have become a prerequisite for obtaining a job, participating meaningfully in society, and learning throughout one’s lifetime. The public library is a place which supports adult education and lifelong learning and has the capability of narrowing the digital divide by providing free computer and Internet access and offering training courses to improve people’s IL skills. Governments around the world have recognized the critical role of public libraries in developing the IL skills of their citizens. As a result, funds have been allocated to public libraries to purchase computers and establish Internet connections, and a variety of IL approaches have been employed (Harding, 2008). In Canada, Industry Canada identified public libraries as appropriate sites to implement Community Access Programs (CAP), an initiative with the aim to provide Canadians with affordable public access to the Internet and the skills they need to use it effectively; thus, the majority of public libraries currently provide Internet access and IL training programs for the public (Julien & Hoffman, 2008).
Although the role of public libraries has been acknowledged as a valuable provider of IL development for the communities, existing literature primarily focuses on addressing the role of public libraries and their IL activities (Harding, 2008). There is still a lack of relevant study investigating IL training in public libraries, especially in the quality and organization of IL courses and the IL skills of public librarians. In Canada, there are two related researches on IL training in public libraries. A survey conducted by Julien and Breu (2004) in the 22 largest Canadian urban libraries found that 36% of those libraries provided formal IL training and 71% offered informal training. Another recent study showed that some of Canada’s public libraries were not engaged well in providing IL training to their customers because they lacked the following, 1) funding, 2) trained staff, and 3) appropriate physical space. However, some were embracing their teaching role in IL education by offering formal lessons for users at different levels (Julien & Hoffman, 2008). Their study surveyed 836 urban and rural public libraries across Canada. These two studies outlined the IL instruction occurring in Canadian public libraries and presented views of library staff and customers toward these training courses. The present study attempted to expand the understanding of IL training in Canada’s public libraries by exploring the strategies and methods used by Canadian public libraries in improving these skills for their staff and customers.

**Literature Review**

The definition of IL, according to the broad context of lifelong learning and the ongoing acquisition of information skills can be described as locating, evaluating, managing, and using information effectively from a range of sources for problem solving, decision making, and research (Koning, 2001). ICT and IL are closely related because the digital and electronic formats are gradually replacing printed materials in libraries. How to effectively use ICT to locate electronic resources has become a major concern for users and public libraries have the responsibility to provide IL education for the public for the purpose of meeting their growing demands to acquire information through libraries’ electronic databases. It is also a challenging issue for public libraries to design proper IL courses for their patrons. Moreover, their staffs’ IL skills are certainly a significant factor in determining the effectiveness of this training.

Research studies regarding the concerns of adult learning in using technology-enabled media have substantially increased in the field of adult education. The early works of Knowles (1990) identified relevant features of adult learners, which are different from those of young people, which consist of self-directed learning as the preferred model, a problem-based learning rather than a subject-centered approach, and sociocultural learning. Based on adult learning theory and the characteristics of computer-based instruction (CBI), Lowe and Holton (2005, p.158) developed a conceptual model to describe critical elements affecting the usefulness of CBI for adults. They listed four arguments according to their proposed conceptual model:

1. The characteristics of self-directedness and computer self-efficacy of adult learners play an important role in designing CBI for adults;
2. CBI design is interwoven with the units of self-directedness, computer self-efficacy, learning goal level, instructional design, and external support;
3. Learning goal level affects instructional design strategy and the instructional control component of CBI design; and,
4. External support and instructional support are needed to provide a positive CBI experience.

Merriam, Caffarella, and Baumgartner (2007) further indicated that linking adult learner’s prior and authentic experiences to practice new skills and knowledge helps them to construct meaning and promote reflective thinking in the learning process. Thus, when designing IL instruction for adult learners, their internal state of psychological readiness to undertake self-directed learning, prior experiences, and computer self-efficacy should be carefully considered. Also, the learning objectives of IL training courses and support from instructors should be well-planned and related to the needs of the learners.

Related studies (Ashoor, 2005; Hart, 2006; Julien & Breu, 2005; Julien & Hoffman, 2008) have suggested that the library staff’s attitudes toward IL training are critical in affecting the usefulness of IL curriculum and learning outcomes of the patrons. In Julien and Hoffman’s (2008) study, they found that library staff who possessed awareness of being IL providers cared more about their teaching role in IL training and these staff expressed their concerns in facing challenges associated with their teaching role, such as digital divide issues, infrastructural
problems with library buildings, and pedagogical challenges related to education. Hart (2006) investigated the IL education programs of public libraries in a South African province and she discovered that the leader’s involvement, library staff’s input, and sustainable IL programs contributed most to the success of IL education for the public. Ashoor (2005) also argued that various formal IL training programs, such as library-orientation and information-searching skill courses, enabled library users to master content and extend their investigations related to their work and life and helped them to become more self-directed learners which can further build their lifelong learning skills.

Since IL competencies have been identified as a crucial element to foster lifelong learning and keep up with the fast changing world, integrating IL learning into education at all levels should be a priority concern (Badke, 2008; Snavely, 2008). Snavely (2008) emphasized that even though people claim that they have a high degree of confidence in using computers, their IL skills might be disgraceful. In today’s workplace, information, in most cases, can be easily retrieved from the Internet, but people waste so much valuable time because of a lack of adequate skills to find appropriate resources, evaluate information, and use the information effectively in solving problems (Badke, 2008). Therefore, in the context of formal institutional learning environments, teaching IL can permit students to navigate the technology effectively and become efficient seekers and users of information (Riedling, 2009).

Recent studies (Barnard, Nash, & O’Brien, 2005; Hohlfeld, Ritzhaupt, Barron, & Kemker, 2008; Probert, 2009; Shanahan, 2007) have revealed that students’ IL skills need to be enhanced and careful attention needs to be paid to these skills in primary, secondary, and even in higher education sectors. Probert (2009) provided evidence from a longitudinal research project in New Zealand which showed that primary school students were not equipped with sufficient IL skills, especially judgment and discrimination when using Internet information. Hohlfeld et al. (2008) analyzed statewide data and discovered that significant differences in students’ ICT literacy existed in Florida’s K-12 public schools. Shanahan (2007) surveyed a group of undergraduate radiography students’ IL skills, and she found that students performed low skill levels in constructing search statements while using databases. Therefore, seeking help from the librarians, who possess knowledge for mastering electronic databases, can provide practical solutions. Barnard et al. (2005) articulated that librarians have a responsibility to work collaboratively with teachers in order to enhance students IL skills in meaningful ways. Snavely (2008) suggested that the best way to teach IL is to integrate it into the most important parts of schools’ curricula, and school administrators can look for ways to connect the public libraries and librarians with the curricula to integrate IL into courses. Hence, the attitudes of library staff toward IL training and the formal and informal IL instruction prepared by public libraries should be carefully organized and evaluated in order to increase library users’ IL skills and further close the digital divide among the people.

Research Methods

Subjects and settings

The subjects for this study were six staff members who were responsible for IL training in an urban public library located on Canada’s west coast. This library is the third largest public library system in Canada and it currently has 22 branches and an extensive virtual library. There are 520 total public Internet-connected computers available for library patrons and training facilities, such as computer labs and classrooms, are also accessible at different locations throughout the city. In addition, new immigrants can request IL instruction in other languages at the central library.

These six participants were the manager, administrator, training coordinator, instructor, and computer technician and they all had been involved in designing and teaching IL training courses for library patrons and staff. Their experience ranged from 3 to 20 years. All research data were collected at the central library and a branch.

Data collection techniques

This study employed document analysis, observations, and focus group interviews to collect research data. Document analysis included analyzing and evaluating significant information contained in the library catalogues, official reports, policy statements, newsletters, memos, posters, lesson plans, and IL training scripts. The researcher observed and examined the setting and environment of training facilities and two training sessions that took place at the central library. The observations mainly were focused on the arrangement of the training facilities and the behaviors and interactions of library patrons while they were taking an IL training course and filed notes were taken.
to record details of what happened during the training sessions. Focus group interviews were conducted to collect the thoughts of people involved in IL training by organizing a discussion to gather their comments. During the focus group interviews, the researcher used a digital recorder to document the discussions. The following research questions were used for the focus group interview:

1. What facilities and resources do the public libraries have in order to run effective IL training in both formal and informal ways?
2. What IL training programs involving librarians and library patrons are being run at present?
3. What were the reactions of library patrons who took the formal or informal training lessons?
4. What experience and training in IL theory and practice do public librarians have?
5. What might inhibit IL training programs in public libraries?
6. What might help IL training programs in public libraries?

**Analysis**

The focus group interview data were completely transcribed and coded and a qualitative analysis software program, Atalas.ti, was used to facilitate content analysis of the research data. All responses to every research question were grouped and potential categories or significant ideas were initially identified during the coding process. Focused themes were then formulated based on the commonalities in the potential categories. When the research data did not fall well into the themes, data re-coding and re-grouping were administered. Within this study, document analysis and the field notes of observations were triangulated with the focus group interview data to support the trustworthiness of the explanations of the research results.

**Research Results**

**IL training: the essential service of public libraries**

The research data, according to the library’s booklets and staff interviews, revealed that public libraries were aware of their educational roles in IL training and regular training sessions were arranged at the central library and other branches across the city. Most participants agreed that IL training was a mandatory service of public libraries and library staff had the responsibility to serve as agents to empower library patrons’ IL skills by providing guidance and instruction in formal and informal means of accessing that information. In addition, the design of IL courses was based on the needs of most library patrons and available resources at public libraries. For example, in a 90-minute hands-on section, the Computer Basics course at the central library taught primary computer skills, Internet browsing, email, and security issues. The training session also included practice of searching the library catalogue, and different searching techniques were introduced. Each training course had its own training script written by experienced instructional designers and the training script provided guidance for instructors to control the pace of the lecture. In addition, because of the growing population of new immigrants in Canada, public libraries also offered instruction in other languages. The central library considered the learning conditions of senior citizens that might require more and specific attention. An IL lesson, Computer Basics for Seniors, was offered exclusively to them on a weekly basis.

The formats of IL training, in addition to formal lectures, one-to-one and group coaching on a particular type of IL skill was available by request. One of the interviewees described that “Library customers can come to the reference desk to request training at a certain level of computer skill or subject, such as working on a business plan or looking for health information from the library database.” Another important issue revealed in the focus group interviews dealt with the strategy of attracting more library patrons to take IL training courses. There were three IL training courses, Computer Basics, Search Smart (figure 1) and TechnoTuesday, regularly offered in the public libraries. Besides posting the course information on the library web and bulletin boards outside and inside the library buildings, the course title was very important. One staff member indicated that “The name of course title affects people’s willingness to come to the class. The original name of Search Smart was Search Your Library and it did not sound attractive, according to library patrons’ opinions.” On the other hand, three respondents articulated that most library patrons were not effectively searching information due to lack of sufficient Internet searching skills and this problem greatly reduced their IL abilities. Public libraries, as IL providers, should pay more attention to this issue by providing IL training in the search techniques of using various search engines and databases.
Figure 1. The “Search Smart” course poster

Staff development: the crucial element of effective IL training

In order to provide effective formal and informal training opportunities to the public, library staff need to improve their IL and teaching skills. During the interviews, many library staff expressed their observations that their input was the most valuable resource needed to run successful IL training programs for library patrons. One library staff member noted that “Information technology has changed dramatically in the past years and librarians have to keep their knowledge and skills updated in every aspect of information technology applications.” Nearly every library staff member was required to participate in IL teaching in the public libraries and programs, and courses for training the staff were given inside and outside the libraries. The central library offered system-wide IL and training skill courses to staff. One of the training coordinators talked about the various IL instruction programs and resources for the library staff. “We expect our staff to provide certain types and levels of training to the public. We need to train the staff first. We offer staff courses in new technologies, training delivery skills, one-on-one coaching, and designing courses.” Also, informal training opportunities were arranged during the regular library staff meetings, that is, library staff were sometimes required to share their knowledge and training skills related to IL with their colleagues. One of the respondents noted that “Training is important not only to enhance staff’s skills in delivering IL instruction, but also to ease their fears when teaching the public.” Usually, staff took training courses based on the recommendations of their supervisors.

Partnership with other organizations to promote IL education

Public libraries’ administrators and staff realized that IL training programs should reach more people who were in need. Thus, the central library has built partnerships with local organizations to provide free IL training opportunities outside the libraries and people can attend IL training courses at community centers, career centers, senior centers, and universities’ continuing education centers. In particular, the public libraries also worked closely with new immigrant service organizations to provide services in helping them to use ICT and to become information literate. For instance, the central library structured a series of training workshops for the members of the S.U.C.C.E.S.S. organization. S.U.C.C.E.S.S. is an abbreviation of Sino United Chinese Community Enrichment Social Service and it is a non-profit charitable organization for the purpose of promoting the well-being of Canadians and immigrants (S.U.C.C. E.S.S., 2008).

Because of the limited IL training resources in most Canadian community centers, the central library had a truck that carried mobile training facilities to the training classrooms. The design of the mobile training facilities was easy to set up.

Factors affecting IL training

Library staff also expressed their concerns regarding effective approaches about how to run IL training programs. One of the major challenges was the pedagogical issue. One respondent said that “Even though we have sophisticated, highly skilled training programs and organizational supports, we kind of miss out—why? And we kind
of jump into doing it.” Another library staff member further showed her agreement by explaining that “Most staff who work in the public libraries must have library science degrees and I assume they know the coherent theories behind teaching but they tend to ignore them.” Another challenge was the financial issue. During the interview, three respondents mentioned that insufficient funding had an impact upon the IL training in the smaller libraries. One staff member explained that “Some small libraries even don’t have full-time staff to do the training.” Moreover, although IL training programs were available to staff working in the public libraries, many library staff still did not value the training opportunities. One staff member indicated that “Some staff members are resistant to embrace their teaching role in providing IL instruction.”

Discussion

The results of this study revealed that IL training was highlighted as an essential service in Canada’s public libraries. IL training courses were provided to the public and staff, and to a great extent, training facilities and programs were designed to meet the needs of library patrons and staff. The well-placed ICT infrastructure in public libraries contributes to the positive influence. In fact, one of the Canadian federal government’s “Connecting Canadians” programs, Canada On-line, labeled public libraries, in addition to other publicly accessible places like schools and community centers, as appropriate sites to get Internet access (Julien & Anderson, 2002). Two subprograms of Canada On-line, LibraryNet and the Community Access Program, have funded all public libraries to purchase computers and establish Internet connections (Julien & Breu, 2005). The above observations suggest that ICT infrastructure is the foundation of bridging the digital divide in a nation, and the other part, which is the most difficult, is how to enable all citizens with the appropriate skills so that they can make good use of ICT. Providing well-organized IL instruction has become the primary goal of IL education for the public libraries to work on.

In this study, public libraries’ administrators and staff seemed to understand the importance of developing their staff’s IL knowledge and their training delivery skills in order to run effective IL programs for the public. Although the instructional design of IL courses took learners’ characteristics and the attributes of technology into consideration, the IL training manager and coordinator were also concerned about how to improve the staff’s teaching skills. The results show that most library staff were not aware of the theories behind IL education and adult learning when they taught IL courses to the library patrons, and this might inhibit the patrons’ learning outcomes. This finding is in accordance with Julien and Hoffman’s (2008) study in which they found that library staff faced challenges of becoming better teachers, and proper pedagogy or teaching models were needed to empower library customers to develop better IL skills.

In order to educate more people to become information literate, public libraries can expand their IL services by keeping close relationships with other organizations. This study found that the public libraries build partnerships with immigrant service providers and local communities. Public libraries provided IL training to new immigrants in their native languages and thus assisted them to find jobs. This observation suggests that partnerships enable public libraries to share their resources and services in ways that benefit their patrons in the larger world. Harding (2008) emphasized the importance of building partnerships between public libraries and other organizations by listing examples of successful cases in Australia. She also suggested that public libraries can partner with private enterprise to “provide opportunities to obtain funding for programs or training for staff or the public” (Harding, 2008, p. 161). The above arguments, on the other hand, imply that public libraries can work closely with faculty members at various levels of schools to make IL education an integral part of the curriculum. Snively (2008) proposed a strategy of integrating IL into course content by giving problem-based or evidence-based assignments to students, so that they do not feel like they are doing extra work. Library staff can contribute their expertise in helping teachers to design assignments that require students to engage with IL strategies.

The challenge of developing effective IL programs for staff and the public requires continually funded support from the government. However, the results of this research revealed that the most critical factor contributing to the success of IL training is the library staffs’ dedication toward their teaching roles in that arena. Based on the results of this study regarding IL training in Canadian public libraries, four guidelines are important to consider when developing IL training in the public libraries: 1) developing advanced ICT infrastructure, 2) providing formal IL training courses, 3) improving library staff’s IL and teaching skills, and 4) building partnerships with local organizations. Figure 2 illustrates the guidelines of producing effective IL training in public libraries.
Conclusions

This study investigated the current state of IL training and the strategies and methods used by certain Canadian public libraries in improving IL skills for their staff and patrons. According to the research findings, Canada’s public libraries exhibit their role as IL training providers by offering free Internet access and IL courses in both formal and informal ways. Also, the public libraries recognized the importance of staff training in order to provide efficient IL instruction for the public, so various training programs were given to the staff. However, some staff members apparently were hesitant to embrace their teaching roles. Additionally, this study revealed an important truth that library staff lacked appropriate guidance in understanding the theories of IL and adult learning while teaching library patrons.

By taking into account the related studies discussed in the literature review and the findings of this investigation, it seems reasonable to conclude that Canadian public libraries still face many challenges in improving the quality and quantity of IL training programs for staff and the public. In addition, public libraries, as community learning centers and IL providers, need to reach more people. Canadian public libraries have recognized the importance of extending their service to community organizations by providing IL training programs and courses outside the libraries. This action suggests that public libraries can also forge close partnerships with K-12 schools and higher education institutions. As Snively (2008) noted that librarians can assist faculty to develop students’ IL skills by setting IL goals for courses and designing assignments that effectively use IL strategies and identify appropriate electronic resources relevant to their studies. Public libraries, community organizations, and schools need to work closely and collaboratively to deal with this critical issue for the purpose of increasing peoples’ IL skills and furthermore to enrich their lifelong learning experiences.

The main contribution of this study is that it provides information on the issue of IL education in public libraries which is still a relatively uncharted field for research. Although there were two existing extant studies related to IL training in Canada’s public libraries, this study expands the understanding of these training programs by providing explanations for some key issues that need solutions. It is recommended that further research continue to focus on the impact of new technologies in regard to IL training in public libraries and formal education settings and what effect that has in bridging the digital divide.

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References


Computer Mediated Communication: Social Support for Students with and without Learning Disabilities

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ABSTRACT
The study examined the relationships between the usage mode of four kinds of computer-mediated communication (CMC) by students with and without learning disabilities (LD) and perceived social and emotional support. Little is known about how undergraduate students with LD interpret and perceive CMC. We investigated the impact of the use of CMC as e-mails, internet, instant messaging (IM), SMS, and its contribution to social and emotional relationships among 364 undergraduate students without LD and 68 students diagnosed with LD, enrolled in a social science program, who completed two questionnaires. Findings pointed to higher usage of CMC to express social support, indicating that most of the students preferred using e-mails and SMS for that purpose. Students noted that IM is more useful for receiving social support, and e-mail is more useful for practical social advice. Students with learning disabilities reported using personal computers more frequently, especially for receiving practical advice. In addition, they reported using more IM compared to students without disabilities. The findings offer empirical evidence supporting the usefulness of CMC for mutual social activities and support, suggesting enhancement of positive support among students, and encouragement of more interaction between students, which might evoke more proactive coping strategies.

Keywords
CMC (computer mediated communication), social support, emotional support, learning disabilities

Introduction
For the last decade, we have witnessed a substantial increase in both the use of Computer Mediated Communication (CMC) and in the growth of social and emotional support amongst users of the different interfaces. The internet and CMC interfaces represent new methods of personal communications. Unlike ‘face-to-face’ relationships, geographical location is insignificant in this medium. The level of intimacy is determined by the length of time spent in the same chat room, forum, mailing list or website (Daum, 2007). Many studies have investigated the influences of the internet on peoples’ daily lives and on their social relationships (Cogat, Yamauchi, and Suman, 2002; Nie and Hillygus, 2002), but most of the studies referred to general use of the internet and not to the impact of the various interfaces in creating social and emotional relationships.

Computer mediated communication
The past decade has seen the rise of an alternative method of social support involving CMC interfaces, which include e-mail, chat, virtual communities, instant messaging (IM), text messaging (SMS), web pages etc. Social support is an integral part of a person’s environmental relationships and this has a significant influence on their quality of life.

This study seeks to examine the differences in the use of four interfaces – e-mail, SMS, IM, and chat – to relay messages of social support amongst students. Researchers reported that CMC was used primarily for interpersonal communications with family and friends. These interfaces have increased the users’ social involvement (Kraut, 2002; Shoklovski, Kraut, and Rainie, 2004), assisted them in maintaining contact with family and friends, and expanded their social network (Howard, Rainie, and Jones, 2002; Schiano et al., 2002). These interfaces have been especially effective in maintaining relationships amongst students (Cummings, Lee, and Kraut, 2006). An additional common interface is the mobile phone, which has led to changes in interaction patterns between social groups, as it enables intimate and direct communications at all times of the day, from anywhere, between members of a social network (Ling, 2004). A survey on the extent of digital media usage - internet, messaging, and SMS - was conducted by the World Health Organization amongst youth in 41 countries. Youth in Israel was ranked fourth in the world in use of digital media (HBSC, 2008). High use of IM and SMS in relaying social support messages, in comparison to e-mail and chat, was reported in a study that examined CMC usage patterns amongst teenagers. It was found that girls
preferred IM and SMS interfaces and were more inclined towards social support-type communications (Daom, 2007).

**Learning disabilities and computerized technology**

The current study addressed the population of students with learning disabilities (LD). The term *learning disabilities* refers to a heterogeneous group of disorders manifested by significant difficulties in the acquisition and use of listening, speaking, reading, writing, reasoning, and/or mathematical abilities (National Joint Committee on Learning Disabilities, 1989). Similar to this definition and criteria, the Israeli Ministry of Education has defined learning disability, and students are usually identified as having an LD prior to their higher education studies. To be diagnosed, they will have obtained a Full Scale score of 85 or above on the Wechsler Abbreviated Scale of Intelligence (WASI; Wechsler, 1991). In addition, individuals with LD must show significant difficulties in the acquisition and application of one or more of the following subjects: reading, writing, inference and mathematical ability, quantitative concepts, memory, and attention span, equivalent to standard scores of 80 or below on one or more of the Spelling, Arithmetic, and Reading subtests of the achievement test of the Wide Range Achievement Test – third edition (WRAT3; Wilkinson, 1993).

The development of technologies that assist students with LD has increased during the past decade. It was discovered that those students who used computerized technological systems improved their grades and learning skills, dropped out less, and reported an improvement in their quality of life (Raskind and Higgins, 1998). Computerized programs have served as a social and emotional intervention tool amongst children with various learning disabilities. For example, the use of computerized technologies allows students to express themselves, contributes to the development of reciprocal social connections between LD children and their non-LD peers, improves their general personal wellbeing (Dole and McMahan, 2005; Hall, Hughes, and Filbert, 2000) and provides a feeling of empowerment and an improved self-image (Lau et al., 2005). The current study deals with the social and emotional aspects of CMC, and focuses on support for those aspects among students with and without LD.

**Social support among students in higher education**

Social support refers to the individual's perception that he or she can be helped or can attain the understanding, cooperation, assistance, and appraisal of close or significant persons (Sarason and Sarason, 1985). Social support is often conceptualized as a protective factor in students’ lives that contributes to students' successful adjustment to university (Solberg and Villarreal, 1997). As mentioned by Nelson-Le Gall (1992), help seeking can be instrumental (e.g., student's need for additional explanation, to solve a problem) and/or can be for social and emotional help and support from a close person (Heiman and Kariv, 2004). Findings indicated that help seeking is a positive instrumental skill that encourages students’ attempts to obtain assistance (Nelson-Le Gall, 1992; Newman, 1994). A review of the literature examining successful academic adjustment of students in higher education and their perceptions of social support (Demaray and Maleck, 2002) suggests that the social support of parents and peers was associated with increased academic achievement of university and college students, has a positive effect on their psychological well-being (Winter and Ben-Knaz, 2000), and is related to a variety of academic and personal adjustments to college (Brissette, Scheier, and Carver, 2002; Winter and Sugar, 2000).

Over the past two decades, there has been an increase in the number of higher education students with LD (Griffin and Pollak 2009; Johnson, Zascavage, and Gerber, 2008). Success in new and complex assignments, both on an academic and social-personal level, is required to gain entrance to a university. It was found that the academic, social, and emotional adjustment of students with LD was lower than that of students without special needs (Adams, 2007). This is often accompanied by difficulties in reciprocal social relations, communication, cooperation, and in maintaining friendships (Moon et al., 2001), which is accompanied by a feeling of loneliness and social rejection (Heiman, 2006). The degree of social support correlates positively with the student’s academic success (Demaray and Maleck, 2002), strongly influencing their personal sense of wellbeing (Winter and Ben-Knaz, 2000) and their adjustment to the university environment (Brissette, Scheier, and Carver, 2002). Students with LD often reported a lower level of social support compared to students without special needs (Heiman, 2006); however, despite these difficulties, many students with LD adjust successfully to the academic requirements and do well in their studies (Heiman and Precel, 2003). Examining the perceptions of students with LD in higher education revealed three main topics which appear as a barrier to success: (a) being misunderstood, (b) needing to work harder than their nondisabled peers, and (c) seeking out strategies for success in education (Hazel, 2008). Other studies (Higgins,
Raskind, Goldberg, and Herman, 2002) found that emotional issues such as depression, unhappiness, being bullied, and teased, as well as high rates of loneliness, despair, anxiety, and low self-esteem were more frequent among students with LD (Gregg, Hoy, King, Moreland, and Jagota, 1992). Research on higher education students with LD have suggested that as they experience academic difficulties, they may also experience additional difficulties with stress management (Heiman and Kariv, 2004; Reiff, Hatzes, Bramel, and Gibbon, 2001), and display a significantly lower score on adaptability to cope with social demands and to deal with unexpected situations (BarOn, 1997). However, examining the experiences of students with LD revealed that students shared many life experiences and preferences for learning style irrespective of their type of LD, and reported similar experiences during education setting and with university support (Griffin and Pollak 2009). Interviews with successful college students with LD revealed family support, early identification, and good self-esteem as key to their competency (Johnson, Zascavage, and Gerber, 2008).

In sum, most of the studies focused on children's use of computers but did not examine additional technological interfaces, or the technological interfaces used by undergraduates. The first purpose of this study was to examine the impact of the use of CMC interfaces and its contribution to social and emotional relationships among undergraduates. As we are witnessing an increase in the number of students diagnosed with various disabilities studying in higher education institutes (Hagar and Goldstein, 2005; Harrison, 2004), our second purpose was to examine the differences between students with and without learning disabilities regarding the CMC interfaces.

### Method

#### Participants

The study included 432 undergraduates Social Science students from two universities and one Teacher College in Israel. Participants comprised 391 women (91%) and 40 men (9%), aged between 20 and 39. The average age of the students was 26.32 years (S.D. = 6.93).

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<th>Table 1. Students with and without Learning Disabilities</th>
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<td>Students without Learning Disabilities</td>
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<td><strong>n = 364</strong></td>
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As presented in Table 1, 68 (15.8%) students reported being previously diagnosed with learning disabilities, while 364 (84.2%) were without learning disabilities. Most of the students who participated in the study were female (91%). Although the mean age of students with LD was higher than non-LD students, no significant differences were found, t = 1.67, p = .09. Most of the students are majoring in education (34.9%), or psychology (25.6%), others were studying in various social and behavioral science departments such as sociology, economics, management, political science (19.6%), or they were majoring in computers, or natural science (13.5), with a few (6.5%) majoring in the humanities (e.g. literature, history, art). No significant differences emerge between students' groups. The GPA of the sample was 81.52.

It was found that, of the entire sample, 43.8% of the students were studying in a traditional university, 33.8% at the Open University, and 22.5% in college. As can be seen, at the Open University, the percentages of student from both groups were similar. As for the traditional university, the percentage of students with LD was lower than the non-LD
students (25% vs. 47.4%), and in the colleges, the percentage of students with LD was higher than the non-LD students (39.7% vs. 19%).

According to the students with LD’s self-report, they were divided into three groups corresponding to their type of disability: attention deficit disorder (n = 26, 38.2%), reading and writing disorder (n = 24, 35.3%), combined disorders (n = 18, 26.5%).

**Procedure**

After receiving ethical approval from the university’s Ethics Board, participants were selected randomly from the department of Social Sciences and were given the choice of manual or computerized questionnaires. All measures were administered or submitted individually to each participating student by one of the researchers. All participants were informed that their participation was voluntary and their anonymity was emphasized. Based on students' answers, they were classified into the LD or non-LD group.

**Instruments**

1. **Personal details questionnaire** – the questionnaire contained 11 questions such as age, gender, technology ownership and questions regarding the existence and type of learning disability.
2. **The effect of technology on humans questionnaire (Kraut, 2002)** — the questionnaire contained 38 Likert Scale questions which examined the frequency of use of CMC and its use for social support. The questionnaire, as reported and validated by Daum (2007), contained three indices:
   a) *The participants' opinions regarding the efficacy of communication in social areas* - examined the efficacy of communication in performing actions, developing and maintaining social connections, exchange of information, the level of pleasure derived from a conversation and the level of closeness towards the other party. The overall level of reliability of the summative index was 0.61.
   b) *The main topics of conversation and the connection with the other party* – examined four supporting factors (reliability ranges = 0.68-0.71): Social Support Partner – including topics such as giving and receiving advice, giving and receiving support, planning and organization, discussing problems, asking a favor and the exchange of information. Negative Partner – argumentative/controversial topics, persuasion, complaining and gossip. Small Partner and Catch-up – small talk topics, jest/laughter, work or school related topics, a day’s summary, and areas of interest and memory recall. Relationship Partner – memory recall and keeping up-to-date, small talk, jest/laughter, work or school related topics, a day’s summary and areas of interest, acquaintanceships, romantic communications and communication with friends.
   c) *The frequency of mutual social activities* – examined by four types of activity in which the participants were requested to rank the frequency of each activity in accordance with the relative interface type. The following activities were examined: participating in mutual activities, talking about hobbies or mutual topics, receiving appropriate assistance, receiving emotional support (alpha = 0.70).

**Results**

**CMC usage.** Analyzing undergraduates' answers, it was found that all the participants possessed a mobile phone. All the students with LD had access to a home computer, 52.9% of them had their own personal computer, whereas only 38.9% of students with no disabilities had access to a computer, and 37.6% of them had their own personal computer. Most students had a broadband internet connection. Regarding the participants’ interface preference: over half the participants (53%) reported frequent use of SMS, about one third (34%) mentioned the use of e-mail, and a smaller proportion (12.8%) the use of IM. Only one participant reported using the chat interface, therefore this interface will not be included in the analysis presented below. Regarding specific interface type preferences, there were no significant differences between those students who had learning disabilities and those who did not.

Regarding the participants ages, significant correlations were found between student's age and the interfaces used, such as higher use of e-mail ($r = .11; p <.05$), and the lower use of SMS ($r = -.22; p <.01$) and IM ($r = -.13; p <.01$). No significant correlation was found between age and frequency of usage of the chat interface ($r = -.04; p >.05$).
Regarding gender, female students were more inclined to use SMS ($t = -2.83$; $p < .01$). No significant differences were found amongst the other interfaces.

*The contribution of the use of CMC interfaces,* e-mail, chat, IM, SMS, to convey messages of social support amongst students with and without LD. The level of social support was examined through three indices:

a) the participants’ opinion regarding the efficacy of communication in social areas
b) the main topics of communication (support factors)
c) the frequency of expression of social support

a) *The efficacy of communication.* In order to examine the differences between three interface types and its impact on the efficacy of communication, univariate analyses of variance (ANOVA) were performed, and a t-test for independent models (per group type), the interface and group types were tested for any impact they may have on the efficacy of communication.

*Table 2:* Average ratings of the efficacy of communication in the social field, by interface type

<table>
<thead>
<tr>
<th>Interface Type</th>
<th>The efficacy of communication</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contrasts</td>
<td>SMS</td>
</tr>
<tr>
<td>IM &gt; @; sms</td>
<td>5.96**</td>
</tr>
<tr>
<td>IM &gt; sms &gt; @</td>
<td>20.31**</td>
</tr>
<tr>
<td>IM &gt; sms, @</td>
<td>7.25**</td>
</tr>
</tbody>
</table>

Note: ** $p < .01$

As Table 2 shows, results revealed significant differences between the different interface types in the efficacy level of the communication. In the summative index, IM has the highest communication efficacy compared to SMS and e-mail. The Scheffe test revealed a significant source gap between IM and e-mail and SMS. IM is the leader on the social level, followed by SMS and finally e-mail. The Scheffe test indicates distinct differences between the three interface types. In practice, e-mail ranks first compared to IM and SMS. Additionally, the Scheffe test shows a prominent gap between e-mail and SMS. Regarding the efficacy of communication between students either with or without learning disabilities, there were no differences in any of the three indices.

b) *Examining the primary topics of communication (support factors).* A one-way test with repeated measures between the communication topics was conducted. Results revealed significant differences in the frequency of different communication topics, $F (2, 414) = 378.28; p < .01; \eta = .47$. The Bonferroni test revealed significant gaps between the four communication topics. The most common topic was social support partner, followed by small partner and catch-up. Negative partner and relationship partner were less common.

Additionally, the influence of the interface type on the support factors was tested with a one-way ANOVA test (per interface type) and the t-test for independent models (per group type).

*Table 3:* Average ratings of the support factors (main topics of communication), by interface type

<table>
<thead>
<tr>
<th>Interface Type</th>
<th>Social support factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contrasts</td>
<td>SMS</td>
</tr>
<tr>
<td>IM &gt; @; sms</td>
<td>1.61</td>
</tr>
<tr>
<td>IM &gt; sms &gt; @</td>
<td>10.54**</td>
</tr>
<tr>
<td>IM &gt; sms &gt; @</td>
<td>30.81**</td>
</tr>
<tr>
<td>IM &gt; sms &gt; @</td>
<td>32.01**</td>
</tr>
</tbody>
</table>

Note: ** $p < .01$

As illustrated in Table 3, there are significant differences between the interface users in relation to three of the four communication topics; negative partner, small partner and catch-up, relationship partner. In all of these topics, IM is rated as the interface with the most frequent communication, followed by SMS and finally e-mail. The Scheffe test
showed that for each communication topic, the significant contrast was obtained due to the gaps between the three different interface types. There were no distinct differences in any of the communication topics between students either with or without learning disabilities. A significant interaction between the interface type and the relationship partner topics was noticed when checking the differences within the group of LD students, $F = 4.17; p < .05$. The frequency of relationship partner topics in the e-mail and IM interfaces was higher amongst participants with combined disabilities and lower amongst those with reading disabilities. On the other hand, the SMS results showed a higher frequency of communication amongst those with reading disabilities and a lower frequency amongst those with combined disabilities.

**c) Frequency of expressing social support.** Examining the five action types regarding the frequency of the different activity types (see Table 4), it was found that receiving useful advice/information and communications on hobbies/mutual topics occurred more frequently than receiving emotional support, practical assistance and mutual activities, $F = 65.49; p < .01; \text{Eta} = .39$. The Bonferroni test showed significant gaps between the two with the highest rating and the three with the lowest rating.

A one-way ANOVA analysis was performed to test the differences between the interface types relative to the activity types. From Table 4 it appears that SMS users are more inclined to participate in mutual activities whereas this occurs less frequently when using the other interfaces. Compared to e-mail users, SMS and IM users are more inclined to communicate on mutual topics and hobbies, receiving emotional support and practical advice. The Scheffe test indicated significant differences between e-mail, SMS and IM. On the other hand there were no significant differences between the various interfaces on the receipt of practical advice.

**Table 4: Average ratings for mutual activities, by interface type**

<table>
<thead>
<tr>
<th>Interface Type</th>
<th>Mutual activities</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SMS</td>
<td>IM</td>
</tr>
<tr>
<td>Contrast</td>
<td>SD M</td>
<td>SD M</td>
</tr>
<tr>
<td>sms &gt; @, IM</td>
<td>4.64 1.88</td>
<td>3.90 1.52</td>
</tr>
<tr>
<td>@ &lt; sms, IM</td>
<td>5.47 1.88</td>
<td>4.30 1.40</td>
</tr>
<tr>
<td>----</td>
<td>4.58 1.69</td>
<td>4.30 1.74</td>
</tr>
<tr>
<td>@ &lt; sms&lt; IM</td>
<td>5.36 1.54</td>
<td>4.77 1.31</td>
</tr>
</tbody>
</table>

Note: **$p < .01$**

The t-test showed that students with LD reported receiving practical advice more frequently than non-LD students, regardless of the interface type being used, $t = -1.74; p = .04$. There were no significant differences between the groups in the other indices. In the two-way analyses (MANOVA) X (3 disability types) X (2) by (5 interface) there were no significant differences between the participants, according to the interface and disability types, relative to the implementation of mutual activities.

**Discussion**

The study examined the usage differences between e-mail, SMS, IM, and chat amongst students with and without learning disabilities. In addition, the study checked whether the students had a preferred interface for conveying social and emotional support. The results of the study indicated a high usage level of CMC interfaces to convey social support, with a preference for e-mail and SMS. The students rarely used chat to convey social support, a statistic that was also revealed in Daum’s study (2007) amongst teenagers. Previous studies revealed a pronounced preference in the use of CMC for social purposes (Kraut, 2002; Schiano et al., 2002; Shoklovski, Kraut and Rainie, 2004), especially in maintaining relationships amongst students (Cummings, Lee and Kraut, 2006).

Regarding the interface types and their qualities, e-mail and SMS are more personal when a single member of a social network is selected for the communication. This fact enables intimate and direct communication at any time, from any place and for any reason. As was tested in this study, intimate use is especially essential for social support and it seems that this is one of the reasons for the students’ preference for these interfaces. In essence, chat is
collective, whereas IM may be used collectively or personally according to the user’s preference; a person answering a call may be invited for a private conversation (Boneva et al., 2005). Another explanation is the popularity of SMS. By enabling direct intimate communication regardless of time and place, the mobile phone has led to a change in interaction patterns of social groups (Ling, 2004). The current study found that all students possess a mobile phone. In today’s world the mobile phone is a vital instrument amongst adults and has become a fashion accessory that reflects social status. The study checked the mutual activity types in which CMC was used and found that students frequently use SMS for all mutual activities, whereas e-mail users reported a lower usage frequency. This finding is partially supported in previous studies which focused on different populations. For example, when social support in CMC in interface types amongst teenagers in Israel was tested, there was an obvious preference for the IM and SMS interfaces in two areas: the effectiveness of the communication and the main subjects for discussion (Daum, 2007).

Regarding learning disabilities, there were imparities between some of the subjects tested. It was evident that LD students require the assistance of a computer in their lives; they all had computers at home compared to only 40% of students without learning disabilities. All of them reported a similar usage of the different interfaces, with a higher IM usage level reported amongst LD students. It is difficult to know the reason for the gap between students with and without learning disabilities as there was no test to check if the use of this interface was collective or personal. Additional differences were found in the main support factors (communication subjects) discussed. Regardless of the interface type, the receipt of practical assistance is slightly more frequent amongst LD students than amongst those without. It seems that, due to adjustment difficulties, students with learning disabilities require more practical assistance. Studies have proved that the academic, social and emotional adjustment of students with special needs, such as learning disabilities, is lower in comparison to students without special needs (Adams, 2007; Heiman, 2006). In this study, students with learning disabilities were divided into two groups: those with attention deficit or reading disabilities, and a minority with a combination of disabilities. It was apparent that the disability type did not influence the student’s perception of the level of social support according to the type of interface. On the other hand, there was a difference in the support factors (communication topics), according to the type of disability and activity type. Within the limitations of this preliminary study, one can see that with regard to communication topics, students with attention deficit preferred the use of e-mail, whereas students with reading disabilities preferred SMS which required less reading and writing. Many studies have discovered that attention deficit is delayed when using a computer and that the computer provides assistance to children with this disorder (Navarro et al., 2001; Shaw, Grayson and Lewis, 2005; Shaw and Lewis, 2005). It is interesting to note that there were gender differences in the study which indicated that female students were more inclined to use SMS. This finding strengthens Daum’s study (2007), which revealed that women are more inclined to have social support conversations and that they preferred the IM and SMS interfaces.

In conclusion, it appears that the use of CMC constitutes a communication method for conveying social messages, including social support, amongst both LD and non-LD students. It is therefore important to pay attention to the provision of CMC facilities to students so they can receive and express social and emotional support. It seems appropriate for all students, but necessary for LD students who suffer from social and emotional deficiency, and frequently don't receive any support. It seems that CMC usage can enhance that support significantly.

In addition to the primary definition of the usage types for each interface reported by the students, the study may also be of interest to software developers who want to direct their applications to student use and utilization of the application’s social potential.

References


The Influence of Adult Learners’ Self-Directed Learning Readiness and Network Literacy on Online Learning Effectiveness: A Study of Civil Servants in Taiwan

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ABSTRACT
This study examined the effect of civil servants’ Self-Directed Learning Readiness (SDLR) and network literacy on their online learning effectiveness in a web-based training program. Participants were 283 civil servants enrolled in an asynchronous online learning program through an e-learning portal provided by the Regional Civil Service Development Institute in Taiwan. Data were collected via a questionnaire containing three parts: SDLR scale, network literacy scale, and online learning effectiveness scale. The findings indicated civil servants’ SDLR and network literacy were positive; however, participants’ involvement in online discussion was not appreciated according to the reported score of online learning effectiveness. Analysis of the data also revealed that three factors of SDLR (active learning, love of learning, and independent learning) and two constructs (Internet skill and information evaluation) of network literacy were significant predictors in predicting online learning effectiveness of civil servants. Additionally, civil servants’ SDLR appeared to be the most important element in determining their online learning success based on the research findings.

Keywords
Adult learning, Self-directed learning Readiness, Network Literacy, Online learning

Introduction
With the relentless advance of Internet technologies, online learning has gained greater attention not only from schools and private organizations, but also from the public sectors. Governments around the world realize that maintaining a dynamic and effective workforce is of extreme importance in facing increasing levels of global competition; thus, ensuring that civil servants’ skills and knowledge are continually updated and refreshed has become a serious and urgent issue (Bose, 2004). Online learning has become a favorite choice for providing training and development needs in government organizations because it provides a cost-effective and timely learning vehicle to meet the need of continuous education and training for the civil servants working at different locations (Combs, 2002; Shinkareva & Benson, 2006). Many developed countries have already established online learning portals specifically for training the large number of civil servants, such as the Virtual School at the United Kingdom’s National School of Government, the United States’ Federal Government’s GoLearn, the Canadian School of Public Service’s Campusdirect, and Singapore’s Civil Service College’s Open Academy. In Taiwan, the Civil Service Development Institute and Regional Civil Service Development Institute also launched online learning portals for civil servants at central and regional governments based on the framework of the National Science and Technology Program for e-Learning. All civil servants are required to take at least five hours of training courses through an online format each year (Taiwan Central Personnel Administration, 2007).

Online learning, in fact, is still in a relatively new domain of adult education practice, and its advanced and unique features require adult learners to have some preparations and skills beforehand. While a great volume of studies has focused on the technical aspects of online instruction, more pedagogical concerns should also be investigated. Factors such as adult learners’ fluency and perception in using Information and Communication Technology (ICT), particularly in network literacy, and their Self-Directed Learning Readiness (SDLR) can be critical elements in determining the effectiveness of online learning (Hiemstra, 2006; Lema & Agrusa, 2009; Song & Hill, 2007). Merriam, Caffarella, and Baumgartner (2007) articulate that exploring how technology relates and affects self-directed learning (SDL) can expand understanding of adult learning through SDL in formal and informal settings. With the increasing trend of utilizing online learning in public sectors, an investigation of the theoretical research of the variables that influence online learning effectiveness will enable government organizations to create more effective and efficient online learning programs to maximize the potential of their workforce.

Recent SDL studies (Hiemstra, 2006; Lowe & Holton, 2005; Lema & Agrusa, 2009; Song & Hill, 2007) on online learning context have focused primarily on the descriptions of influences and strategies with little support of
Literature Review

Research and concerns of SDL have substantially increased in the field of adult education since the seminal work of Tough in 1971 (Merriam et al., 2007). The research works of Tough (1971, 1979) illustrated that most adults engage in some form of learning project in a year, and his continuous studies in SDL provide valuable suggestions for promoting SDL from institutions to group learning. The most popular definition of SDL was proposed by Knowles (1975) which describes SDL as “a process in which individual take the initiative, with or without the help of others, in diagnosing their learning needs, formulating learning goals, identifying human and material resources for learning, choosing and implementing appropriate learning strategies and evaluating learning outcomes” (p.18). The initial SDL research of Tough (1971) and Knowles (1975) viewed SDL as a linear and continuum model, and later studies added two new approaches, the interactive and instructional models (Brockett & Hiemstra, 1991; Garrison, 1997; Grow, 1991; Hammond & Collins, 1991; Spear, 1988) to discuss the different aspects of SDL as a process of learning. The other focus of SDL research, according to Merriam (2001), described self-direction as a personal attribute of learners. Song and Hill (2007) suggested that resource use, strategy use, and motivation are the three main characteristics of personal attributes in which learners take responsibility for their own self-directed learning. Research instruments aiming to assess SDL as a personal trait were developed and have been evaluated at many learning settings and linked to other variables, such as learning style, level of education, and life satisfaction (Merriam et al., 2007). Two popular Likert-type instruments for evaluating SDLR are Guglielmino’s Self-Directed Learning Readiness Scale (SDLRS) and Oddi’s Continuing Learning Inventory (OCLI) (Litzinger, Wise, & Lee, 2005). These two instruments, according to Merriam et al. (2007), have been popularly used to evaluate aspects of self-directedness as a personal trait. The present study adopted the approach of self-directedness as a personal attribute because civil servants, as adult learners, were psychologically ready to be self-directing at certain levels. Thus, SDLR can be measured by quantifying their attitudes, values, and abilities.

In addition, many studies (Bell, 2007; Nicol, 2007; Shinkareva & Benson, 2007) have attempted to discover the effect of online learning related to SDL in a school setting, and that of higher education in particular. Recent research (Hiemstra, 2006; Lema & Agrusa, 2009) recognized that the Internet is a valuable resource for meeting the needs of self-directed learners and adopting online training has brought great influence to the human resource development in organizations. Some of the most important skills for today's rapidly changing workforce are skills in using ICT and the ability of learning. Howland and Moore (2002) indicated that learners’ ICT skills play an important role in helping them to learn independently. Also, learners who possessed high level experiences with online applications tended to engage more in SDL activities (Lema & Agrusa, 2009). Thus, the learners’ computer skills and experiences, particularly in network literacy, are crucial for developing their SDL capability. McClure (1994) used the term “network literacy” to portray one’s ability to identify, access, and use electronic information from the network. Knowledge and skills, according to McClure (1994), are the two major components that comprise network literacy for the general public. With the proliferation of the Internet, measurement of network literacy has shifted to focus on users’ skills and knowledge of navigating the Internet and formulating search queries through online search engines (Ngulube, Shezi, & Leach, 2009). An earlier study on developing students’ Internet literacy in an undergraduate engineering program confirmed that using the Internet as a learning tool requires sophisticated skills, knowledge and help from instructors (Blanchard & Carter, 1999). Another recent investigation conducted by Chen and Williams (2009) also discovered that college students with higher levels of technological competency, particularly in online learning environments, engaged and enjoyed more in learning online course modules. The same holds true for civil servants’ engagement in online learning that sufficient knowledge and skills in the web-based learning environment may generate to affect overall quality of online training effectiveness.

Evaluation of online learning can be approached from different aspects, such as learners, instructors, courses, technology, design, and environment (Sun, Tsai, Finger, Chen, & Yeh, 2008). Because learners are the primary participants, many research studies have been conducted to investigate factors affecting the learning effectiveness of online learners (Chou and Liu, 2005; Piccollli, Ahmed, & Ives, 2001; Sun et al., 2008; Vogel, Davison, & Shroff,
In particular, due to the difference between the online and traditional learning environments, Chou and Liu (2005) suggested that assessment of the use of technology and the shift of learners’ control and responsibility are two critical factors from the learners’ perspective. In their study, four dimensions, learning achievement, computer self-efficacy, satisfaction, and learning climate were investigated to compare students in the two different learning settings. One of the important findings, according to Chou and Liu (2005), was that online students tended to develop higher computer self-efficacy and skill than their counterparts. Another important aspect affecting online learning effectiveness related to learners’ control is their participation (Cashion & Palmieri, 2002; Richardson & Newby, 2006), that is, higher participation rates in online discussion, reading, and interaction with colleagues and instructors can produce better learning results and greater satisfaction. Hence, encouraging learners to participate and dedicate more in online learning activities would facilitate them to build up more responsibility in planning their own learning pace and strategies, and increase their technological proficiency in the online learning process.

Design of the Study

Instrument Selection

This purpose of the study was to explore the relationship between SDLR, network literacy, and online learning effectiveness of civil servants in Taiwan. The SDLR, an internal state of psychological readiness to undertake SDL, contains complex attitudes, values, and abilities that create the likelihood that an individual is capable of SDL (Guglielmino, 1977, 1997). The most adopted survey instrument, the SDLRS, was developed and modified by Guglielmino (1977, 1997), and it has been widely used to assess quantitative aspects of SDL as a personal trait (Merriam et al., 2007). There are eight factors identified during the development of SDLRS. These factors are openness to learning opportunities, self-concept as an effective learner, initiative and independence in learning, informed acceptance of responsibility for one’s own learning, a love to learn, creativity, future orientation, and the ability to use basic study and problem-solving skills (Candy, 1991). The prevalent use of SDLRS has shown stable reliability and validity. Thus, Guglielmino’s SDLRS has been translated into several languages. In Taiwan, Teng (1995) first translated SDLRS into Chinese, and the translated version has been modified by some experts. Also, the number of questions was reduced from 58 to 55 and the original eight factors were decreased to six aspects (effective learning, love of learning, learning motivation, active learning, independent learning, and creative learning) based on the considerations for cultural differences (Chang, 2006).

The SDLRS has been utilized to measure different adult students’ SDL attitudes in numerous studies. Also, some scholars have examined the relationship of SDLRS with other instruments, such as cross-cultural adaptability, learning style, and creativity (Merriam et al., 2007). In the study of technology learning settings, Chang (2006) employed the Chinese version’s SDLRS to measure college students’ competency-based web learning, and he discovered some correlations among the factors of SDLR and different stages of competency-based web learning. Mamary and Charles (2003) investigated the relationship of physicians’ SDLR and different types of computer training tools, and their findings suggested that the development of interactive media and Internet programs can be beneficial to continuing medical education. Based on the research settings and online teaching faculty’s suggestion, the instrument adopted in this study was the Chinese version of the SDLRS, and four factors were included to measure the degree of SDLR. The four dimensions were active learning, independence learning, love of learning, and creative learning.

In addition, a network literacy scale was developed based on the suggestion of McClure (1994) and characteristics of adult learners. Two dimensions, Internet skill and information evaluation, were used in this investigation. Users answered a set of questions on a self-reporting basis. Online learning effectiveness was also evaluated by a survey which contained four antecedents, 1) satisfaction, 2) participation, 3) learning achievement, and 4) self-efficacy in online courses, from the learners’ perception. The network literacy and online learning effectiveness scales were modified from the exiting instruments developed by Lin (2002) and Liang (2002). In order to ensure the content validity of the two scales, 10 university professors were invited to review the questions. Because the modified scales’ questions were carefully organized and designed to meet the needs of the research purpose and target population, a few revisions in the wording of some items were made based on the panel’s suggestions.

A pilot study was administered to test the reliability of the survey instrument, and 82 participants from the Nantou County government were invited to complete a preliminary form of the questionnaire. The instrument contained 50
Likert-type items of a 5-point rating scale corresponding to 4 dimensions of SDLR, 2 dimensions of network literacy, and 4 dimensions of online learning effectiveness. Table 1 lists the internal reliability of the 10 factors aspects, where Cronbach’s Alpha lies between 0.71 and 0.92 of which all reached the acceptance threshold of 0.7 recommended by Vogt (2001).

Table 1: Reliability of pilot test of the instrument

<table>
<thead>
<tr>
<th>Construct</th>
<th>Number of questions</th>
<th>Cronbach’s Alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-Directed Learning Readiness</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Active learning</td>
<td>6</td>
<td>0.84</td>
</tr>
<tr>
<td>Independent learning</td>
<td>4</td>
<td>0.71</td>
</tr>
<tr>
<td>Love of learning</td>
<td>6</td>
<td>0.87</td>
</tr>
<tr>
<td>Creative learning</td>
<td>4</td>
<td>0.72</td>
</tr>
<tr>
<td>Network Literacy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Internet skill</td>
<td>5</td>
<td>0.89</td>
</tr>
<tr>
<td>Information evaluation</td>
<td>5</td>
<td>0.91</td>
</tr>
<tr>
<td>Online Learning Effectiveness</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Satisfaction</td>
<td>5</td>
<td>0.71</td>
</tr>
<tr>
<td>Participation</td>
<td>5</td>
<td>0.83</td>
</tr>
<tr>
<td>Learning achievement</td>
<td>5</td>
<td>0.92</td>
</tr>
<tr>
<td>Self-efficacy</td>
<td>5</td>
<td>0.90</td>
</tr>
</tbody>
</table>

Participants and Setting

A total of 283 regional civil servants voluntarily participated in this study, and they all enrolled in an online training program provided by the Regional Civil Service Development Institute located in Nantou County, Taiwan. The training program consisted of 180 courses, and most of the courses’ formats were either computer simulations or video-enhanced PowerPoint presentations. Learners who completed a course can get 1 or 2 credit-hours depending on the length of course materials, and each participant was asked to finish at least 5 credits. At the time of the study, the Regional Civil Service Development Institute’s e-learning portal offered courses at three categories—leadership, on-job training, and professional development, and the e-learning platform also contained sections of threaded discussion, course modules, and assessment.

One hundred thirty-eight participants were female (48.8%), and 145 respondents were male (51.2%); 30% were 30 years old or younger, 25.1% were between 31-40, 34.5% were between 41-50, 10.6% were 51 or older. Exactly 79.9% (N=226) of participants were college graduates, 14.1% (N=40) of participants hold master (or above) degrees, and only 6.0% (N=14) of respondents had a high school diploma or lower. All participants had a varied background knowledge of computers and were from different regional government organizations, including the office of commerce, fire/police department, public libraries, tax bureaus, and others.

Table 2: Mean and standard deviation of variables

<table>
<thead>
<tr>
<th>Factor</th>
<th>Mean (M)</th>
<th>Standard Deviation (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-Directed Learning Readiness</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Active learning</td>
<td>3.87</td>
<td>0.55</td>
</tr>
<tr>
<td>Independent learning</td>
<td>3.77</td>
<td>0.58</td>
</tr>
<tr>
<td>Love of learning</td>
<td>4.03</td>
<td>0.57</td>
</tr>
<tr>
<td>Creative learning</td>
<td>3.63</td>
<td>0.61</td>
</tr>
<tr>
<td>Network Literacy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Internet skill</td>
<td>4.00</td>
<td>0.63</td>
</tr>
<tr>
<td>Information evaluation</td>
<td>3.76</td>
<td>0.67</td>
</tr>
<tr>
<td>Online Learning Effectiveness</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Satisfaction</td>
<td>3.44</td>
<td>0.70</td>
</tr>
<tr>
<td>Participation</td>
<td>3.01</td>
<td>0.88</td>
</tr>
<tr>
<td>Learning achievement</td>
<td>3.50</td>
<td>0.66</td>
</tr>
<tr>
<td>Self-efficacy</td>
<td>3.99</td>
<td>0.66</td>
</tr>
</tbody>
</table>
Findings

Descriptive Analyses of Variables

The participants were asked to rate each survey question from 1 to 5 (1 = Extremely unlikely; 2 = Quite unlikely; 3 = Slightly likely; 4 = Quite Likely; and 5 = Extremely likely). The mean and standard deviation scores of each variable are displayed in Table 2. The love of learning (M = 4.03, SD = 0.57) was rated highest in the SDLRS. Internet skill received a better score (M = 4.00, SD = 0.63) than information evaluation (M = 3.76, SD = 0.67) in the network literacy scale. The analyses’ outcome also revealed that civil servants’ self-efficacy (M = 3.99, SD = 0.66) in online courses was favorable on the online learning effectiveness scale.

Age Differences on the SDLR and Network Literacy Scales

One-way analysis of variance (ANOVA) tests were conducted on the total scores and sub-scores of the SDLR and network literacy scales. A significant effect of age difference was found for love of learning scores, $F(3, 279) = 2.66, p < 0.05$. Post hoc comparisons (using Scheffe) revealed no significant differences among the four age groups. However, civil servants who were older tended to have better self-perceptions toward learning by spending more time and dedicating to the learning contents and activities according to their responses to the questions of love of learning dimension. The mean scores and standard deviations of these four age groups on the love of learning dimension are: 30 years old or younger (M= 3.87, SD =0.59), 31-40 (M = 4.04, SD = 0.54), 41-50 (M = 4.10, SD= 0.54), 51 or older (M = 4.12, SD = 0.65). There were no significant effects in civil servants’ network literacy total and sub-scores among the four age groups.

Linear Regression Models

Related literature (Hiemstra, 2006; Lema & Agrusa, 2009) suggests that adult learner’ SDLR and Internet competencies play significant roles in determining their online learning experiences. One of the research interests in the study was to understand the relationship between civil servants’ SDLR, network literacy, and online learning effectiveness and furthermore to identify how well the civil servants’ SDLR and network literacy could predict their online learning success. A linear regression analysis was performed on online learning effectiveness calculated by SDLR and network literacy of civil servants. Two multiple regression equations were examined to determine how well the participants’ SDLR and network literacy could predict the dependent variable: online learning effectiveness. The relationship between the four subscales of SDLR and the total score of online learning effectiveness was investigated using the Pearson product-moment correlation coefficient (Table 3). Results of the correlation analyses of two subscales of network literacy and online learning effectiveness score are presented in Table 4.

<table>
<thead>
<tr>
<th>Table 3: Correlation of the SDLR subscales and online learning effectiveness score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subscale</td>
</tr>
<tr>
<td>---------------------------</td>
</tr>
<tr>
<td>Active learning</td>
</tr>
<tr>
<td>Independent learning</td>
</tr>
<tr>
<td>Love of learning</td>
</tr>
<tr>
<td>Creative learning</td>
</tr>
</tbody>
</table>

** $p < 0.01$

<table>
<thead>
<tr>
<th>Table 4: Correlation of the network literacy subscales and online learning effectiveness score</th>
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<tbody>
<tr>
<td>Subscale</td>
</tr>
<tr>
<td>---------------------------</td>
</tr>
<tr>
<td>Internet skill</td>
</tr>
<tr>
<td>Information evaluation</td>
</tr>
</tbody>
</table>

** $p < 0.01$

The total scores of online learning effectiveness were first regressed on the linear combination of variables of SDLR. Assumptions related regression including normality, homoscedasticity, and linearity were tested, and no violation was found. Homoscedasticity (homogeneity of variance) refers to equal variances in the dependent variable, online learning effectiveness, for the independent variables, dimensions of SDLR and network literacy. The linear
combination of the independent variables of SDLR significantly predicts \((F = 32.13, p < 0.001)\) online learning effectiveness of civil servants. Three variables—active learning, love of learning, and independent learning, tend to be associated with online learning effectiveness scores. Approximately 32% of the variance in the online learning effectiveness scores was accounted for by the three predictors. The prediction equation for the standardized variables is as follows:

\[
\text{Online learning effectiveness} = 0.27 \text{ active learning} - 0.01 \text{ creative learning} + 0.20 \text{ love of learning} + 0.19 \text{ independent learning}
\]

Stepwise regression revealed that active learning was the strongest factor influencing respondents’ online learning effectiveness \((F = 98.20, p < .001)\), which accounted for 26% of the variance of the total score of the dependent variable. The combination factors of active learning and independent learning accounted for 29% of the variance in the dependent variable (significant at \(p < .001\)). The third model, which added love of learning to active learning and independent learning, accounted for 31% of the variance (significant at \(p < .001\)).

To obtain insight into the predictive ability of civil servants’ network literacy measures on their online learning effectiveness scores, a multiple regression analysis was also conducted. The result of the regression examination showed a significant statistic. The two variables of network literacy significantly predicted online learning effectiveness scores \((F = 61.25, p < .001)\) which explained 30% of the variance of the dependent variable. The predicted standardized regression equation can be written as follows:

\[
\text{Online learning effectiveness} = 0.20 \text{ Internet skill} + 0.39 \text{ information evaluation}
\]

Stepwise regression results showed that the information evaluation was the primary factor significantly predicting participants’ online learning effectiveness scores \((F = 112.96, p < .001)\). This model accounted for 28% of the variance in the significance of the dependent variable. The second predictor, Internet skill, explained a further 2% variance in the total score (significant at \(p < .001\)).

**Discussion**

This study found that civil servants’ SDLR was positive which signified that civil servants valued the importance of being self-directed learners in online learning environments. One of the reasons that can explain this finding is that since February 2007 taking online training courses has become a requirement for all civil servants in Taiwan; thus, most civil servants might be aware of this new policy and were prepared for this change, and most of them already had the opportunity to participate in SDL using online formats. Another explanation, according to the descriptions of SDL theory (Knowles, 1975), is that adults are capable of self-directing their own learning when they identify their needs and then take action to achieve their learning goals. Civil servants, in this study, presented good SDL scores which coincide with SDL theory. Moreover, a recent study (Nazim, 2008) suggested that self-instruction was the best method of learning Internet usage for adult students. It further implies that adult learners’ SDL ability might help them to get acquainted with new learning tools during the learning process. Among the four variables of SDLR, love of learning received the highest score, demonstrating that civil servants enjoyed learning new knowledge and the learning content might be useful for their work.

The results of the participants’ network literacy scores were also encouraging. Most civil servants were confident about their Internet skills, and confident of being able to tap into vast resources on the course web. This result corroborates the findings of a similar study (Hiemstra, 2006) indicating that the Internet has become an essential learning tool and indispensable information source for enhancing the lives of adults who use it. In addition, the analyses of respondents’ online learning effectiveness scores revealed an important fact that learners’ participation was still a critical issue in online learning. Although learning online enable adult learners to access education and training more easily and flexibly than traditional classrooms, interactions between learners were still low. Two survey questions obtained relatively low scores with regard to learners’ participation. The mean and standard deviation of the question “I often express my thoughts on the discussion board” were 2.72 and 0.91, respectively, and the other question “I often reply to others’ postings on the discussion board” had a mean and standard deviation of 2.82 and 0.88, respectively. A partial explanation for this may lie in the fact that participating on the discussion board was not required by the online course in this study. This result may also be explained by considering the participants’
expectations when they began to engage in online learning. In Conrad’s (2002) study, she found that adult learners tended to ignore the messages posting on the discussion board in the beginning of online learning class if instructors did not appropriately respond and conduct discussions.

This study also examined civil servants’ age differences on SDLR and network literacy scores and found that older learners showed more positive enjoyment toward learning than younger learners. This might be due to older civil servants’ who had more working experiences and had encountered more job-related challenges that might enable them to undertake SDL in order to solve problems. A workplace learning study conducted by Straka (2000) found that experienced work conditions affected employees’ interest to control their self-learning pace. Another qualitative study noted that older adults’ educational pursuits were motivated by the unique issues of their life, such as time and family (Roberson & Merriam, 2005). Most adults dedicate significant amount of time in their work, so mature and experienced workers might develop optimistic SDL attitudes. The above arguments imply that working environments are capable of triggering civil servants’ collective natures of SDL when they accumulate years of working experiences. Therefore, a key task for HRD practitioners at public sectors is to provide an SDL supportive environment for employees.

The results of regression analysis which examined SDLR factors as predictors of participants’ online learning effectiveness scores revealed that three elements—active learning, love of learning, and independent learning—were significantly related to the dependent variable. This finding is in accordance with the results of a previous study (Lee, Hong, & Ling, 2002) which discovered that certain aspects of SDL attributes were related to learners’ attitudes and achievements in online learning. The component of active learning was the strongest predictor in the regression model, indicating that active learning contributed most to the total score of civil servants’ online learning effectiveness. This finding implies that adult learners who can make appropriate arrangements of their own learning schedules and choose learning materials and activities they like on online training courses can generate better learning outcomes. It further suggests that adult educators or training coordinators can work more on the issue, which is, providing guidance, such as time management skills and offering relevant course content to meet the learners’ needs. In a related SDL study conducted by Lema and Agrusa (2009), they recommended that providing learning opportunities that have immediate impact on learners may increase their learning motivation in active learning. On the other hand, the results of the predictive model of network literacy and online learning effectiveness scores showed that learners’ information evaluation skills were a vital part in determining their online learning success. According to Rager (2003), the ability to critically evaluate Internet resources should be an area of concern to adults interested in SDL. Thus, adult education practitioners can and should play a role in focusing on the need to critically evaluate Internet information and in helping adult learners develop the ability to do so (Rager, 2003).

Another important finding based on the regression analyses was that the ability of adult learners’ SDLR was more important than their network literacy affecting the outcome of online learning effectiveness. This result suggests that, in addition to helping learners’ acquire technical skills utilized in online courses or programs, adult educators or training coordinators should note the great influence of SDL in facilitating adult learners to develop positive online learning experiences. Furthermore, Shinkareva and Benson (2006) explained in their research on adult students’ SDL and instructional technology competency that adult students who already possessed a relatively high level of SDL ability also performed better in learning ICT. In light of this information, online learning and training designs should be focused on developing learners’ SDL abilities to a great extent, and help from instructors, such as diagnosing learners’ learning needs and designating key tasks toward achieving learning goals, would be highly needed (Timmins, 2008).

Conclusions

This study investigated the current state and relationships of SDLR, network literacy, and the online learning effectiveness of civil servants participating in an online learning program in Taiwan. The resultant findings revealed that civil servants’ SDLR and network literacy were positive. However, civil servants’ participations in online learning, particularly in discussions, were unfavorable. Older civil servants tended to have more positive self-perception in SDLR, love of learning in particular, than younger employees. Additionally, based on the regression analyses, it suggested that civil servants’ SDLR was critical in determining their online learning success. The present study enhanced the previous SDL studies and understandings by providing a full examination of empirical data in an online learning context.
The key contribution of this study is that it is the first attempt to explore civil servants’ SDLR and network literacy towards online training programs in Taiwan. As more government organizations around the world gradually adopt online training for their employees, more online learning courses will be developed as well. This study could help human resource development professionals with the issues involving organizing online training and paying careful attention to provide the best conditions that promote SDL for the trainees. Future research should continue to focus on the impact of SDL in various online learning settings and different groups for the purpose of expanding our understandings of adult learning through SDL in using technology-enabled media.

Acknowledgement

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References


Usability Testing and Expert Inspections Complemented by Educational Evaluation: A Case Study of an e-Learning Platform

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ABSTRACT

This paper presents a comprehensive usability study conducted within the context of a Europe-wide project. The design of the evaluated e-learning platform is based on an innovative approach to the education of young Europeans by integrating into the curricula of a Europe-wide network of 14 schools different state-of-the-art technologies in e-learning. The evaluation methodology brings together end-user assessments and expert inspections, thus providing a detailed students’, teachers’ and experts’ feedback. User testing integrates six empirical methods into a laboratory-based test. Usability inspection ascertains usability problems by means of recognized heuristics and enables an "educational evaluation" of the platform by means of three sets of criteria. The paper aims to present the effectiveness of the engaged evaluation methods as applied to e-learning platforms. It offers implications from the empirical findings of the user-based methods together with a quantitative and qualitative analysis of the employed inspection methods. Special attention is given to the aspect of educational evaluation. The conducted critical usability examination of a large-scale e-learning system across several countries in Europe revealed which of the chosen assessment methods should be combined to provide constructive and valuable improvement suggestions. A more significant contribution of this research is that the used evaluation approach proved successful, providing some general findings and know-how from the experience and could be reused by other researches because of its thorough structure. As there are relatively few existing accounts of usability assessment in the e-learning context, this paper adds to the body of knowledge.

Keywords
e-Learning, e-Learning system, User testing, Expert inspection, Educational evaluation

Introduction

In the context of the inclusive knowledge society, the role of system interfaces that are more closely tailored to the way people naturally work, live and acquire knowledge is unquestionably recognized as important. In addition, the need for active and accessible learning promotes only the e-learning that engages the users effectively. Nevertheless, despite so much publicity and activity, the progress in the field of e-learning has been relatively slow until recently, when problems were often associated with poor designed e-learning applications cf. (SIGCHI, 2001; Granić, 2008).

It seems that too much of the research has been driven by technical possibilities, while paying inadequate attention to the area of application. This issue has been ignored for some time, in the hope that new technologies will somehow resolve the lack of real progress. However, to efficiently communicate the contents and improve the learning experience, interaction mechanisms merit particular consideration. Usability studies in the e-learning field are not very frequent despite the important role that usability plays in the success of every e-learning system. If the interface is not transparent and easy to use, the learners/students concentrate on interaction aspects and not on acquiring content. In addition, it has been claimed that usability assessment needs further consideration of the learning perspective. Namely, the approaches to e-learning usability range from those adapted to e-learning to those applying heuristics without special adjustment to the educational context. Accordingly, as an established set of heuristics and a joint evaluation methodology for e-learning systems do not exist yet, there is obviously a need for further research and empirical evaluation.

The paper reports on a case study of an e-learning platform implemented in the network of fourteen European schools. The contribution of this paper is two-fold. First, it critically examines the usability of a large-scale e-learning system across several countries in Europe. The second contribution of the paper is providing some general findings and lessons learned from the experience. Usability testing, which integrated six empirical methods into a laboratory-based test, was complemented with heuristic inspections. Interface compliance with Nielsen’s (1994) traditional principles was enhanced with experts’ judgment of the system’s "educational evaluation" by means of three sets of criteria: Learning with software heuristics (Squires & Preece, 1999), Educational design heuristics (Quinn, 1996) and Pedagogical dimensions (Reeves, 1994). We expect that this contribution with its general findings and know-how from the experience will facilitate the understanding on how to evaluate and improve the usability of...
e-learning systems based on users’ (learners’/students’ and teachers’) and experts’ feedback. Since there are limited studies in the field, this contribution adds to the body of knowledge.

Related Work

Research in the human-computer interaction (HCI) field has provided numerous principles and guidelines that can steer designers in making their decisions. Although applying good design guidelines alone is a good start, it is no substitute for system usability evaluation. In general, usability is context-dependent and is shaped by the interaction between users, tasks and system purpose. A variety of usability evaluation methods have been developed over the past few decades and most are grouped into usability test methods, user-based involving end-users, and inspection methods engaging HCI experts. Research studies involving different kinds of applications, different user groups and evaluation techniques have been conducted and the need for combining the methods is well understood in the usability field; see e.g., Sears & Jacko (2008).

To analyze usability of interaction mechanisms of e-learning systems, more or less standard assessments and studies have been carried out. Some authors have used traditional usability techniques for e-learning system evaluation and have applied Nielsen’s (1994) heuristics for usable design directly (Rentroia-Bonito & Jorge, 2003). Others have proposed to adopt a checklist of well-established principles shared by many lists of guidelines (Parlangeli, Marchigiani & Bagnara, 1999), or have suggested design heuristics without further adjustment to the e-learning context (Dringus, 1995). A number of authors have argued for more synergistic collaborations between usability and e-learning researchers. Squires and Preece (1999) have made an initial attempt toward integration of usability and learning proposing Learning with software heuristics, a list of guidelines adapted to the context. De Villiers (2004) built further on their criteria, adapting and extending heuristics, not for inspection by experts, but as a basis of a questionnaire survey among learners. Drawing on the considerable research devoted to the usability of performance systems and e-learning design, Meilenbacher et al. (2005) have outlined a set of twenty-one usability heuristics for evaluating e-learning environments and experiences for the designers. Zaharias and Poylymenakou (2009) have proposed a questionnaire-based usability evaluation method that extends the current practice by focusing also on affective considerations (motivation to learn) that might influence e-learning usability. In order to make use of complementing usability techniques, a relatively small number of studies has been made. eLSE (e-Learning Systematic Evaluation) methodology (Lanzilotti et al., 2006) has been derived from SUE (Systematic Usability Evaluation) methodology, originally developed for evaluating hypermedia systems (Matera et al., 2002). eLSE suggests coupling user-testing and specific inspection activities, which use evaluation patterns that precisely describe the activities to be performed during inspection. Bolchini and Garzotto (2008) have proposed MiLE+ which integrates strategies from various traditional evaluation methods, thus offering an analytical guidance to carry out the evaluation. MiLE+ is an evolution of two previous approaches, SUE methodology and MiLE (Milano-Lugano Evaluation) scenario-driven inspection technique (Triacca et al., 2004).

Despite the undertaken research and efforts, the e-learning field still lacks a widespread culture of usability. Approaches that address both the traditional usability and the pedagogical aspects of e-learning systems in the context of use are still a research issue. Additionally, there is a growing need for thorough usability studies whose results would have an impact on "real" e-learning design and development. An integrated systematic evaluation approach to help with the design and development of cost-effective learner-centered solutions is required. Obviously, there is a clear need for further elaboration and empirical validation even more as neither a recognized set of heuristics, nor a consolidated evaluation methodology of e-learning applications are yet available cf. (Ardito et al., 2006; Zaharias & Poylymenakou, 2009).

E-Learning Platform Description

UNITE (www.unite-ist.org) is a European IST-project with the main goal "to contribute to the improvement of Europe-wide education in secondary schools based on innovative principles in technology, pedagogy and learning scenarios, tested by a well-defined validation framework" (UNITE, 2006). The e-learning platform UNITE seamlessly integrates three distinct technologies including their diverse functionalities into an effective e/m-learning environment: an e-learning portal, an eKnowledge repository and a mobile learning component.
Technically, the system is based on Service-Oriented Architecture (SOA) concepts with two access points: the portal and learning management system are accessed via a web server (http://pilot.unite-ist.org), while the mobile devices connect via a dial-in server (Hornung et al., 2008). From a system design point of view, modularity and re-usability of the system are very important and provide benefit. For easier understanding of our research results, some platform features are elaborated further based on (Kouloumbis, Lu and Wunner, 2007; Lu et al., 2006). The users’ area is a personal space (similar to virtual desktop) incorporating the users’ personal page, personal notes, their journal and agenda, their allocated tasks and personal resource area (Infopool repository). It lists the workspaces the user is a member of and gives access to the messaging environment. The Infopool is a "container" for all e-learning content that can be accessed from workspace areas. The Infopool viewer module provides the common content management facilities while other modules support SCORM-compliant reuse and the editing of the learning courses and its metadata. The reusability of content in Infopool is enabled through metadata searching and tagging (using Metadata editor) while Course editor and Course viewer enable creating, editing and publishing new courses to authorized users. The Mediaboard is a virtual "place" where students and tutors can set up an image/map as the front page of their working space, send text, pictures and audio messages to different locations (i.e., zones) on the image or map. It shares files with the Infopool repository. SMS quizzes and SMS quiz engine support activities that require students to send text messages. These activities can be of two types: students interacting with their tutor or with a computer that sends automated replies. The SMS engine tracks the answers and sends an instant feedback message. PPC Author tool and MyLearning player enable creation and playing of various games and quizzes that can be run on Pocket PCs. Students access the online quizzes using their Pocket PCs though the quizzes can be played offline also. MyLearning player supports different formats of learning materials and tracks a student’s journey through them.

Figure 1 shows snapshots of the interface from a workspace (created for the course "Wonderful world of inventions").

![Figure 1. Snapshots of the UNITE interface](image-url)
A high-fidelity prototype of the system was released at the end of 2007. Two evaluations were performed on the earlier versions: task-centered walkthrough usability test on the platform mock-up (i.e., low-fidelity prototype) and controlled functionality test. A number of identified problems and bugs with different levels of severity were fixed. However, a large empirical study of the high-fidelity prototype was conducted to fine-tune the system design. This comprehensive and well-documented account of a thorough exercise in usability evaluation of an e-learning platform is presented in the following section. We also offer reflections on what worked and what did not, along with general findings and suggestions for doing similar studies in order to be useful to other researchers in the field.

Evaluation Approach

The experimental approach adopted to critically examine and assess the UNITE usability is illustrated in Figure 2. We expected to find different problems because of a wide variation in tasks and different assessment methods applied, both empirical and analytic. A number of problems were identified through testing user tasks in a scenario-based testing. Other problems were detected through tasks mentally simulated by experts from both the HCI and the e-learning field using inspection methods. We assumed that the usability testing complemented with inspections that rely upon experts judging the interface compliance with recognized usability principles along with considerations of educational perspective would provide a more accurate evaluation.

To collect quantitative and qualitative data, a number of measuring instruments were used:

- **multi-choice questionnaire**, aimed at obtaining users’ personal information along with the ones related to their possible prior involvement in the UNITE,
- **memory test**, a questionnaire for measuring the number of successfully memorized system functions,
• attitude questionnaire called System Usability Scale (SUS) (Brooke, 1996), a simple standard ten-item questionnaire with five-point Likert scale used for users’ subjective valuation; it is argued that SUS yields the most reliable results across sample sizes (Tullis & Stetson, 2004),
• semi-structured interview, an instrument for acquiring further subjective feedback,
• evaluator’s booklet, a booklet in which experimenter conducting the assessment procedure took notes, described problems identified and filled in information about accuracy of task completion and time spent on task performance, and
• evaluation form, a set of heuristics augmented with auxiliary guidelines related to e-learning systems used in heuristic inspection.

All the aforementioned instruments were used in end-user testing except the evaluation form that was used in expert reviews.

User testing along with thinking aloud session were conducted individually with Internet access and screen capturing software for tracing and recording users' actions and navigation. It was based on criteria expressed in terms of four quantitative measures. The relevant usability goals were established as well (Figure 3).

<table>
<thead>
<tr>
<th>Usability criteria</th>
<th>Usability goal</th>
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<tbody>
<tr>
<td>! Accuracy of task completion as an objective performance measurement of effectiveness.</td>
<td>Successful task completions should be above 95% cf. (Laws, 2005)</td>
</tr>
<tr>
<td>! Task completion time as an objective performance measurement of efficiency in using the system.</td>
<td>The mean time to complete five key tasks for students should be less than 20 min and less than 30 min for six key tasks for teachers cf. (Mayhew, 1999)</td>
</tr>
<tr>
<td>! Memorability as a number of successfully memorized functions while using the system.</td>
<td>The novice users should memorize at least half of the functionalities of the system (score above 5 for students and above 6 for teachers) whereas the experienced users should memorize over 80% (score above 8 for students and above 9.5 for teachers) (ibid.).</td>
</tr>
<tr>
<td>! Users’ subjective satisfaction as a subjective measure of the system usage.</td>
<td>Average satisfaction scores are usually between 65 and 70 (Bailly, 2006) System SUS rates should be above 65.</td>
</tr>
</tbody>
</table>

Figure 3. Acceptance criteria (Kellner et al., 2008)

Usability Testing

Individual test sessions were conducted separately from February to March 2008 on the high-fidelity prototype. Note that the prototype was cleared of the bugs identified by the mock-up evaluation and functionality test. The system was implemented in Europe-wide network of 14 schools with 512 students and 46 teachers participating in the implementation. Due to technical limitations, usability testing was conducted in lab environment of 9 schools, involving 47 students (9.18%) and 23 teachers (50.00%). No restrictions were imposed on the involved UNITE user population, so this can be interpreted as one of the study limitations. It is possible that users volunteered or were selected as ones which like or dislike the platform, but there is no way to be sure. Regarding the technical setup, it was difficult to standardize the apparatus on nine different locations, so there could have been some minor deviations of e.g., screen sizes and connection’s speed. Recommendations concerning the computer configuration and browser requirements were given to all the persons in charge of the test. However, it is possible that general system performance might have had a slight impact on the users’ comfort or ability to perform a task, particularly since some of the tasks were dependent on content uploading/downloading.

Regarding the general characteristics of the student sample, 47 individual one-hour sessions were held with an equal number of students from eight different countries (Figure 4a). Almost 60% of students (59.57%) were sixteen and seventeen years old (Figure 4b); 57% of them were male and 43% female. The pre-experiment multi-choice questionnaire provided some information about students’ computer experience and possible prior familiarity with the system. The rollout of the system pilot was completed in late 2007 with the experiments conducted in March 2008. In the meantime, both students and teachers were “exposed” to the system, i.e., they were using it for the learning, teaching and testing purposes. It is rather hard to quantify their exposure since it largely depended on the specific
scenario they were involved in, but it can be assumed that the exposure time rarely exceeded one hour per week. Users themselves were asked to describe their system foreknowledge. Ten students (21.28%) were characterized as novice users, i.e., they were the ones that had only seen the presentation and had not had a chance to work with the system yet.

Concerning the general characteristics of the teacher sample, 23 individual one-hour sessions were held with an equal number of teachers from seven different countries (Figure 5); 39.13% of teachers were male and 60.87% were female. The average teacher age was 40. Based on teachers’ computer experience and prior involvement in the project, only one teacher was characterized as novice and others as experienced users.

Given the remote collaboration, a usability test booklet containing all the testing materials (i.e., pre/post questionnaires, task scenarios, memory test, attitude questionnaire and evaluator’s booklet) was prepared to standardize the procedures at nine test sites. Work scenarios as sequences of typical tasks and user actions showing the system’s basic functionality were elaborated in order to understand the effect of system design in a sample work situation. Five representative tasks for students and six for teachers were chosen (short descriptions of tasks are given on Figure 6). To check the assigned tasks and time interval, clarity and unambiguousness of measuring instruments and adequacy of hardware and software support, pilot testing was performed. A week before the testing a brief presentation of the evaluation objective along with one-hour lecture on the platform main functionalities was given to all participants.

Each individual testing session started with a short introduction when the experimenter briefed the test user about the assessment experiment and the steps that had to be undertaken. First, the participant was asked to fill in the multiple-choice questionnaire. Note: the user could fill in the required forms directly in the computer (digital form) or could...
fill in the paper version. Second, each participant was required to use the platform to perform task-based user testing. The test-user was asked to think out loud while carrying out a set of tasks, particularly to articulate whenever there was a problem. An experimenter took notes and documented all the relevant information in the booklet (the use of a recorder was optional). The booklet included several forms, one for every predefined task. The experimenter enumerated and described the problems detected and further explained them in the problem-description column, additionally identified issues related to where, how and how many times the detected problem occurred. Severity rating on a four-point scale (cosmetic, minor, major or catastrophic problem) was also assigned. S/he then filled in the accuracy of task completion in the respective booklet field (characterized as correct, partial or failure) along with the task completion time that was extracted from the Log Management module and filled in the relevant booklet field. At the end of the experimental session, all the forms were collected. Third, upon completion of tasks from the work scenario, each user had to complete a memory test followed by a satisfaction questionnaire. Fourth, every user participated in a short semi-structured interview in which (s)he expressed her/his satisfaction or dissatisfaction with the system design and offered suggestions for improvement. Additionally, the participants rated and commented on the overall implementation of the UNITE’s concepts. The findings of the individual sites were first compiled locally and then combined, interpreted and presented in an evaluation report that was sent to the development team (Kellner et al., 2008).

Usability Inspection

Heuristic inspection was concurrently performed on the same version of the UNITE system by four evaluators from three countries (the United Kingdom, Latvia, Lithuania) who inspected the platform independently. The recruited evaluators fall into the category of "double experts", the specialists who have experience in both the HCI field and the e-learning systems. The inspection ascertained usability problems by means of Usability heuristic (Nielsen, 1994), judging interface compliance with recognized usability heuristics, and enabled "educational evaluation" of the system by means of three sets of criteria: Learning with software heuristics (Squires & Preece, 1999), Educational design heuristics (Quinn, 1996) and Pedagogical dimensions (Reeves, 1994). The heuristics along with the specific principles for "educational evaluation" focused the evaluators' attention as they worked their way through the system, using their expertise to role-play the behavior of a typical end-user. The evaluators were given a short lecture on the system to be evaluated. Their familiarity with the platform was described as low. The introduction session lasted one hour. A general recommendation was to go through the interface at least twice. The first pass (self-guided exploration) helped the evaluator to get a feel for the "flow" of the interaction and the general scope of the system. To perceive how the system was intended to be used by the end-users, a few representative tasks (teachers’ and learners’) were recommended. The second pass allowed them to focus on specific interface elements as they knew how they would fit into the larger whole; evaluators also used self-exploration.

Overall, experts systematically went through the interface and noted problems that violated the general heuristics and the three sets of criteria for "educational evaluation". Detected problems could equally violate several heuristics. The sets of criteria were randomly chosen. The evaluators tried to be as specific as possible listing each usability problem along with assigned severity rating. From each evaluator, problems were recorded as written electronic reports. For an individual expert, the inspection session lasted about four hours. The debriefing session, conducted in a brainstorming mode, focused on a discussion related to severity ratings of problems and possible redesigns to address the major difficulties of the UNITE interface.

Results and Interpretation of Findings

Analysis of students' feedback

Regarding the accuracy of task completion (user’s effectiveness), as assessed by the experimenter and expressed by a grade in her/his booklet, learners were able to perform 78.3% tasks correctly, 6.8% partially and failed to perform 14.9% tasks. Task completion time (user’s efficiency) was extracted from the Log management module of the system after the evaluation session. The mean time to complete all five tasks was 14.76 minutes. See Figure 6 for mean task completion times per task and Figure 7 for the total time required.
Valuable information was extracted from qualitative material collected during thinking aloud session. Based on this feedback the design team was able to make specific interface adjustments. Here are some examples of what evaluators wrote down: User initially didn't enter the topic field - generated error message (only error number!); User looked for the reply button at the top; User sent a message to non-existing user; User initially tried to copy and paste the document within UNITE.

The distribution of scores for memorability (a number of correct answers, from 0 to 10 points for ten questions) ranges from 2.5 to 9.5. On the memory test novice users scored on average 5.75, while experienced ones 6.58. The scores for users' subjective satisfaction acquired by the SUS can range from 0 (very little satisfaction) to 100 (very high satisfaction). The calculated average of the students’ satisfaction score is 59.36. Students’ ratings of the platform and the project obtained through semi-structured interview are shown in Figure 8. To analyze the relations of the listed variables, the Pearson $r$ and Spearman $\rho$ correlation coefficients were used. There is a highly significant correlation between all task completion times: time required to complete a certain task does not depend on the system solely, but it also depends on user’s skills (previous experience, reactions, etc).
Highest correlations significant at 1% level are between Task 4 and Task 2 completion time ($r=0.668$) and Task 5 and Task 4 completion time ($r=0.684$). Adding metadata (Task 4) and sending messages to Mediaboard (Task 5) are very specific platform tasks. More significant and positive correlations between various subjective or objective measures of the system perception/performance are listed in Figure 9.

Based on the presented analysis, we conclude that the subjective user evaluation is closely related to the user’s age (experience), the ratings of the interface design and of the overall project concepts. While the SUS score and rating of both interface design and project correlate positively, the SUS score and age correlate negatively, meaning that older learners were less satisfied with the system. The highest relation is between two subjective variables – the rating of the overall concepts and the rating of the interface design. We claim that the success of the project in general depends on the technical platform. Task 3 significantly influences total task completion time. Several severity ratings and accuracy of task completions are also significantly correlated.

### Analysis of teachers' feedback

Regarding the accuracy of task completion, the teachers were able to perform 70.59% tasks correctly, 18.38% partially and failed to perform 11.03% tasks. Mean task completion time for six key tasks was 24 minutes (see Figure 6). Follow some of teacher’s thoughts and comments written by the experimenter: User didn’t post a topic but opened a new forum; A lot of resources were available and he could not decide which of them was the most appropriate one; User created the course but did not understand the content of the xml file.

The calculated scores of the satisfaction questionnaire show that the average teacher’s satisfaction score is 53.15. See Figure 10 for the numeric ratings of the interface design and the project in general (1 being the lowest and 5 being the highest score). The distribution of scores for memorability (a number of correct answers; from 0 to 12 points for

### Table: Correlations between measures

<table>
<thead>
<tr>
<th>Measure</th>
<th>Spearman rho Correlation Coefficient</th>
<th>Sig. (2-tailed)</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>SUS score x Age</td>
<td>.687</td>
<td>0.001</td>
<td>47</td>
</tr>
<tr>
<td>SUS score x Rating of the system interface design</td>
<td>.468</td>
<td>0.001</td>
<td>46</td>
</tr>
<tr>
<td>SUS score x Rating of the overall project concepts</td>
<td>.404</td>
<td>0.005</td>
<td>47</td>
</tr>
<tr>
<td>Rating of the overall project concepts x Rating of the system interface design</td>
<td>.803</td>
<td>0.000</td>
<td>68</td>
</tr>
<tr>
<td>Total completion time for all tasks x Accuracy of task completion (task 3)</td>
<td>.377</td>
<td>0.006</td>
<td>47</td>
</tr>
<tr>
<td>Task completion time (task 1) x Severity rating (task 1)</td>
<td>.393</td>
<td>0.006</td>
<td>46</td>
</tr>
<tr>
<td>Accuracy of task completion (task 2) x Accuracy of task completion (task 1)</td>
<td>.468</td>
<td>0.001</td>
<td>47</td>
</tr>
<tr>
<td>Severity rating (task 3) x Severity rating (task 2)</td>
<td>.464</td>
<td>0.001</td>
<td>47</td>
</tr>
<tr>
<td>Task completion time (task 5) x Accuracy of task completion (task 3)</td>
<td>.426</td>
<td>0.000</td>
<td>39</td>
</tr>
<tr>
<td>Rating of the overall concepts x Rating of the interface design</td>
<td>.821</td>
<td>0.000</td>
<td>23</td>
</tr>
<tr>
<td>Result of the memory test x Accuracy of task completion (task 6)</td>
<td>.749</td>
<td>0.000</td>
<td>23</td>
</tr>
<tr>
<td>Result of the memory test x Rating of the interface design</td>
<td>.565</td>
<td>0.007</td>
<td>23</td>
</tr>
<tr>
<td>SUS score x Rating of the system interface design</td>
<td>.584</td>
<td>0.003</td>
<td>23</td>
</tr>
</tbody>
</table>
twelve questions) ranges from 2 to 12. On the memory test, novice users scored on average 5.5 while experienced ones 7.4 on average.

To analyze the relations of the listed variables, we used the Pearson $r$ and Spearman $\rho$ correlation coefficient. There is an interesting negative correlation of task completion time for task 4 and age ($r = -0.0646$, significance 0.002 ($N=20$). Apart from some obvious correlations (e.g., intensity of the use of the Internet and developed IT skills, the overall rating of the project concepts and the task severity rankings), there are several other significant and positive correlations between various subjective or objective measures of the system perception/performance listed in Figure 9.

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**Figure 10.** Platform and project ratings, $N=23$

**Figure 11.** Heuristic violations and related severity ratings of the identified usability problems
Based on the presented analysis, we conclude that the highest relation is again between the two subjective variables—the rating of the overall project concepts and the rating of the interface design. Satisfaction score, as another subjective variable, depends largely on the rating of the system design. The results from the memory test depend on one particular task (task 6, creating a course) and the system design ratings.

**Expert Reviews**

The results from expert assessments represent a list of problems with references to those usability principles that were violated by the design along with the classification of the problem severity (Figure 11).

Severity ratings indicate whether the problem is superficial (1), minor (2), major (3) or catastrophic (4). However, the overall number of 25 major or catastrophic problems indicates that a lot of work regarding the interface redesign has to be done. Experts express concerns about Infopool, SMS quizzes and Course editor. Severity ratings show equal frequency of both superficial and minor problems on the one hand and major and catastrophic ones on the other. The feedback regarding the second and the third heuristic lists was rather poor. As an argumentation, a quote of one expert is offered: "It was quite difficult to evaluate the system against these two heuristics because they were focused on learner's experience. I would say that overall the system could be used to build and house resources, courses and learner 'experiences' which meet the criteria expressed in the learning design heuristics. Equally, poor use of the system, or the inclusion of poorly designed content, could lead to failure against those same design criteria."

![Platform pedagogical dimensions](image)

**Figure 12. Platform pedagogical dimensions**

Regarding the fourth heuristic that UNITE was evaluated against, the trend-line showed that on Reeves' pedagogical dimensions experts perceived the platform as being more toward the right side of the scale, i.e., the constructivist and
cognitive foundations. In February 2008, we used this methodology to rate the pedagogical dimensions of 14 learning scenarios (Čukušić et al., 2008). The purpose was to provide a qualitative and graphical comparison of scenarios and to create their "profiles". Namely, Reeves considers that numerical values may cause the evaluator focusing on the quantitative scale itself rather than on dimensions of qualitative aspects. While the aspects of his multidimensional model (see Figure 12) mostly represent a framework for comparative analysis, the continuum could be used for planning purposes, as part of the deliberations on the future design of a learning scenario or an educational program. The purpose of this (second) evaluation, in which the same methodology was used, was to evaluate the platform as a whole. The plotted trend line based on the inspection results is illustrated in Figure 12. The experts perceive the platform to be more toward the right side of the continuum implying that the platform promotes constructivist approach, cooperative learning, intrinsic motivation, flexibility, the acquisition of practical experience, etc. These are the aims of most of today's e-learning systems. The fact that the platform tends to be "on the right" only shows that the system design and implementation were in line with teachers' requirements. The experts' opinions related to five selected pedagogical dimensions are offered in Figure 13. The comments are related to the system's pedagogical philosophy, experiential value, program flexibility, level of learner control, and user activity. As can be seen from the remarks, double-experts commented both on UNITE's usability and its educational aspects.

![Figure 13. Double-experts' comments on five selected pedagogical dimensions](image)

### Discussion

To get a better insight into the obtained correlations, it is useful to visualize some interesting findings. Figure 14 illustrates an individual's (student's) IT skills and previous experience with the system in relation to his/her scores on the memory test, subjective satisfaction and total time necessary to complete allocated tasks. Learners' individual characteristics are shown in the first two coordinates: computer skills (IT skills label) and previous experience with
the platform (UNITE label) marked from 1 to 4 in the student’s self-assessment (1 denoting "no experience" and 4 "worked with the system for some time"). These two variables could be related to the student results on the memory test (M-total label), his/her subjective satisfaction (SUS label) and the time to complete representative tasks (Task-total label).

It is evident that the users that have lower IT skills and no previous experience with the system have very low scores on the memory test, are not quite satisfied with the platform and need more time to complete the tasks. User’s better performance is correlated with her/his better skills and/or higher experience, thus, as in most complex systems, a learning effect cannot be ignored. However, the system interface should be easy to use and learn, especially for novice users. When considering students, an usable e-learning system is not just a resource with a nice "look & feel", but an application that communicates content and structures the interaction in a way that facilitates the learning experience. Consequently, there remains a challenge to design a system that is transparent and usable for users with different skills, experience and ability. We have presented concrete quantified relations between the above-mentioned variables, pointing out extremely high correlations between all achieved times of task completions. This is reasonable, because the time required to complete a particular task depends not only on the system but also on the user’s skills (previous experience, speed of reaction and the like). The highest correlation coefficient \( r = 0.684 \) significant at the level of 1% is the time between the completion of task 5 (sending messages to Mediaboard) and task 4 (adding metadata), very specific for this platform, thus resulting in a positive correlation.

Another interesting positive correlation is between two subjective variables: the evaluation of platform design and the overall project success \( \rho = 0.598 \). Users who required a lot of time to complete key tasks (e.g., teachers’ average time was 24 minutes, ranging from 13 to 46) were extremely displeased and frustrated with the system, thus giving to the platform and the project low marks. It is noticeable that the overall success of the project largely depends on the success of the technological platform.
Concerning the presented case study of the UNITE e-learning platform we conclude that although many interface problems were identified by expert reviews, it was the user testing that enabled us to determine which problems actually impeded the users’ (students’ and teachers’) ability in successful task completion. The development team was provided with the detailed information regarding goal achievement and prioritized problems. The decision was made regarding whether or not there was sufficient evidence that the platform had met its objectives. Set quantitative usability goals were an objective that served as an acceptance criteria. The list of the outcomes is given in Figure 15.

![Usability goal outcomes](image)

**Figure 15. Usability goal outcomes**

This is the first critical usability study that has employed user-based methods together with a quantitative and qualitative analysis of a number of "educational" inspection methods. Accordingly, it has made a substantial contribution to the research in the area of usability and educational evaluations of e-learning systems at least in three ways:

- presenting a successful systematic evaluation approach that revealed which of the employed assessment methods should be combined to provide constructive and valuable improvement suggestions;
- providing comprehensive assessment results of a large-scale e-learning system implemented in the network of fourteen European schools, revealing some of the technical and pedagogical issues that could obstruct effective use of the system;
- offering thorough usability examination in educational settings whose results have an impact on "real" e-learning design and development.

The study supported the assertion that we should not rely on isolated evaluations and that expert reviews are not yet a substitute for end-user testing. Actually, those are complementary approaches. Users are oriented toward tasks accomplishment and subjective look and feel of the system design, and hence the results achieved through user testing are appropriate for identification of general usability problems. On the other hand, experts go deeply into the structure trying to identify problems that influence system functions. Therefore, inspection provides a more precise detection of usability setbacks and at the same time offers suggestions for possible solutions. Concerning the employed inspection methods, Nielsen’s (1994) traditional heuristics along with Reeves’s (1994) Pedagogical dimensions for educational evaluation provided enough qualitative and quantitative feedback. On the contrary, other two sets of criteria, Squires and Preece’s (1999) Learning with software heuristics and Quinn’s (1996) Educational design heuristics, showed poor applicability and provided very modest experts’ feedback.

Consequently, there are several important implications on how e-learning systems should be designed and evaluated based on issues identified through users’ scenario-based testing and detected through inspection methods by experts from both the HCI and the e-learning field:

- Expert evaluations were fruitful part of the study that resulted in an exhaustive list of problems relating them to those principles that were violated by the system design, offering also a classification of the problem severity. Contrary to expectations, the feedback regarding Learning with software heuristics and Educational design heuristics was rather poor. It could be argued that it was quite difficult to evaluate the system against these two heuristics because they focused more on learner's experience.
- Reeves's multidimensional model, the fourth heuristic that the system was evaluated against, proved useful since it provided extensive comments from double-experts on both system’s usability and its educational aspects. Additionally, it was also valuable in our research when several learning scenarios were qualitatively and graphically compared. The same model could be used for planning purposes as part of the deliberations on the future design of a learning scenario or an educational program.
• Experts also acknowledged the fact that even if the system is designed to meet the criteria expressed in the learning design heuristics, if it is used improperly, or stores poorly designed learning content, it could lead to failure against those same design criteria.

• The study revealed the highest correlation between two subjective variables: the rating of the overall project concepts and the rating of the interface design. Prior research has shown a positive impact of a well-designed technical platform on the success of the e-learning project in general. Our study extends this research by finding that subjective user evaluation is closely related to user’s age (experience).

• Our experience strongly recommends that, in order to develop user-centered e-learning solutions, is crucial to start validation activities at the early design stage and continue to employ diverse assessment methods throughout the whole development process.

Overall, our findings suggest that there is a value in exploring aspects and strategies for enhancement of "traditional" usability assessment of an e-learning system with educational evaluation. We conclude that accurate assessment is provided by end-user testing complemented with expert inspection that relies upon specialists judging the interface compliance with Nielsen’s recognized usability principles along with considerations of Reeves’s pedagogical perspective. Thus, detailed students’, teachers’ and experts’ feedback from both technical and pedagogical viewpoint could be provided. We conjecture that the effectiveness of the usability testing depends on the experimental design, the chosen tasks and the experimenters, while in the inspection we could speculate on the expertise of engaged double-experts. That's why the results of end-user testing and expert inspections would be far from similar, even if other researchers/teams chose to apply the same integrated systematic approach to evaluate the same e-learning platform, cf. (Molich et al., 2004).

Although traditional heuristics have already been modified/extended and specified to cope with some distinct features of the e-learning applications, the e-learning field and instructional design still lack a widespread culture of usability. The approaches that address both the traditional usability and the pedagogical aspects of e-learning systems in the context of use are still a subject of research. An integrated systematic evaluation approach to help design and develop cost-effective learner-centered solutions is required. We expect that this empirical investigation by itself could provide sufficient motivation for educational system developers and pedagogues to continue to emphasize the integration of usability principles into present e-learning systems. The study offers insights and better understanding on how to evaluate and improve the usability of e-learning systems based on users’ (learners’/student’s and teachers’) and specialists’ feedback. The recommendations deduced from our findings could be useful to other researchers in the field, at the same time aiding in the enhancement of the adoption of usability techniques by designers and project teams as well.

**Conclusion**

The progress in the field of e-learning has been rather slow, with problems mainly related to poor design of e-learning systems. So far, the development focus has been more on technology aspects rather than on user-centered design issues. Due to the underestimated importance of usability, there are limited studies in the field. This paper reports on a comprehensive usability study that took place within the context of a Europe-wide project. The design of the e-learning platform evaluated is based on an innovative approach – to provide novel services in education for young Europeans. The contribution of the paper is two-fold: a case study of evaluating a large scale e-learning system across several countries in Europe along with providing general findings and lessons. The evaluation procedure includes inspection reviews, judging system interface compliance with recognized usability heuristics and as well as enabling "educational evaluation", and end-user assessments that embody an integration of six empirical methods into laboratory-based usability testing. The research and experimental work undertaken within the context of this Europe-wide project are in line with the growing need to intensify the development of new usability evaluation approaches for e-learning and/or to advance the existing ones.

**Acknowledgments**

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References


A New ICT Curriculum for Primary Education in Flanders: Defining and Predicting Teachers’ Perceptions of Innovation Attributes

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ABSTRACT

Teachers play a pivotal role in implementing educational innovations and realising curriculum change. Consequently, their perceptions of innovations and curricula content are of crucial importance. In this study, teachers’ perceptions of the new ICT curriculum in Flanders are examined. This curriculum reflects Flemish society’s underlying vision of the role of technology and ICT in teaching and learning. The curriculum is compulsory for all primary schools and focuses on the cross-curricular integrated use of ICT. Teachers’ perceptions of the curriculum are operationalised using Rogers’ innovation diffusion theory, and are specified as innovation attributes. These are defined as the perceived characteristics of the ICT-curriculum. Factors explaining these attributes are investigated. A questionnaire is administered to a representative sample of Flemish teachers (N = 471). Factor analysis and hierarchical regression analysis are conducted. The results indicate that teachers have moderate opinions about the new ICT curriculum and that both teacher and school level conditions explain teachers’ perceived characteristics of the new ICT curriculum. ‘ICT competences of teachers’ and the ‘schools’ ICT vision and policy’ were found to be the strongest predictors. These results are of particular importance to policy makers and school leaders and shed light on the complex process of ICT curriculum implementation.

Keywords
ICT curriculum, Teacher perceptions, Innovation attributes

Introduction

In response to economic and social change, countries all over the world are formulating policies that incorporate the use of ICT or educational technology in education. Most of these countries have set national guidelines that outline the role that ICT should play in improving the system of education as a whole (Kozma, 2003). In this respect, the use of ICT in education is becoming an important part of educational policy making and reform (Wong, Li, Choi, & Lee, 2008) and has already brought about substantial expenditure (Mulkeen, 2003). The primary function of most educational policies is to provide schools with funding and resources for equipment, network infrastructure, and to a lesser extent, the professional development of teachers (Jones, 2003; Owston, 2007). Recently, however, some national governments have broadened their scope by administering formal and compulsory ICT curricula to schools. These curricula reflect society’s underlying vision and philosophy of the future role of ICT in education; they have a clear pedagogical foundation and focus on the use of ICT as a tool for teaching and learning, rather than the sole development of technical skills. Vanderlinde, van Braak, and Hermans (2009) argue that the formulation of such ICT curricula causes a shift in the policy actions of ICT support, i.e., from a technical rationale that focuses on funding and resources to a pedagogical rationale stressing student competences emphasizing the integrated use of ICT within the teaching and learning process.

The Flemish Educational Technology Curriculum

One region that has been administered an ICT curriculum to schools is Flanders, the Dutch-speaking part of Belgium. This curriculum was launched in September 2007 by the Flemish Government and is structured in terms of attainment targets. These are defined as minimum objectives regarding the ICT knowledge, skills, and attitudes viewed by the government as necessary for students in compulsory education. The ICT attainment targets do not focus on technical skills, but emphasise the integrated use of ICT within the teaching and learning process. The Flemish Government proposes that the implementation of ICT attainment targets should foster students’ ability to use educational technology to support and reinforce their learning (Vandenbroucke, 2007). With this development the Flemish Government clearly outlines its vision of ICT to schools and expects them to put this formal curriculum into practice. From now on, schools and teachers should have a clear understanding of what the government expects when it comes to ICT integration (Vanderlinde et al., 2009). In a decentralised educational policy system like
Flanders, schools are autonomous and have the responsibility of translating the broadly formulated ICT attainment targets into concrete teaching and learning activities.

The main policy goal behind the Flemish ICT curriculum is to cope with social inequity in education. The Flemish Government expects every child to be digitally literate when leaving compulsory education. As such, the Flemish ICT attainment targets are designed to meet societal expectations about the role of ICT in education. In this context, Vanderlinde et al. (2009) argue that the implementation of the ICT curriculum will affect the whole educational system (e.g., students’ learning processes and pre-service teacher training programs) and is linked to other policy initiatives (e.g., update of school technology infrastructure, professionalisation of the teaching staff), Flanders is going through a process of systemic change. Indeed, research has shown that a holistic and systematic approach to facilitating ICT change is needed (Fox & Henri, 2005).

**Innovation Diffusion Research**

Due to the compulsory character of these curricula, the administration of ICT curricula as a top-down policy initiative brings ICT to a ‘turning point’ (Vanderlinde, et al., 2009). Flemish teachers are expected to implement the ICT attainment targets into practice and therefore change their teaching and learning activities. Since teachers play a pivotal role in implementing innovations and curriculum change, their perception of the innovation will strongly influence this process (Fullan, 2001). In other words, the personal willingness of teachers to adopt and integrate innovations into their classroom practice is of crucial importance for the innovation to be successful (Gess-Newsome, Southerland, Johnston, & Woodbury, 2003; Ghaith & Yaghi, 1997). From a curriculum perspective, Van den Akker (2003) speaks of the ‘perceived curriculum,’ and argues that teachers’ perceptions of educational innovations and curriculum reform initiatives are significant factors for researchers when studying implementation processes. Understanding teachers’ perceptions is also important for the successful implementation of ICT into education, which Watson (2006) describes as a specific form of educational innovation. Groff and Mouza (2008) argue that teachers act as innovators when integrating ICT into their classrooms. Recent examples of research in this area include Parker, Bianchi, and Cheach (2008), who examined students’ perceptions of instructional technology in higher education, Ajayi (2009), who studied the perceptions of pre-service teachers when implementing asynchronous discussion boards, Cope and Ward (2002) who investigated teachers’ perceptions of learning technologies, and Martins, Steil, and Todesco (2004) who used perceived attributes of the Internet to predict the adoption of the Internet as a learning tool. These last authors found that observability and trialability (see further) were the two most significant influences. Noticeable in this context, is the study of van Braak and Tearle (2007) who assessed how university students perceive the attributes of computer use for learning, and found that perceptions of computer attributes have a strong impact on computer use for learning. Most of these studies have in common that perceptions were considered as explanatory for the success of technology implementation in education. While the cited studies have a focus on the use of specific technologies (see also Ferster & Bull, 2007), our study will focus on a broader technology curriculum, and more specifically on the Flemish ICT attainment targets.

In this study, we use the innovation diffusion theory of Rogers (2003) to examine and operationalise teachers’ perceptions of the Flemish ICT curriculum. In general terms, innovation diffusion research studies the process by which the use of a perceived new idea, practice, or object is adopted within a given social system (Rogers, 2003). It provides a generic model of the process of the adoption of an innovation by acknowledging a strong relationship between perceived attributes of innovations and the rate of adoption of these innovations. Rogers’ theory has been widely used in sociology, anthropology and marketing research, but also in educational research. Plank, Villenas and Reese (2008) argue in this context that innovation diffusion research has a long and rich history in educational research.

In terms of research on the diffusion and implementation of educational technology, e-learning, and ICT-applications, Dooley (1999) argues that the work carried out by Rogers (2003) on decision-making and diffusion processes help us better understand the process of integrating ICT into schools. Rogers’ theory - and more specifically Rogers’ notion of perceived characteristics of innovations - provides a useful framework to study both the implementation of ICT in education (Dooley, 1999; Ellsworth, 2000) and the study of curriculum change (Hewitt, 2006). Perceived characteristics of ICT innovations or ICT curriculum changes help us to understand the diffusion process because of the relationship between perceived characteristics and the implementation success or rate of adoption.
As presented above, Rogers’ innovation diffusion theory studies the process by which a new idea, practice, or object is adopted within a given social system (Rogers, 2003), and emphasises the role of innovation characteristics in the process of adoption (Ellsworth, 2000). Rogers (2003) defines diffusion as ‘the process by which an innovation is communicated through certain channels over time among members of a social system’. Van Braak and Tearle (2007) argue that innovation diffusion can be considered as the reason why, and as the process by which, an innovation is adopted by people in a specific setting or community. Rogers (2003) argues that the nature of an innovation, as perceived by individuals, helps to determine the rate of its adoption. He emphasises the importance of understanding perceptions of an innovation, as this has significant strength in predicting future adoption of the particular innovation. In other words, an individual’s perception of an innovation will significantly affect his/her use intention, acceptance behaviour, and adoption behaviour (Liao & Lu, 2008). Rogers (2003) outlines five attributes of an innovation that influence an individual’s perception of the innovation, including: relative advantage, compatibility, complexity, trialability and observability. In this context, Dearing and Meyer (1994) describe ‘innovation attributes’ as the perceived characteristics of a new idea, process or technology. However, in terms of ICT in education, little attention has been given to the role of perceived innovation attributes (Van Braak & Tearle, 2007).

Turning the attention to the Flemish ICT-curriculum, teachers’ perceptions of innovation attributes are defined as the perceived characteristics of the ICT-curriculum. In this study, the five innovation attributes outlined by Rogers have been translated and contextualised as follows:
1. Relative advantage: the degree to which the ICT-curriculum is perceived as better than the actual situation;
2. Compatibility: the degree to which the ICT-curriculum is perceived as being consistent with existing values, past experiences and the needs of teachers;
3. Complexity: the degree to which the ICT-curriculum is perceived as difficult to understand and use;
4. Trialability: the degree to which the ICT-curriculum may be experimented with on a limited basis;
5. Observability: the degree to which the results of the implementation of the ICT-curriculum are visible to others.

Next to these attributes, Rogers (2003) describes other variables that may determine the rate of innovation adoption, including the type of innovation-decision, the communication channel, the nature of the social system, and the level of promotional effort made by change agents. In the context of ICT-curriculum reform in Flanders, these variables are assumed to be less important than individuals’ perceptions, because they are rather equal for all Flemish teachers given the compulsory character of the ICT attainment targets.

Research Purpose

The purpose of the present study is threefold. First, we aim to develop a valid and reliable instrument that measures teachers’ perceptions of the innovation attributes of the new Flemish ICT curriculum. Operationalisation of innovation attributes has not been consistently described in either the educational research literature or the ICT integration literature. Because researchers mostly examine perceptions of specific innovations, and name the innovation in the item wording, the creation of consistently used and validated measurement scales is absent (Dearing, 2007).

As research suggests that individuals’ perceptions of the characteristics of an innovation affect their acceptance behaviour and determines their rate of adoption, the second aim of this study is to examine teachers’ perceptions of the innovation attributes of the ICT curriculum. The third aim of this study is to explore which factors predict teachers’ innovation attributes. These factors include both ICT related teacher and school conditions and are based on the e-capacity framework of Vanderlinde and van Braak (2010).

Research Method

A review of the educational research literature on innovation diffusion was recently carried out by Plank et al. (2008). They analyzed 93 studies of innovation diffusion in educational settings paying attention to issues like type of innovation (e.g. target or area of innovation, level of K-12 education intended to be affected), data collection and techniques, timeframe of the study, etc. One conclusion put forward by the authors is that most studies on innovation diffusion in education use qualitative data (e.g., case studies, ethnographies). The authors suggest that more quantitative research is needed in the field of innovation diffusion and educational change research. The present
study responds to this challenge with a quantitative investigation of teachers’ perceptions of the innovation attributes of the Flemish ICT curriculum.

Participants

Data were collected from a sample of 471 primary school teachers in 62 primary schools in Flanders (the Dutch speaking region of Belgium). All participants teach in grades 1-6 and are evenly distributed across the 62 primary schools. The sample was 78% female, the age ranges from 22 to 61 years old, with an average age of 38. On average, teachers reported that they have used a computer for approximately 12 years at home and 8 years in the classroom.

Procedure and variables

In terms of our first and second research aims, a questionnaire was developed in order to gather information on teachers’ innovation attributes of the new ICT curriculum. This newly constructed measurement scale is our dependent variable and all items for this variable are presented in Table 1.

In terms of our third research aim, the questionnaire also contains independent variables that assess both ICT related teacher and school conditions. The selection of independent variables is based on the framework of Vanderlinde and van Braak (2010). This framework was developed from a school improvement perspective and consists of conditions fostering the integration of ICT into teaching and learning practices. Central to this framework is the e-capacity of a school, which refers to the schools’ ability to create and optimise school and teacher level conditions to bring about effective ICT change. These conditions have been translated into reliable and valid measurement scales (see Vanderlinde and van Braak, 2010) and are clustered into four mediating subsets of variables: teachers’ actual use of ICT, ICT related teacher conditions, ICT related school conditions, and school improvement conditions. The subsets

![Research design](image-url)
of variables illustrate the multilayered nature of conditions affecting ICT integration. All variables from the e-capacity framework are presented together with the dependent variable of this study in Figure 1.

The first layer of variables refers to teachers’ actual use of ICT in their classroom practice. In the e-capacity framework of Vanderlinde and van Braak (2010), teachers’ actual use of ICT is not considered as a dependent variable, but as an independent or process variable (see Figure 1). The scales described in the e-capacity framework are based on revised scales of Tondeur, van Braak, and Valcke (2007), where three rather traditional types of ICT use are distinguished:

- The use of basic ICT skills.
- ‘ICT as a learning tool’, referring to the use of ICT to support pupils’ learning.
- ‘ICT as an information tool’ referring to the use of ICT to select, retrieve, and present information.

The second layer of variables refers to ICT related teacher conditions: In the e-capacity framework, two endogenous conditions are put forward; the relevance of ICT knowledge and skills and ways of acquiring them (see also Granger et al., 2002). More concretely, Vanderlinde and van Braak (2010) present two measurement scales:

- The ‘teachers’ ICT professional development’ scale assesses the extent to which teachers keep up with developments in the field of ICT integration, like taking part in in-service teacher training programmes.
- The ‘teachers’ ICT competences’ scale measures the degree to which teachers find themselves competent in integrating ICT into their classroom practice.

The third layer of variables refers to ICT related school conditions: This includes a range of organisational features or local conditions that affect ICT integration. Vanderlinde and van Braak (2010) constructed three scales measuring these conditions:

- The ‘schools’ ICT vision and policy’ scale assesses (a) the extent to which a school has a clear vision on the place of ICT in education, and (b) the extent to which a school has a policy and policy plan containing different elements concerning the integration of ICT in education.
- The ‘ICT infrastructure’ scale assesses the availability and appropriateness of the ICT school and classroom equipment (i.e., hardware, software, and peripheral equipment).
- The ‘ICT school support and coordination’ scale assesses the degree to which ICT integration is coordinated at the school level and the extent to which ICT support is arranged within the school.

The fourth layer of variables refers to conditions described in the school improvement literature as contributing to the implementation and realisation of educational change. Vanderlinde and van Braak (2010) include four of these school improvement conditions in their e-capacity framework:

- The leadership scales of Hoy and Tarter (1991, 1997) contain the ‘supportive leadership’ and ‘initiating structure’ scale. The first scale measures efforts to motivate teachers by using constructive criticism and setting an example through hard work. At the same time, the school leader is helpful and genuinely concerned with the personal and professional welfare of teachers. The second scale is related to task and achievement oriented leadership behaviour. The school leader makes his or her attitudes and expectations clear and maintains definite standards of performance (Hoy & Tarter, 1991, 1997).
- The ‘professional relations among teachers’ scale measures the level of communication and cooperation between teachers (Staessens, 1990; Staessens & Vandenberghe, 1994).
- The ‘participation in decision making’ scale of Geijssel (2001, 2009) measures the extent to which teachers believe that they participate in processes and outcomes of the schools’ decision making around issues of education, innovation, and school improvement.

All items of the independent variables and the dependent variable have a Likert-scale answer format ranging from 0 (totally disagree) to 4 (totally agree). Items of the teachers’ actual use of ICT scales have a frequency Likert-scale answer format (i.e., 0 = never, 1 = every term, 2 = monthly, 3 = weekly, and 4 = daily). The items are presented in Vanderlinde and van Braak (2010).

**Data Analysis**

In constructing the questionnaire that measures teachers’ perceptions of the innovation attributes of the ICT curriculum, several steps were taken. First, exploratory factor analysis was conducted to identify the number of
factors in teachers’ innovation attributes. Next, summary statistics were calculated for the independent variables and Chronbach’s $\alpha$ was calculated to assess their reliability or psychometric properties. Scales are reliable if the Chronbach’s $\alpha$ is greater than .70. Third, the influence of school and teacher level conditions on teachers’ perceptions of the new ICT curriculum was investigated by conducting a hierarchical regression analysis. This analysis makes it possible to examine the additional contribution of logically connected subsets of variables on the dependent variable, i.e., the four layers from the e-capacity model.

**Results**

**Construction of the dependent variable**

The five innovation attributes proposed by Rogers (2003) were not found as five separate dimensions when conducting factor analysis (maximum likelihood with orthogonal rotation) on the total item pool. Conversely, when single exploratory factor analyses were carried out on each of the five innovation attributes separately, the results indicate fair to good factor loadings and internal consistency (see column three in Table 1). Given these results, the dependent variable ‘teacher perceptions of the ICT curriculum’ was constructed as an overarching and one-dimensional variable with five innovation attributes. Factor analysis on these 20 items confirms the one-factor structure with an eigenvalue of 7.60 and factor loadings ranging between .38 and .75 (see column eight in Table 1). Chronbach’s $\alpha$ for this scale is .93 indicating good internal consistency.

Table 1 presents the items of the five innovation attributes, the descriptive statistics, and the factor loadings. The items from the ‘teachers’ perceptions of the innovation attributes of the new ICT curriculum’ scale were summarised into a sum score ranging from a minimum score of 0 to a maximum score of 100. Given the second research aim of this study, descriptive statistics indicate that teachers have a moderate opinion of the new ICT curriculum (M = 59.98, SD = 11.24). They score rather on average on the ‘teachers’ perceptions of the innovation attributes of the new ICT curriculum’ scale. Moreover, teachers specify that they do not know about (7.8 %) or hardly know (46.8 %) the new ICT attainment targets. For these teachers, the questionnaire contained a presentation of the new Flemish ICT attainment targets so they were able to evaluate the content of the ICT curriculum.

<table>
<thead>
<tr>
<th>Innovation attribute</th>
<th>Item</th>
<th>Factor loadings (5 factors)</th>
<th>Mean</th>
<th>SD</th>
<th>Alpha</th>
<th>R²</th>
<th>Factor loadings (1 factor)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advantage</td>
<td>Implementation of the ICT attainment targets will bring about change and improvement.</td>
<td>.66</td>
<td>61.66</td>
<td>13.03</td>
<td>.73</td>
<td>55.47</td>
<td>.55</td>
</tr>
<tr>
<td></td>
<td>Education needs ICT attainment targets.</td>
<td>.64</td>
<td></td>
<td></td>
<td>.58</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>The establishment of the ICT attainment targets is a real improvement for our educational system.</td>
<td>.58</td>
<td></td>
<td></td>
<td>.55</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>My current classroom ICT activities will improve by the ICT attainment targets.</td>
<td>.58</td>
<td></td>
<td></td>
<td>.55</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Compatibility</td>
<td>The ICT attainment targets are consistent with my ideas about learning and instruction.</td>
<td>.83</td>
<td>61.43</td>
<td>13.61</td>
<td>.79</td>
<td>61.66</td>
<td>.76</td>
</tr>
<tr>
<td></td>
<td>My personal vision on the use of ICT in education is in line with the content of the ICT attainment targets.</td>
<td>.80</td>
<td></td>
<td></td>
<td>.74</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>The ICT attainment targets correspond with my vision about the nature of ‘good’ education.</td>
<td>.64</td>
<td></td>
<td></td>
<td>.65</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>My current classroom ICT activities fit within the philosophy of the ICT attainment targets.</td>
<td>.53</td>
<td></td>
<td></td>
<td>.59</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Complexity</td>
<td>The ICT attainment targets are formulated in a straightforward way.</td>
<td>.79</td>
<td>60.11</td>
<td>14.05</td>
<td>.74</td>
<td>56.40</td>
<td>.65</td>
</tr>
<tr>
<td></td>
<td>The ICT attainment targets are difficult to grasp.*</td>
<td>.67</td>
<td></td>
<td></td>
<td>.40</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
It is clear what the ICT attainment targets mean for me as a teacher. The ICT attainment targets are aimed too high for primary education.*

<table>
<thead>
<tr>
<th>Trialability</th>
<th>I get enough opportunities to work with the different ICT attainment targets.</th>
<th>.76</th>
<th>59.29</th>
<th>15.72</th>
<th>.83</th>
<th>66.64</th>
<th>.58</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I have enough room to experiment with the ICT attainment targets.</td>
<td>.75</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.61</td>
</tr>
<tr>
<td></td>
<td>I can implement the ICT attainment targets in my own pace.</td>
<td>.75</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.64</td>
</tr>
<tr>
<td></td>
<td>I get enough time and space to familiarise myself with the ICT attainment targets.</td>
<td>.73</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.58</td>
</tr>
</tbody>
</table>

| Observability | Implementation of the ICT attainment targets will lead to clearly observable changes in teaching and learning activities. | .75 | 55.94 | 13.19 | .66 | 49.83 | .56 |
|               | Implementation of the ICT attainment targets will lead to clearly observable changes in student learning. | .71 |       |       |     |       | .54 |
|               | Realisation of the ICT attainment targets into classroom practice will be visible for the inspectorate. | .40 |       |       |     |       | .66 |
|               | Realisation of the ICT attainment targets into classroom practice will be visible for my colleagues. | .35 |       |       |     |       | .56 |

* Reversed item

**Psychometric properties of the independent variables**

Summary statistics for the independent variables are presented in Table 2. To facilitate interpretation of the results, all items were summarised into a sum scores ranging from a minimum score of 0 to a maximum score of 100.

Table 2. Summary statistics of the independent variables (n = 471)

<table>
<thead>
<tr>
<th>Scale</th>
<th>Number of items</th>
<th>α</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Teachers’ actual use of ICT</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basic ICT skills</td>
<td>4</td>
<td>.88</td>
<td>47.34</td>
<td>25.22</td>
</tr>
<tr>
<td>Information tool</td>
<td>7</td>
<td>.87</td>
<td>22.64</td>
<td>19.77</td>
</tr>
<tr>
<td>Learning tool</td>
<td>5</td>
<td>.88</td>
<td>42.45</td>
<td>25.50</td>
</tr>
<tr>
<td><strong>ICT related teacher conditions</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ICT professional development</td>
<td>4</td>
<td>.82</td>
<td>43.04</td>
<td>19.64</td>
</tr>
<tr>
<td>ICT teachers’ competences</td>
<td>5</td>
<td>.85</td>
<td>58.09</td>
<td>19.51</td>
</tr>
<tr>
<td><strong>ICT related school conditions</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ICT infrastructure</td>
<td>4</td>
<td>.83</td>
<td>58.65</td>
<td>23.11</td>
</tr>
<tr>
<td>Schools’ ICT vision and policy</td>
<td>9</td>
<td>.93</td>
<td>51.69</td>
<td>18.92</td>
</tr>
<tr>
<td>ICT schools support and coordination</td>
<td>7</td>
<td>.91</td>
<td>64.40</td>
<td>20.12</td>
</tr>
<tr>
<td><strong>School improvement conditions</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initiating structure (leadership scale)</td>
<td>5</td>
<td>.88</td>
<td>73.50</td>
<td>16.96</td>
</tr>
<tr>
<td>Supportive leadership</td>
<td>7</td>
<td>.94</td>
<td>71.02</td>
<td>19.93</td>
</tr>
<tr>
<td>Professional relations among teachers</td>
<td>7</td>
<td>.85</td>
<td>68.36</td>
<td>14.24</td>
</tr>
<tr>
<td>Participative decision making</td>
<td>5</td>
<td>.81</td>
<td>51.37</td>
<td>11.43</td>
</tr>
</tbody>
</table>

Furthermore, Chronbach’s alphas were calculated for the independent variables (see Table 2). All measurement scales show good internal consistency scores (from .81 to .94) and, therefore, are reliable instruments.
Predicting conditions

Table 3 presents the results of a hierarchical regression analysis conducted to investigate which variables from the e-capacity model predict teachers’ perceptions of the innovation attributes of the new ICT curriculum. The regression model consists of five steps which successively examine the contribution of the different variables from the layers of the e-capacity model on the dependent variable.

Step 1 of the model accounted for only 0.2% of the variance in teachers’ perceptions of the innovation attributes of the new ICT curriculum, entering background variables: teachers’ age and gender. Teachers’ demographics were thus not significant. In the second model, the first ‘layer’ of variables from the e-capacity model was added, which refer to teachers’ actual ICT use. The addition of these three variables produced significant multiple R² (R² = .184 and Δ R² = .182). The significant predictors were ‘ICT basic skills’ (β = .257, p < .001) and ‘ICT as an information tool’ (β = .203, p < .001). Almost 18% of the variance in teachers’ perceptions of the innovation attributes of the new ICT curriculum was accounted for when adding ICT related teacher conditions (Model 3). ICT professional development activities and teachers’ ICT competences were strong predictors of teachers’ perceptions of the innovation attributes. In the next model (Model 4), ICT related school conditions were added leading to an increase of R² (R² = .408 and Δ R² = .047). In this fourth model, the effect of ICT related teacher and school conditions was significant. Especially schools’ ICT vision and policy was a significant school level predictor. Furthermore, in this fourth model, the effect of teachers’ actual ICT use was no longer significant. The positive effect in Model 2 was mediated by ICT related teacher and school conditions. In the final model (Model 5), school improvement conditions from the last ‘layer’ of the e-capacity model were added. In this final model (R² = .408), school improvement conditions were the strongest predictor (β = .257, p < .001). Other significant predictors were the schools’ ICT vision and policy (β = .199, p < .001) and teachers’ ICT professional development activities (β = .181, p < .001). School improvement variables, including leadership, collegiality and participative decision making, did not lead to a significant increase in explained variance in the dependent variable.

Table 3. Hierarchical regression analysis

<table>
<thead>
<tr>
<th>Independent variables</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
<th>Model 4</th>
<th>Model 5</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Teachers’ demographics</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td>.021</td>
<td>-.004</td>
<td>-.042</td>
<td>-.016</td>
<td>-.021</td>
</tr>
<tr>
<td>Age</td>
<td>.080</td>
<td>.064</td>
<td>.028</td>
<td>.029</td>
<td>.020</td>
</tr>
<tr>
<td><strong>Teachers’ actual use of ICT</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basic skills</td>
<td>.257**</td>
<td>.191**</td>
<td>.118</td>
<td>.116</td>
<td></td>
</tr>
<tr>
<td>Information tool</td>
<td>.203**</td>
<td>.077</td>
<td>.068</td>
<td>.070</td>
<td></td>
</tr>
<tr>
<td>Learning tool</td>
<td>.048</td>
<td>.036</td>
<td>.048</td>
<td>.043</td>
<td></td>
</tr>
<tr>
<td><strong>ICT related teacher conditions</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ICT professional development</td>
<td>.204**</td>
<td>.181**</td>
<td>.181**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ICT teacher competence</td>
<td>.308**</td>
<td>.252**</td>
<td>.257**</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>ICT related school conditions</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ICT school infrastructure</td>
<td></td>
<td>.064</td>
<td>.061</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Schools’ ICT vision and policy</td>
<td>.209**</td>
<td>.199**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ICT school support/coordination</td>
<td>.016</td>
<td>.023</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>School improvement conditions</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initiating structure (leadership)</td>
<td></td>
<td></td>
<td></td>
<td>.067</td>
<td></td>
</tr>
<tr>
<td>Supportive leadership</td>
<td></td>
<td></td>
<td></td>
<td>-.003</td>
<td></td>
</tr>
<tr>
<td>Professional relations</td>
<td></td>
<td></td>
<td></td>
<td>-.047</td>
<td></td>
</tr>
<tr>
<td>Participation decision making</td>
<td></td>
<td></td>
<td></td>
<td>.006</td>
<td></td>
</tr>
<tr>
<td><strong>R² (proportion of variance explained)</strong></td>
<td></td>
<td>.184</td>
<td>.361</td>
<td>.408</td>
<td>.408</td>
</tr>
<tr>
<td>Δ R²</td>
<td>.182</td>
<td>.177</td>
<td>.047</td>
<td>.000</td>
<td></td>
</tr>
</tbody>
</table>

a Dependent variable: Teacher perceptions regarding the new ICT curriculum
*p≤.01, **p≤.001
Conclusion and discussion

The current study examined teachers’ perceptions of the innovation attributes of the ICT curriculum administered by the Flemish government and sheds light on the complex process of ICT curriculum implementation. Although the study is limited in some respects, like that measurement scales are based on self-reported data or that the study doesn’t explore the relation between perceived innovation attributes and rates of adoption, the results are of particular importance for educational policy makers and researchers. Moreover, because of the rapidly changing society and the rapidly changing nature of educational technology, it is important for educational developers to understand the diffusion of educational technology in education. A better understanding of perceived innovation attributes advances a better understanding of the adoption and diffusion process.

The results of this study indicate that teachers have rather moderate perceptions about the new ICT curriculum. Some teachers report that they have never heard about the ICT attainment targets. This result highlights the need for better communication between educational policy makers, schools, and teachers. This is an essential condition for ICT policy implementation to be successful. Jones (2003) argues that the information that schools and teachers receive must be consistent in order to link national ICT policy to local school level ICT policy. This is particularly important for decentralised educational systems, like the Flemish system, because in such systems schools have greater autonomy and are responsible for putting curricula into practice (Jones, 2003; Vanderlinde, et al., 2009).

The hierarchical regression analysis focused on the relationship between school level and teacher level conditions and teachers’ perceptions of the innovation attributes of the new ICT curriculum. The results indicate that teachers’ ICT competence has the strongest influence on teachers’ perceived characteristics of the ICT curriculum. In other words, teachers must believe that they are competent in order to successfully integrate ICT into their classroom practice (see also Hew & Brush, 2007; Mumtaz, 2000). This study reveals that teachers’ assessment of their ICT competence is more important than their ICT behaviour (i.e., actual use of ICT). ICT competence refers to more than basic ICT skills (e.g., how to handle a computer or how to use a spreadsheet). Following Hew and Brush (2007), it also refers to the pedagogical use of ICT in the classroom (e.g., having insight into the effects of ICT on students’ motivation and learning) and classroom management (e.g., how to organise the class effectively so that students have equal opportunities to use ICT). Educational system developers and educational policy makers must become aware of this multifaceted concept so that teachers can be given opportunities to develop their ICT competences. In this context, the ‘Technological Pedagogical Content Knowledge (TPCK)’ concept recently introduced by Mishra and Koehler (2008) can be very useful. TPCK emphasises a comprehensive set of competences teachers need to successfully integrate ICT in their educational practice, stressing an integrative knowledge base of technological knowledge and skill, knowledge of learners, subject matter content and pedagogy. The results of this study also identify teachers’ ICT professional development activities as a significant predictor of teachers’ perceptions. ICT professional development activities and ICT teacher competence are strongly interwoven conditions (BECTA, 2004; Vanderlinde & van Braak, 2010). Galanouli, Murphy, and Gardner (2004) argue that ICT professional development should reflect the level of ICT competence of the teachers involved. In this context, Cope and Ward (2002) argue that teachers not only need instruction in terms of ICT use, but also need professional development in terms of how educational technology can be used to enhance learning outcomes in students. ICT training activities always need a focus on both pedagogical aspects and teachers’ ICT skills (BECTA, 2004), and need to be imbedded in a supportive professional school culture (Dexter, Anderson, & Becker, 1999). Educators must be aware of these conditions in order to develop effective ICT trainings.

Next to individual teacher characteristics, this study identifies variables at the school level as predictors of teachers’ perceptions of the innovation attributes of the ICT curriculum. In this context, the schools’ ICT vision and policy was significant. This finding is useful for school leaders as it underlines the importance of having a shared vision on the place of ICT in education and having a school based ICT policy plan. Such a plan acts as a blueprint for the sequence of goals a school hopes to achieve. It also outlines the overall philosophy of technology use and indicates how ICT will improve teaching and learning (Baylor & Ritchie, 2002). In order to be successful, an ICT policy plan should focus on teaching and learning processes, not on hardware and internet connections (Gülbahar, 2007). Moreover, teachers should participate in the process of ICT policy plan development (Vanderlinde, et al., 2009), and educational system developers could facilitate this process by providing schools with online supporting tools (see Vanderlinde, van Braak, & Tondeur, 2010).
Besides, the results of the hierarchical regression analysis indicate that the role of the ICT coordinator does not have any impact on teachers’ perceived characteristics of the ICT curriculum. Although the Flemish government expects ICT coordinators to guide teachers and schools in the process of putting the ICT attainment targets into practice, our findings suggest that teachers do not perceive ICT coordinators in this way. Indeed, recent research indicates that in Flanders and other countries, the role of ICT coordinators is often restricted to technical support with little time dedicated to pedagogical or management tasks (e.g., Tondeur, Van Keer, van Braak, & Valcke, 2008). In the context of ICT curriculum implementation, ICT coordinators need to act as change agents, responsible for translating the broadly formulated ICT attainment targets into concrete learning and teaching activities. ICT coordinators can then support teachers in the process of implementing the ICT attainment targets into their daily classroom practice. Furthermore, ICT coordinators acting as change agents should be responsible for providing a vision of ICT integration, developing a school based ICT policy, and providing professional development activities. In order to meet the demands of this role, ICT coordinators should receive a clear mandate from the school community (Vanderlinde et al., 2009), and receive training in leadership skills and change strategies (Hsu & Sharma, 2008).

Our finding that school improvement variables did not lead to a significant increase in explained variance in the dependent variable is rather surprising. This quantitative research reveals that for the case of ICT integration, it appears that content specific conditions are more significant than generic school improvement conditions. This is in contrast to earlier qualitative research (e.g., Wong, et al., 2008) which suggests that leadership approaches and collaboration between teachers are factors that influence ICT integration. More research is needed to outline the role of generic school improvement conditions when implementing and realising an ICT curriculum. To further explore how the new ICT curriculum is realised in practice, we intend to study the relation between perceived innovation attributes and different levels of ICT integration.

References


A Data Management System Integrating Web-based Training and Randomized Trials

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ABSTRACT

This article describes a data management system (DMS) developed to support a large-scale randomized study of an innovative web-course that was designed to improve substance abuse counselors’ knowledge and skills in applying a substance abuse treatment method (i.e., cognitive behavioral therapy; CBT). The randomized trial compared the performance of web-course-trained participants (intervention group) and printed-manual-trained participants (comparison group) to determine the effectiveness of the web-course in teaching CBT skills. A single DMS was needed to support all aspects of the study: web-course delivery and management, as well as randomized trial management. The authors briefly reviewed several other systems that were described as built either to handle randomized trials or to deliver and evaluate web-based training. However it was clear that these systems fell short of meeting our needs for simultaneous, coordinated management of the web-course and the randomized trial. New England Research Institute’s (NERI) proprietary Advanced Data Entry and Protocol Tracking (ADEPT) system was coupled with the web-programmed course and customized for our purposes. This article highlights the requirements for a DMS that operates at the intersection of web-based course management systems and randomized clinical trial systems, and the extent to which the coupled, customized ADEPT satisfied those requirements. Recommendations are included for institutions and individuals considering conducting randomized trials and web-based training programs, and seeking a DMS that can meet similar requirements.

Keywords
Data management system, Web-based training, Randomized trials, Systems development, Systems requirements

Introduction

The World Wide Web makes interactive web courses available to anyone with a computer and Internet connection. Businesses, universities, non-profit organizations, health plans and governmental organizations favor such courses because this type of instruction provides access to cutting edge knowledge, transcends state and national boundaries, and is a means to maintain a trained workforce. Research findings on educational technology show promising results. For example, physicians participating in internet-based continuing medical education had significant knowledge and skill gains comparable or superior to physicians attending in-person workshops (Fordis, King, Ballantyne, Jones, Schneider, et al. 2005). These findings are echoed in a study of interns completing computer-based learning whose knowledge gains were equal to those of interns attending in-person lectures (Davis, Chryssafidou, Zamora, Davies et al., 2007). Computer engineering supervisors’ knowledge of ways to support mental health-troubled subordinates improved following web-based training (Kawakami, Kobayashi, Takao, & Tsutsumi, 2005), as did the knowledge and skills of raters conducting efficacy evaluations in depression studies (Kobak, Engelhardt et al., 2006). Counselors were more able to link clients to 12-Step Programs following web-training (Sholomskas & Carroll, 2006) and web-training was superior to a manual-only approach for educating counselors in cognitive behavioral therapy (CBT) (Sholomskas, Syracuse-Siewert, et al., 2005). Another recent study of CBT showed an increase in substance abuse counselors’ knowledge and confidence in applying this treatment method following completion of a web-course and a small number of weekly supervision meetings (Weingardt, Cucciare, Bellotti, & Lai, 2009). However, findings from studies of on-line courses and e-learning systems (Chan & Robbins, 2006; Weingardt & Villafranca, 2005) show the need to address the “goodness of fit” between the technology and learners’ needs as well as organizational needs.

Our research and training team was faced with such a challenge when we received a five-year grant from the National Institute on Drug Abuse (NIDA) to develop and deliver an innovative web-course to trainees across the country, and conduct a large-scale randomized study of the course’s effectiveness. We designed the multi-module
web-course to improve substance abuse counselors’ knowledge and skills in applying cognitive behavioral therapy (CBT) and be asynchronously delivered. We designed the randomized trial to compare the performance of web-course-trained participants (intervention group) with the performance of printed-manual-trained participants (comparison group) to determine the effectiveness of the web-course in equipping counselors with CBT skills.

A DMS was needed to support all aspects of the study: web-course delivery and management, as well as randomized trial management. A review of the literature and exploration of systems in development revealed no system that was appropriate for our needs. We subsequently participated in the development of a system that met most of our needs.

In the following pages, we describe the innovative web-course we developed, the randomized trial that evaluated the effectiveness of the web-course, the other data management systems we reviewed, and the requirements for the DMS needed to support our project as a whole. The major focus is on the requirements for a DMS that operates at the intersection of web course management and randomized trial systems, and the extent to which the system we developed satisfied those requirements. Our goal is to help organizations who seek to do similar research (a) examine the types of systems requirements for such randomized trials, (b) compare their own systems requirements to those of our project, (c) think creatively about how a system can meet their needs or how it must be customized for their particular study, and perhaps, (d) build a system that best fits their needs.

**Innovative CBT Web-Course**

The authors led the development of a training innovation called Technology to Enhance Addiction Counselor Helping--Cognitive Behavioral Therapy (TEACH-CBT), a web course to improve the knowledge and skills of substance abuse counselors in using cognitive behavioral therapy (CBT). CBT is one of a small number of therapeutic approaches with overwhelming evidence of effectiveness in treating substance abuse problems (Carroll, 1998; Kadden et al., 1992).

TEACH-CBT contains eight instructional modules focusing on the principles and techniques of CBT for treating substance abuse. The modules highlight issues such as using a functional analysis to understand client patterns, behavioral skills training, cognitive skills training, applying CBT to a case, and applying CBT to HIV/AIDS concerns. The curriculum for the e-learning program was developed by project faculty and experts in the areas of CBT and addiction. (A CBT Therapist Manual from NIDA (Carroll, 1998) was used as the outline for content scope.) Curriculum designers developed CBT content that would match desired behaviors in counselor knowledge, attitudes and skills. Specific outcomes to be measured and methods for measuring them were: (a) changes in the counselors’ knowledge, attitudes and confidence, assessed with pre- and post-training and follow-up questionnaires, (b) changes in the counselors’ level of competence in CBT delivery, assessed by independent ratings of audio-taped counseling sessions pre- and post-training, and (c) the counselors’ maintenance of CBT skills at three-month follow-up, assessed by independent ratings of audio-taped counseling sessions.

**Randomized Controlled Trial of the TEACH-CBT Web-Course**

The study recruited counselor-supervisor teams from addiction treatment programs, requiring one supervisor and two counselors per team plus an agency liaison to support data collection. The randomized controlled trial, which employed a control group design, consisted of 54 treatment program teams (181 participants total: 54 supervisors and 127 counselors) that were randomly assigned to either the web-course or to training with a printed copy of NIDA’s CBT Therapist Manual (Carroll, 1998) to evaluate training effectiveness. Both study arms were offered supervisor training and support to encourage practice of skills developed through training.

As shown in Figure 1, the study proceeded through a number of discrete phases, beginning with announcements and agency recruitment and extending through enrollment, randomization, training participation and data collection and analysis, with management, reporting and monitoring of project activities occurring throughout the project. All human subjects procedures were approved by NERI’s Institutional Review Board and complied with a data safety monitoring plan. Throughout the study, modest payments were made to participants.
To accomplish this work, it was realized that a system would be required that could respond to the multiple needs of the project: (a) Design, develop and deliver an innovative web-course to teach and practice new knowledge and skills, (b) give feedback to web-learners on their mastery of module material, (c) promote communication among web-learners (d) collect and report out data on intervention and study progress, and (e) manage the data collection protocol aspects of the randomized trial.

Other Data Management Systems for Web-Course Functions and Randomized Trials

Data management systems have been developed that facilitate distance-education courses, many web-enabled and others accessed through the web although not web-interactive, and/or assist in evaluating the effectiveness of those courses. Although there are similarities in their functioning, the systems are not interchangeable and they each have their own strengths and limitations. A review of the documentation for these systems revealed large gaps in their capabilities to satisfy the requirements of our project. Our purpose is not to include a detailed comparison of their capabilities to the system we customized (ADEPT) but rather to highlight ways they have been utilized.

Course/Curriculum Focused

Web Course tools (WebCT): WebCT has been used in a number of web-based training studies, including the evaluation of continuing medical education courses (Curran, Lockyer, Sargeant, & Fleet, 2006), a pharmacology course for nursing students (Tse, Pun, & Chan, 2007), a course on postpartum emotional distress for community nurses (Ingadottir & Thome, 2006), a medicine course for preclinical medical students (Srinivasan et al., 2002), a course on self-change and health interventions for physicians (Robinson, Francis, Simpson, & Rutledge, 2006), a mental health course for social workers (Knowles, 2001), and a course on the elderly for health professionals (Juntunen & Heikkinen, 2004). Tools for course management included quizzes, pre- and post-course surveys, bulletin-board postings, and tallies of utilization of other course materials and activities.

ACCESS: ACCESS, used for the National Center for Suicide Prevention Training (NCSPT), monitors training participation by tracking the number and results of learner visits to the NCSPT web site, the number and type of registrants, the number of pre-tests, posttests, and evaluations completed, and comments posted on the web board (Stone et al., 2005).

eMed: A “web-enabled database-driven curriculum management system,” eMed was used to support an undergraduate medicine program and interrelates with WebCT (Watson et al., 2007, p.353). eMed “contains information about the learning content, graduate capabilities that learning activities develop, teaching activities, resources, schedules, assessment types, and assessment records (including peer assessments)… [and] manages information across all years of an educational program (Watson et al., 2007, p.353).”
e-Coach: The MD Health e-Coach was used to support web-based training in self-change for physicians. The goal was to assist physicians in improving their own health by increasing their awareness of psychological aspects of their health and showing them how to use psychological techniques to address health concerns (Robinson et al., 2006). Elements of e-Coach included tracking health related self-assessments, personalized plans for health change, individualized health reports, visits to the site, and email reminders for assessments.

Other curriculum systems include ANGEL (A New Global Environment for Learning), Blackboard, Desire 2 Learn and Sakai (Benjamin, Robbins, & Kung, 2006); E-learning or web-conference companies include Placeware, WebEx, Centra, Interwise, and Hewlett-Packard (Weingardt, 2004, p.318).

In summary these systems fulfill many of the needs for course development, delivery and management, but were not designed to support clinical trials.

Research/Clinical Trials Focused

Several proprietary systems exist to monitor implementation of clinical trials, such as the system described by Unutzer and colleagues (2002) to support a multi-center trial of a disease management program for late-life depression in primary care (Project IMPACT) (Unutzer, Choi, Cook, & Oishi, 2002). Its capacities include a recruitment entry and monitoring system, enrollment and dis-enrollment tracking, and storage of contact information, baseline and follow-up data and laboratory data.

Other systems support multi-site data collection absent a randomized design. PEMS: The Program Evaluation and Monitoring System (PEMS) used for an HIV prevention program “is a national data reporting system that includes a standardized set of HIV prevention data variables, web-based software for data entry and management, data collection and evaluation guidance and training, and software implementation support services” (Thomas et al., 2006, abstract). It is funded by the Centers for Disease Control and Prevention. BioDBx: BioDBx is a database application that manages clinical and epidemiologic data, tracks inventory using a linked barcoding system, and analyzes laboratory operations and test results. (https://biodbx.med.umich.edu/). It is currently being used in a research study examining an internet enhanced cognitive behavioral treatment for patients with fibromyalgia (http://www.averasacredheart.com/amck/research/researchpatients/studyfibromyalgia.aspx).

Other systems that support clinical trials include Clinical Trials Management Application (CTMA; http://www.dbmi.pitt.edu/services/ctma.html) and Velos e-Research.

These systems fulfill many of the requirements for clinical trial management, but offer no capabilities for web-course delivery and management.

We found systems built to handle distance or web-based training programs and accompanying data collection or monitoring, and systems built to handle randomized trials (most built for clinical trials of medications and other medical procedures, so they track issues such as patient morbidity and mortality). We found no system described in the literature or identified through explorations of systems in development at the time our project was initiated that satisfied our unique requirements for both randomized trials management and web-based training and evaluation, and using two separate systems was deemed unworkable given our project goals.

Customized DMS to Meet Project Needs: Study Requirements and System Support

Advanced Data Entry and Protocol Tracking (ADEPT) System

In order to have a system that supported both randomized trials management and web-based training and evaluation, the study staff programmed a web course utilizing HTML and Javascript that interacted with a specialized DMS that utilized the New England Research Institutes (NERI) proprietary Advanced Data Entry and Protocol Tracking (ADEPT) system. All technology elements were designed by NERI’s technology development staff. NERI’s media and e-programs (www.neriscience.com) had already trained medical clinicians on the research aspects of the studies of pain and other symptoms (http://symptomresearch.org/) with an e-book, and provided Continuing Education
Credit-approved ethics training for nurses (i.e., https://www.nursingethicsce.com/). ADEPT data management systems are developed and hosted by NERI for clinical trials and registries and can be accessed from anywhere in the world using a standard browser and the Internet (see http://www.NERIScience.org). Current clinical trials and registries include a) Society for Vascular Surgery (SVS) - Vascular Registry, b) Trial of Aldosterone Antagonist Therapy in Adults with Preserved Ejection Fraction Congestive Heart Failure (TOPCAT), c) Hepatitis C Antiviral Long-term Treatment Against Cirrhosis (HALT-C), d) The Pediatric Heart Disease Clinical Research Network (U01HL68270).

ADEPT was customized to integrate the functions of course management and data collection for this randomized controlled trial. (Use of the term ADEPT here means ADEPT plus customized elements). The software design is multi-tiered, and utilizes Oracle 8 database servers and Microsoft IIS 4.0 Web servers. ADEPT employs secure access via assigned user names and passwords, and is monitored and restricted using a firewall. All communication is encrypted using secure socket layer protocols. Routine web-page technology was employed for user interfaces.

Figure 2 illustrates the overall project technology structure and the interfaces between the participating community agencies, NERI, ADEPT and the Worldwide Web. The primary NERI and participating agency functions are also shown.

In the following figures, we identify the system requirements at each study phase (what the study needed), then describe how ADEPT satisfied those requirements (how the need was fulfilled). Except for those noted as performed manually, all requirements were implemented in ADEPT and all were evaluated as equally critical.

**Systems Requirements at Each Project Phase**

*Agency Recruitment:* Figure 3 illustrates the activities within the Agency Recruitment phase, and the system requirements associated with each activity. The screening of supervisors and counselors was asynchronous, with some agencies taking only one week to be accomplished, others requiring multiple new counselor or supervisor applications when some applicants failed eligibility criteria, left the agency, or became too busy to participate.
Using routine web-page technology, the system supported recruitment activities through web-based announcements and e-mails. Potential applicants were directed to a recruitment web-page (periodically updated by staff) that explained the training opportunity and study requirements, and provided a study e-mail address and 1-800 phone number. Through an interface with ADEPT, interested persons could fill-in and submit a form requesting additional information, which went into a study database. Although the project began with two months of traditional US postal mail activity (sending to all New England-based addiction agencies colorful study brochures, one-page flyers, and applications), all subsequent recruitment was conducted via the Internet and web.

Ultimately, the recruitment web-page was the primary communication source and was supplemented over time with sample screen shots of the web course, a section for Frequently Asked Questions (FAQs), and inspirational quotes from current participants about the ease of study participation and their enthusiasm for the web-course www.teachcbt.org. Early on the website was modified so that potential participants could download .pdf versions of all application forms rather than request that an application be sent by US mail or e-mail. One advantage of the recruitment web page was that the project monitored visits or “hits” to this recruitment page. When activity diminished, project staff sent brief e-mail ‘blasts’ to state agencies, addiction associations, and networks of clinics to inform or remind them of the training opportunity and the web address.

NERI staff entered application and screening information into ADEPT, which then automatically created user accounts on the project web site and generated notification e-mail announcements to participants. One manual step was telephone screening of each applicant. (In a small subsequent “spin-off” study for a stand-alone product, this screening step was also accomplished on-line). ADEPT automatically generated a contact record for each counselor or supervisor who needed to be screened; this screening was asynchronous within study teams. Once two or more counselors and a supervisor met the study eligibility requirements the study Research Associate (RA) was notified to verify complete agency information (e.g., no outstanding local IRB review was required). RA approval resulted in automatic emails of registration information to each participant and they were notified to log onto the web site using their individual user account information and read and “sign” an informed consent by checking a box indicating that they understood and agreed to the study. They then proceeded on the web to provide demographic information, and complete a multiple screen pre-test questionnaire (assessing knowledge, attitudes, behavior, and confidence in using certain treatment methods). Data collection occurred via the web for both intervention and comparison group members. Participants who exited prior to complete data collection were directly returned to the incomplete form.
Out-of-range values could not be entered. These data were transferred directly from the web form into an Oracle database that stored data by study ID only for subsequent analyses.

**Baseline Taping and Randomization:** Figure 4 illustrates the activities within the Baseline Taping and Randomization phase, and the system requirements associated with each activity.

![Diagram representing Baseline Taping and Randomization](image)

**System Requirements Implemented in ADEPT**

- Generate random ID number for tape session
- Generate tape labels and ID log for agency use
- Generate tape forms with pre-filled names and ID numbers
- Track all tapes mailed to an agency
- Track unused tapes (not implemented)
- Log tapes received from counselor
- Reconcile received tapes against client permissions and counseling session form information
- Log description of tape sound quality (good, poor)
- Generate payments to liaisons and counselors
- Print contact records for counselor with incomplete tapes
- Print list of agencies with data complete; ready to be randomized
- Generate email to counselors notifying of group status (web course or NIDA manual)
- Generate mailing labels for comparison agencies
- Activate web-course access for intervention counselors and supervisors

**Figure 4: Baseline Taping and Randomization**

Once permissions were obtained from clients to audiotape their sessions, ADEPT generated random ID numbers and labels for the tapes that would be used. ID numbers were cross-referenced to agency and counselor and whether the counselor had completed the pre-test or post-test. Forms were generated by ADEPT with pre-filled names and ID numbers, and these forms were packaged with the tapes and a gift for the client and sent to the agency. Counselors filled in the dates of the sessions when the taping was complete, and the tapes were returned to NERI for independent rating. The mailing date was recorded in ADEPT, and the return date of materials was shown as ‘expected’ until they were received at NERI or they were determined to be dropped. All information related to taping (e.g., ID numbers, session forms, client permissions) were maintained by ADEPT in a database that allowed tracking of tapes sent to agencies as well as status of each counselor in the unit. After baseline taping, modest payments were made to counselors and liaisons.

The RA periodically generated simple tabulations of each data form using a pre-programmed report so the investigators could examine the sample profile. Random assignment of agencies to study conditions required first pooling agencies by state location and other characteristics to ensure balance on a small number of stratification variables. This complexity meant random assignment was done manually by the study statistician based on agency information in ADEPT, with the randomization result stored in ADEPT.

**Training Participation:** Participants utilized either the TEACH-CBT web course or the NIDA training manual according to the randomization outcome. This phase of the study imposed a number of requirements on the support system, as shown in Figure 5.

Training participation included: returning on multiple occasions to learn the 8-module web-course (or read the NIDA manual content), and if web-course, completing a quiz linked to each web-course module, engaging in module specific assignments to practice skills and post on the study bulletin board. For all participants, submitting base-line, post-training, and follow-up audio-taped sessions, and completing pre-test, post-test and follow-up forms. Web programming supported participants by ensuring accurate and timely completion of study forms (e.g., consent forms,
pre-test, post-tests, follow-ups, self-monitoring forms, etc.), web-module quizzes (indicating completion of module), web-practice assignments, and audiotape submissions. Such functions included sending automated e-mails to participants to introduce the course and the schedule, sending timely automated ‘gentle prods’ to web-course participants via e-mail reminder when 14 days had elapsed since they last logged-on or when the next data collection event was scheduled, and sending e-mail prompts to the RA regarding scheduled research tasks. Thus, throughout the TEACH-CBT study, ADEPT was also used to monitor and report participants’ activity on the web site.

![System Requirements Implemented in ADEPT](image)

**Post-training Activities:** This phase of the study involved the random selection of three audiotapes out of the eight audiotaped client sessions (or the number recorded as ‘fair or good audio quality’) of each counselor. These...
randomly selected tapes were assigned to one of five study raters for independent rating to determine the extent to
which counselors employed CBT techniques in their client sessions. Figure 6 illustrates the requirements of the
support system for the Post-training phase.

For rating audio tapes, the authors developed a Rating Guide that covered eight core counseling skills and multiple
sub-skills taught in the course. Five trained raters rated the sessions; each rater was blind to whether tapes came from
the web-course or NIDA manual participants and whether tapes were from baseline, post-training or follow-up. The
study investigators pre-defined a passing algorithm using the ratings across all eight counseling skills. Investigators
subsequently performed statistical analyses of the audiotape ratings to determine the percentage of intervention and
comparison group counselors who received passing scores at baseline and again at the post-training periods.

Summary of Trial Management

Nearly all data was collected remotely via web data entry forms designed for easy and direct completion by the
participants. Other study monitoring, tracking data, and tape rating data were directly entered by the RA. ADEPT
provided easy export of formatted datasets for further statistical analysis in SAS. ADEPT also monitored elapsed
time from the point of randomization for all participants to indicate when new data collection was due, and provided
automatic delivery of e-mail prompts both to participants about the date to begin the next data collection event and to
the RA to begin the mailing of audio-taped materials

Using ADEPT reports, the NERI staff monitored the timely completion of the dozens of study steps that were
expected of each participant. Investigators monitored and could reconstruct information on how the participants
made use of the web course. Statistics that could be reported for each participant and aggregated for analyses
included:

- Numerical counts of: log-on sessions, pages visited, links used, discussion board posts
- Modules completed, end-of-module quiz scores, days elapsed between quizzes and log-ins
- Time spent on course activities, per visit, per module, and total

As outlined above, ADEPT also collected data to allow the tracking of:

- Agency progress, including nested applications for multiple participants’ enrollment and screening forms
- Screening and status of each participant; at some points participants progressed as a group; at other points as
  individual participants
- Randomization goals and balanced groups of randomized agencies
- Accurate, complete, timely web data entry of counselor and supervisor data forms
- Receipt of three forms necessary for each audiotape submission
- Completion of module quizzes
- Completion of participants’ self-monitoring of CBT application in session
- Completion of web-administered pre-test forms and post-test forms

Further, ADEPT provided automatic notification of out-of-window status (failure to comply with the timeline) (e.g.,
regarding the need to start post-test data collection, the need to determine if a participant was still active in the
study).

Empirical Trial Findings

The development of the customized DMS led to successes in some aspects of trial implementation and also eased
the burden on project staff as the recruitment stage eventually spanned 18 months. We recorded over 3,000 inquiries on
the web page where potential applicants could download application materials or request additional information.
Using ADEPT support, over 180 counselor and 65 supervisor applicants were screened. We randomly assigned to
the training condition 127 counselors and 54 supervisors at 54 agencies (LoCastro, Larson, Smith, Amodeo, Muroff,
2008). Project staff monitored for each applicant and study participant the timely completion of the dozens of study
steps expected of each participant. In all, in addition to the traditional function of storing study-acquired research
data, ADEPT assisted the study staff to track more than 10,000 unique research events (50 events per counselor
participant and 27 events per supervisor) over the course of the full study. One illustration of these research events is the multi-form asynchronous data collection required for participant audiotape data collection. Each audiotape submission required pre-labeling by ADEPT of a unique linked number on a consent form, session form, and audiotape. The project received 855 consents to audiotape individual counseling sessions and later received 819 usable (not blank) session audiotapes and session forms. The research assistant could easily confirm with the agency when a missing tape was the result of a missed appointment (no tape expected) or a tape was still outstanding. Collection of audiotapes spanned three waves and ultimately the number of tapes and forms tracked in ADEPT at baseline, post-training and 3-month follow-up were 251, 313, and 255, respectively.

A second illustration of ADEPT findings is related to the tracking of web usage of participants. Of the 62 counselors randomly assigned to the Web course, 57 ultimately started the course (92%). Of those who started, 82 percent (47/57) completed 6 or more of the 8 modules. From log-on information captured by ADEPT, we computed that web course completers averaged, 70.6 days between their first log-on and last log-on to the course. We tracked that non-completers, on average, completed 2.3 modules and averaged 49.0 days from first to last log-on. The DMS also captured web course postings resulting from module assignments. There were 178 assignments posted or on average 3.1 assignments per web course starter. Statistics showed that modules varied in intensity and scope, with the average days between the start and completion of one module ranging from 3.4 days to 10.6 (behavioral skills module and cognitive skills module, respectively) (LoCastro, Larson, Smith, Amodeo, Muroff, 2008).

Recommendations: Using a DMS for Training, Research and Clinical Projects

Choosing a DMS

It is imperative that individuals and institutions interested in developing or utilizing a DMS such as the one described here develop a complete list of their specific needs (i.e., system requirements) before evaluating the various systems available. A key question is, “What should the ideal DMS do?” This question should be considered from four points of view: (1) the learner, (2) the web administrator, (3) the researcher/evaluator, and (4) the course instructor (in some settings). In this project, the study investigators served the roles of web administrator and researchers. One novelty is that this web course had no formal instructor other than automated feedback, although it had two faculty monitoring the content of the bulletin board assignments and offering group telephone sessions for agency supervisors.

Other considerations are the type of reports or outputs needed from the system and the frequency with which they will be needed; the type of data that will be entered into the system, whether the system needs to maintain a history of the data, and if so, for how long; and the speed with which the system needs to respond to user inquiries or transactions.

In addition to the specific requirements, a number of general factors should be considered in evaluating systems of any sort. In particular, Abowd (1994) has compiled a list of usability factors that should prove helpful either in evaluating existing systems or in designing a new system.

- **Visibility of system status:** The system should always keep users informed about what is going on, through appropriate feedback within reasonable time. *We did this in ADEPT by providing a visual timeline of the study steps accomplished and remaining in our automated emails to participants. Web course participants also had visual cues to remaining pages in a module. Study investigators had reports showing participant progress against weeks enrolled and a report of all counselors by a flow-diagram of study steps.*

- **Match between system and the real world:** The system should speak the users' language, with words, phrases, and concepts familiar to the user, rather than system-oriented terms. Follow real-world conventions, making information appear in natural and logical order. *We violated this in ADEPT by assigning random log-in ID numbers, for study purposes, but these IDs were only four digits long. When assigning passwords, the system generated two concatenated short words for easy recall (e.g., cakewalk).*

- **User control and freedom:** Users often choose system functions by mistake and will need a clearly marked "emergency exit" to leave the unwanted state without having to go through an extended dialogue. Support undo and redo. *We accomplished this in ADEPT in the web course and 'saved' the participant’s screen location so he/she could jump back to that spot.*
- **Consistency and standards:** Users should not have to wonder whether different words, situations, or actions mean the same thing. Follow platform conventions. *In our project, each module followed a well thought-out template, had colorful logos designating the type of optional material (advanced, review), and screen icons indicating the type of screen (activity, quiz, content).*

- **Error prevention:** Even better than good error messages is a careful design which prevents a problem from occurring in the first place. *Our web data forms had built in validation so that only valid answers could be provided.*

- **Recognition rather than recall:** Make objects, actions and options visible. The user should not have to remember information from one part of the dialogue to another. Instructions for use of the system should be visible or easily retrievable whenever appropriate. *The customized ADEPT options for project staff were difficult to understand for all but one project staff most familiar with the system.*

- **Flexibility and efficiency of use:** Accelerators - unseen by the novice user - may often speed up the interaction for the expert user to such an extent that the system can cater to both inexperienced and experienced users. Allow users to tailor frequent actions. *In data collection for a research study, speed must be balanced with data quality. For the participants, ADEPT recorded pages visited and returned the user to the previous page; content had hot-links to module sections. However, all users were forced to start at the same beginning and take the same path in order to record course progress.*

- **Aesthetic and minimalist design:** Dialogues should not contain information which is irrelevant or rarely needed. Every extra unit of information in a dialogue competes with the relevant units of information and diminishes their relative visibility. *Web pages became less dense as we designed more modules. Dialogue was limited to 30 second segments after pilot evaluation of the prototype module.*

- **Help users recognize, diagnose, and recover from errors:** Error messages should be expressed in plain language (no codes), precisely indicate the problem, and constructively suggest a solution.

- **Help and documentation:** Even though it is better if the system can be used without documentation, it may be necessary to provide help and documentation. Any such information should be easy to search, focused on the user's task, list concrete steps to be carried out, and not be too large.

**Anticipating the Need for Customization**

While this article focused on one of ADEPT’s applications, the dissemination and evaluation of an EBP to community-based organizations, it and similar systems may be customized to support essentially any type of research inquiry (e.g., on learning, teaching, clinical and non-clinical interventions). However, despite the best efforts to define system requirements, project staff should anticipate that requirements can almost never be fully known at the beginning.

For example, in addition to the usual considerations of the computer literacy of the learners and their access to computers, this study also encountered special issues.

- We received very few complaints that the learners could not navigate the web course or the data collection modules, however the questionnaire data was on several forms requiring periodic submission and some users were unfamiliar with submission of data within certain time constraints before continuing onto another form.
- The learners were inside agencies with spam software, and tests of automatic emails generated by ADEPT were needed for each new participant to ensure receipt. NERI staff needed to advise agency staff on how to change their servers to accept automatically-generated emails.
- Research project staff was decentralized and changed over time; new staff and non-RA’s required substantial orientation to the ADEPT system. The system had complex triggers and logic; customized features were not well documented for newcomers; the logic behind custom reports was not obvious.
- Design of custom reports occurred before the research staff were fully aware of their project management needs, and changes to the reports was awkward and time-consuming.
- The system requirements for web course and research purposes may place competing demands on the system. For example, for learning purposes we wanted the participants to go at their own pace; however, for study purposes, we needed to force participants to take the post-test before too much time elapsed and we risked losing post-test data. Learners were sometimes frustrated by the need to provide data before they had completed training. This study also had added complexity because at times participants progressed in a group and at other
times as individuals. Learners would prefer to navigate freely among modules and pages whereas the research required a more linear progression through materials.

Institutions and individuals anticipating the use of such a system should remember that, in spite of the impressive capacity of such a system to deal with complexity, some customization will still be necessary. Typically, these systems are developed to meet a set of requirements dictated by the project for which they will be used. To the extent that projects, and thus requirements, are different, the system must be modified to accommodate the differences.

Conclusions

This article has described a specialized data management system which married web course materials with a DMS (ADEPT) that was customized to provide real-time information for both the management of web-based educational courses and the collection of a large volume of reliable, valid data at multiple stages for a randomized research trial of training program outcomes. ADEPT was invaluable in its ability to manage ambitious and challenging recruitment and enrollment steps which required that participants be embedded inside of agencies but at the same time screened asynchronously with additions and drops before a set of participants enrolled as part of three-person or larger teams. Participation in Web-training was participant-driven, with some finishing in four weeks and others being prompted at seven weeks to finish.

Educational, health, and human service organizations should consider integrating the innovative data management functions described here into their web-courses if they are planning to engage in: (a) research on learning outcomes, as we did in the study discussed here, (b) research on teaching, that is, examination of effective pedagogical methods, (c) clinician applications such as counselor tracking of whether or not his/her clients complete the homework assigned each session, which hand outs are used in a session, and which hand outs were given to clients. Longitudinal tracking could identify areas which could be enhanced through additional supervision; or (d) clinical supervisor applications, for example, monitoring print outs of counselor self-ratings and identifying CBT strategies that are being underused and which might benefit from supervision.

Since this project, we have further customized ADEPT and our web programming approach for a commercial version prototype of the course. In this second generation we have automated additional recruitment and screening steps, automated randomization to group based on screening data, and created a ‘case-oriented’ navigation system through the web content. A DMS such as ADEPT is critical for accurate and efficient research data support. This technology exists and is underutilized. Given researchers’ need for such sophisticated systems for research project support, those individuals who are building systems need to focus on how to create similar systems and make them accessible to a wider audience.

Acknowledgements

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Blogging for Informal Learning: Analyzing Bloggers’ Perceptions Using Learning Perspective

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ABSTRACT
This study defines a blog as a contemporary web-based environment that can make a difference in adult informal learning practice. An online survey with 70 adult bloggers in Korea was undertaken to understand the nature of adults’ blogging and its meanings in terms of learning. This study investigates (a) adults’ blogging experiences related to learning, (b) bloggers’ perceptions of the usefulness of blogging in terms of four perspectives on learning processes (i.e., learning as an acquisition process, a reflection process, a practice-based community process, and an embodied co-emergent process), and (c) the link between adult informal learning and blogging. The findings show that the majority of participants became aware of positive changes, including learning experiences, in everyday life after blogging. Among the four perspectives on learning processes, bloggers perceived blogging mainly as acquisition and/or reflection oriented learning process. Also, adult bloggers identified the characteristics of learning through blogging as ‘self-directed,’ ‘practical,’ ‘situative,’ ‘unlimited and accessible,’ and ‘self-regulated,’ which are distinguished from those of formal education in schools. This study therefore implies that the blog can be a meaningful learning environment and the blogging can be a significant factor in having the informal learning for adults more enriched and fulfilled.

Keywords
Blog, Adult learning, Informal learning, Learning perspective

Introduction
This study intends to explore blogs as a meaningful environment for informal adult learning. A blog, an individually maintained web page, has been a social phenomenon for the last decade (Boyd & Ellison, 2007). As the latest development in web-based technology, the functions of blogs vary. They can be online personal journals (Wang & Hsua 2008), Web-based media facilitating communication and interaction with other bloggers (Godwin-Jones, 2003), or interactive knowledge-exchange tools (Herring et al., 2005). Blogs also can capitalize on the strength of authentic writing, the power of the writing process, and the engagement of collaborative writing (Boling, Castek, Zawilinski, Barton, & Nierlich, 2008). Today, more people are reading and keeping blogs. For example, as of March 2008, 184 million worldwide users have started a blog while 26.4 millions uses in US; 346 millions worldwide users read blogs while 60.3 millions in US (Winn, 2008). Since it does not require any specific programming skills such as writing HTML codes, this technology-enabled online space now seems to have gained world-wide popularity by making it easier to search and collect documents, share thoughts in an open public space, and contribute to communities.

Blogs have been studied on various aspects in different disciplines, for example, blogging for marketing in business sectors (Singh & Singh, 2008; Wright & Crossland, 2006) and blogging for expressing and sharing their political voices with explicit intention to influence others in political sector (Coleman & Wright, 2008; Francoli & Ward, 2008; Wright, 2008).

The question now is: Can this new form of people’s expression be used effectively for education and learning? We argue in the remainder of this paper that the chances are high. First, several studies indicate that the features of blogs are used for educational purposes, particularly for various kinds of classroom instruction (Boling, et al., 2008; Glass & Spiegelman, 2008; Hramiak, Boulton, & Irwin, 2009; Kajder & Bull, 2004; Martindale & Wiley, 2005; Quible, 2005; Ray, 2006; Wassell & Crouch, 2008). Researchers argue that blogging is an effective instructional tool in which instructors and students can communicate with each other to discuss issues raised in class. For example, college faculty members can use blogs as teaching and learning aids in a higher-education context (Glass & Spiegelman, 2008; Martindale & Wiley, 2005; Quible, 2005); and students can demonstrate their projects on blogs (Overby, 2009; Ray, 2006). K-12 teachers can use blogs to help their students reflect on their own thoughts (Kajder
& Bull, 2004) while pre-service teachers or student teachers can utilize blogs for their own professional development (Haramiak, Boulton, & Irwin, 2009; Wassell & Crouch, 2008).

While the studies addressed above have argued the usefulness of using blogs for educational purposes in which teachers actively lead for effective learning, their self-directed use by bloggers and its embedded meaning for effective learning remains an area of exploration. Also, less research has been conducted to explore blogs as a newly emerging space where learners can benefit informally.

This study, therefore, aims to explore the nature of adults’ blogging and its effectiveness in terms of their everyday learning. It investigates the reasons for adult bloggers’ use of blog, their conception of learning, and the interpretations of the linkage between their blogging and learning. Therefore, the research questions were:

- Which experiences do the adult bloggers perceive conducive to learning?
- What are the potential uses of blogs for learning in relation to the perspectives of adult learning processes?
- What are the characteristics of adult informal learning through blogging compared to the formal education in school?

**Theoretical Framework**

**Characteristics of Adult Informal Learning**

To respond to the accelerated changes in the world and the increasing and diversified demands of society, lifelong learning has been considered not something extra but something required and essential. Since adult learning has become a major part of lifelong learning discussions in recent decades (OECD, 1996), contemporary adults have been encouraged to find learning opportunities in diverse places including home, educational institutions, workplace, community, and even cyberspace (Kwon, 2001).

Unlike children or adolescents who generally learn in formal educational settings such as schools, adults learn in more diverse and flexible settings and may learn significantly more in incidental and spontaneous learning situations than in educational settings. Adults also learn without any direct reliance on teacher or instructors, sometimes learning through serendipity. These cases correspond to informal learning (Marsick & Watkins, 2001). In a broader sense, informal learning includes everyday experiences from which we learn something (Merriam & Cafarrella, 1999).

Informal learning has great flexibility allowing people to gain knowledge without instructors and externally imposed curricular criteria (Livingstone, 2001). With less restriction, it can be more learner-centered and learners can decide for themselves important things they want to learn.

This flexibility is favored by many adult learners. Empirical studies regarding adult informal learning show that the overwhelming majority of adults spend substantial time in the pursuit of informal learning (Johnstone & Rivera, 1965; Livingstone, 2001; Tough, 1971, 1978). For example, Tough’s study found that more than two-thirds of adults’ intentional learning occurred outside schools or educational institutions (Tough, 1971). According to these findings, informal learning can well be defined as one of the important and predominant forms of learning in adult lives.

Informal learning, however, has not yet been investigated fully due to its broad definition. Some of it is conducted by agency, the learner, obviously intentionally. Much of it, however, is hard to distinguish from life experiences since it occurs in everyday life. Indeed, it often is viewed as an “iceberg” phenomenon (Brockett & Hiemstra, 1991; Brookfield, 1981) since so much of it is invisible and easy to underestimate. Whether visible or invisible, few studies have been conducted on how effectively informal learning enriches adults with tangible learning outcomes (Livingstone, 2001; 2002).

Researchers have attempted to classify informal learning to deal with it in more manageable ways. Even though some researchers often use informal learning and self-directed learning as interchangeable terms, many agree that informal learning includes more than the self-directed one shown above. According to Schugurensky (2000), informal learning can take different forms due to the presence or absence of intentionality and awareness of learning.
He defines informal learning in three forms - self-directed learning, incidental learning, and socialization (see Table 1).

<table>
<thead>
<tr>
<th>Forms</th>
<th>Intentionality</th>
<th>Awareness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-directed</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Incidental</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Socialization</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

In Schugurensky’s classification, self-directed learning refers to 'learning projects' undertaken by individual learners. Since adults are believed to be self-directed in nature, or the contemporary world encourages learners to be more self-directed, adults pursue more and more self-directed learning opportunities, not fixed and full-time but open and flexible. Such informal learning is intentional because the learner intends to learn something before the learning process starts. It also is a conscious process in that the learner is aware of the learning when it happens.

Incidental learning, in contrast, refers to the learning experiences that occur when the learner may not intend to learn something. After the experience, however, she or he becomes aware of it. Thus, it is an unintentional but conscious process.

Socialization, also called tacit learning, refers to the internalization of values, attitudes, behaviors, or skills that occur in everyday life. The concept of socialization as a type of informal learning is very hard to research since it is neither intended nor perceived by the learner. Therefore, this study does not discuss socialization or tacit learning despite its significant value in adult informal learning.

**Processes of Adult Informal Learning**

Adult informal learning, either self-directed or incidental, follows different processes with different outcomes. No single theory of learning comprehensibly explains these various learning processes. Many learning theories have contributed to this discussion and offered unique and valuable perspectives on the process of adult learning (Mitchell & Livingstone, 2002). For example, adult learning not only includes the acquisition and accumulation of information, but also embraces “making sense of our lives, transforming not just what we learn but the way we learn, and it is absorbing, imagining, intuiting, and learning informally with others” (Merriam, 2001, p. 96). It also engenders certain identities and belongingness to adult learners (Merriam, Courtenay, & Baumgartner, 2003) while it brings total changes to the agency and the related objects (Law, 1992).

To address the adult informal learning processes and outcomes through blogging, this study depends on Fenwick and Tennant’s (2004) categorization of adult learning, which, according to them, can be viewed from four different perspectives: (a) an acquisition process, (b) a reflection process, (c) a practice-based community process, and (d) an embodied co-emergent process.

First, “learning as acquisition” understands knowledge as a substantive skill or competency, concept, or new language that a learner can acquire. Fenwick and Tennant illustrate that the acquisition is related to “how mental information processing occurs and how cognitive structures develop and change” (Fenwick & Tennant, 2004, p. 57). Not only knowledge contents but also strategies or skills to develop new knowledge can be acquired.

Second, learning involves a reflection process. “Learning as reflection” interprets learning as a meaning-making process. This kind of learning often brings transformative outcomes that can lead learners to challenge and transform their assumptions and values (Mezirow, 1991; Schugurensky, 2000). As learners interpret what they sense, depending on the aspects of personal interests or familiarity, they transform the existing knowledge or even construct new and/or unique ones. This means that, for example, each blogger will most likely construct a very different understanding of what he or she reads on the same blogging site. Although all adults are exposed to a myriad of experiences, not everyone learns the same from them. Learning happens “only when there is reflective thought” (Fenwick & Tennant, 2004, p. 60).
Third, learning can also be viewed as a social activity embedded in authentic social relations. The concept of community of practice (in abbreviation, CoP) explains that any group of individuals collaborates to pursue shared goals and works. Lave and Wenger (1991) argue that individuals learn as they participate by interacting with the community (with its history, assumptions and cultural values, rules and patterns of relationship), the tools at hand (including objects, technology, languages and images), and the moment’s activity. They learn and form a certain identity after this process.

The fourth perspective views adult learning as a co-emergent process. This perspective criticizes the view of learning as participation in a community of practice because it still separates individuals from group, humans from environment, subject from object (Fenwick & Tennant, 2004). The co-emergent process is, in contrast, a holistic perspective on learning processes. That is, it is not limited to the state that individuals and communities learn something from something somewhere. Rather, the learning systems and human beings co-adapt, organize and transform interactions to create new forms of knowledge and the learning systems. Overall, learning is a highly complex process in which the individual’s cognitive and social dimensions of learning are co-emergently achieved through interactions with the knowledge system, and the outcome is the fundamental change for the both, the learning systems and human beings.

The meaning of this classification of adult learning in terms of its process can be connected to the issue that this study focuses on - adult informal learning. First, acquisition of knowledge is necessary for learners at all age levels; but its significance cannot be too overemphasized for adults in these days when lifelong learning such as continuous job-related training has become the norm. Second, learning through meaning-making or reflection is more meaningful for adults in that it reconstructs the meaning of existing experiences, which adults are assumed to accumulate more than children or adolescents throughout the years of their lives. Third, as adults are involved with various communities, it is important for them to gain appropriate identities related to these communities. Learning through community-based processes is therefore important to adults whose relationships and interactions within a community play important roles for their careers and personal lives. Lastly, considered a part of complex learning systems, adults develop through continuous interaction with people and objects around them, which in turn affect and advance the whole systems.

Thus, adult informal learning often takes place in adults’ everyday lives and is quite valuable. In this study, various scholarly definitions and classifications regarding adult informal learning are used to conceptualize the meaning of blogging as adult informal learning. Schugurensky (2000)’s categorization of informal learning helps to formulate an argument that blogging can facilitate either self-directed learning, incidental learning, or socialization depending on whether there is intention or awareness. By using Fenwick and Tennant (2004)’s categorization, blogging activities are to be understood as learning activities that require uniquely different processes to yield various outcomes of learning such as acquisition of knowledge, reflection of experience, formation of identity by participation, and co-emergent change of both learners and the system.

**Methods**

Within a mixed model research approach (Johnson & Christensen, 2004), an online survey questionnaire was developed for this study and included both quantitative multiple-choice items and qualitative open-ended questions. The online survey was designed to derive respondents’ self-reports in terms of how adult bloggers use blogs, their general understanding of the usefulness of blogging, and the meanings of blogging in their everyday lives and learning.

The survey questions generally were grouped into three categories: demographic background, personal experiences with blogs, and the perceptions of learning in relation to blogging experiences. As part of the survey, a questionnaire (see Table 2) consisting of twelve items on a Likert scale (from 1, strongly disagree to 5, strongly agree) was developed specifically to investigate bloggers’ perceptions of the usefulness of blogging for different types of learning based on the four perspectives identified by Fenwick and Tennant (2004): Learning as (a) an acquisition process, (b) a reflection process, (c) a practice-based community process, and (d) an embodied co-emergent process.
Table 2. Questionnaire for the usefulness of blogging for learning

<table>
<thead>
<tr>
<th>Learning perspectives</th>
<th>Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning as an acquisition process</td>
<td>1. Blogging can be useful in acquiring various kinds of knowledge and information.</td>
</tr>
<tr>
<td></td>
<td>2. Blogging can help me develop my own expertise in some areas.</td>
</tr>
<tr>
<td></td>
<td>3. Blogging can help me engage more actively in my fields of interests.</td>
</tr>
<tr>
<td>Learning as a reflection process</td>
<td>4. Blogging can help me experience the ‘a-ha’ moment that transforms my old views to a new one.</td>
</tr>
<tr>
<td></td>
<td>5. Blogging can provide me opportunities to grow by looking back on my own thoughts, views and experiences.</td>
</tr>
<tr>
<td></td>
<td>6. Blogging can be useful to describe and/or express my thoughts and views.</td>
</tr>
<tr>
<td></td>
<td>7. Blogging can help me gain new awareness and set up plans on the basis of it.</td>
</tr>
<tr>
<td>Learning as a practice-based community process</td>
<td>8. Blogging can be useful to build up some social networks around me.</td>
</tr>
<tr>
<td></td>
<td>9. Blogging can help me realize the influence of other bloggers on me.</td>
</tr>
<tr>
<td></td>
<td>10. Blogging can help me realize the importance of it as a collective activity in a community.</td>
</tr>
<tr>
<td>Learning as an embodied co-emergent process</td>
<td>11. Blogging can make me communicate with the world and can influence every area of my life.</td>
</tr>
<tr>
<td></td>
<td>12. Blogging can help me create new knowledge and I can share this with others as an expert.</td>
</tr>
</tbody>
</table>

Data Collection

Seventy Korean adult bloggers (i.e., over 20 years of age) were recruited for the study. They were users of Naver ([http://www.naver.com](http://www.naver.com)), which is one of the representative blog service providers in Korea. Bloggers enrolled in any formal education programs (e.g., college, university, graduate school) were excluded because their uses of blogs could be influenced by formal education, which may affect the focus of the study, adult informal learning. To recruit the participants, the strategy of snowball sampling was used. Each researcher initially invited a couple of Naver bloggers among personal acquaintances who fit the criteria for participation and asked them to introduce the survey to other bloggers.

The majority of survey participants were in their 30s (57.2%), female (75.7%), and office workers (40.0%) or professionals (20.0%). Forty-three participants (61.4%) had used blogs for more than two years. The detailed demographics are presented in Table 3.

Table 3. Demographics of the Survey Participants

<table>
<thead>
<tr>
<th>Category</th>
<th>Items</th>
<th>Number of Responses</th>
<th>Percent of Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>Female</td>
<td>53</td>
<td>75.7 %</td>
</tr>
<tr>
<td></td>
<td>Male</td>
<td>17</td>
<td>24.3 %</td>
</tr>
<tr>
<td>Age</td>
<td>20-29</td>
<td>20</td>
<td>28.6 %</td>
</tr>
<tr>
<td></td>
<td>30-39</td>
<td>40</td>
<td>57.2 %</td>
</tr>
<tr>
<td></td>
<td>Over 40</td>
<td>10</td>
<td>14.3 %</td>
</tr>
<tr>
<td>Occupation</td>
<td>Office workers</td>
<td>28</td>
<td>40.0 %</td>
</tr>
<tr>
<td></td>
<td>Professional</td>
<td>14</td>
<td>20.0 %</td>
</tr>
<tr>
<td></td>
<td>Self-employed</td>
<td>9</td>
<td>12.9 %</td>
</tr>
<tr>
<td></td>
<td>Full-time housewives</td>
<td>8</td>
<td>11.4 %</td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>7</td>
<td>10.0 %</td>
</tr>
<tr>
<td></td>
<td>Job-seekers</td>
<td>4</td>
<td>5.7 %</td>
</tr>
</tbody>
</table>

Data Analysis

The data were analyzed using both quantitative and qualitative methods. A statistical analysis was conducted to investigate whether there are any correlations among the variables describing the participants: their demographic information, their patterns of using blog, their recognitions of change in life through the blogging, their descriptions
of learning, and their perceptions on the usefulness of blogging for learning. The results did not show any meaningful correlations between and within variables. It would be difficult to articulate the behavioral patterns of using blogs accordingly. Bloggers use blogs in many different ways depending on their own purposes, preferences, and life styles. Hence, it is necessary to investigate more qualitatively regarding various features that would be found from their blogging experiences.

The qualitative data obtained from the open-ended survey questions (e.g., the experiences of change in life through blogging, the definitions of learning, the characteristics of learning through blogging and learning in school) were analyzed using the microanalysis method (Strauss & Corbin, 1998) to fully understand their blogging experiences by “coding the meaning found in words or groups of words”(p. 65) and improve the credibility of our interpretations regarding the results of data along with rich descriptions. To ensure the inter-reliability in coding, all of data was reviewed by three researchers respectively and the consensus among three researchers was involved.

**Findings**

**Blogging Experiences related to Learning**

In terms of bloggers’ behaviors, the statistical analysis of the survey responses did not offer any meaningful correlations between and within variables: the participants’ demographic information (e.g., age; occupation) and their patterns of using blogs (e.g., the number of hours spent blogging including managing their own blogs and visiting others’ blogs; the numbers of neighbors who they regularly had visited and who regularly visited their blogs). The results show that it would be difficult to articulate the behavioral patterns of using blogs. Bloggers use blogs in many different ways depending on their own purposes, preferences, and life styles. Hence, it is necessary to investigate more qualitatively regarding various features that would be found from their blogging experiences.

Out of 70 survey respondents, 61.4% had used blogs more than two years and thus were relatively steady users of blogs. While the majority of participants (68.6%) indicated that they engaged in blogging about two hours per week, there were 13 bloggers (18.6%) who had spent more than five hours, ranging up to 30 hours, per week. Interestingly, when they were asked to estimate the time spent managing their own blogs and visiting others’ blogs, the total figures were higher than the numbers of hours for blogging they indicated.

Regarding the purposes for using blogs, 43 participants (61.4%) indicated that they had used blogs for the sharing of information in relation to general issues. Other reasons were identified, such as (a) for satisfying personal interests and hobbies (40.0%) or (b) for developing their own expertise on more specific areas (30%), (c) for expressing and reflecting by themselves (37.0%), such as writing journals including personal experiences, thoughts, and opinions, and (d) maintaining social relationships (37.0%) by connecting with other bloggers (see Table 4).

<table>
<thead>
<tr>
<th>Reasons</th>
<th>No.</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sharing information</td>
<td>43</td>
<td>61.4 %</td>
</tr>
<tr>
<td>Personal interest or hobby</td>
<td>28</td>
<td>40.0 %</td>
</tr>
<tr>
<td>Self-expression and self-reflection</td>
<td>24</td>
<td>37.0 %</td>
</tr>
<tr>
<td>Maintaining social relationships</td>
<td>24</td>
<td>37.0 %</td>
</tr>
<tr>
<td>Developing expertise</td>
<td>21</td>
<td>30.0 %</td>
</tr>
<tr>
<td>For fun</td>
<td>15</td>
<td>21.4 %</td>
</tr>
<tr>
<td>Interpersonal communication</td>
<td>14</td>
<td>20.0 %</td>
</tr>
<tr>
<td>Developing self-identity</td>
<td>13</td>
<td>18.6 %</td>
</tr>
<tr>
<td>Observing others’ lives</td>
<td>7</td>
<td>10.0 %</td>
</tr>
</tbody>
</table>

Based on their blogging experiences, the participants were asked if there had been any changes in their lives and their way of thinking after they began blogging. Forty-six respondents (65.7%) gave positive answers and explained the changes in areas as below:

- Ways to deal with information and knowledge (23%):
“I got a habit that I searched and collected information like collecting different coins. I became sort of expert-minded on certain topics.” (participant 30)

“Easy access to information gives me stronger desire to experience a certain thing.” (participant 13)

- Personal ways of thinking (23%):
  “I reflect myself by sharing thoughts with other people.” (participant 25)

  “Blogging gave me a chance to look back on my life. I realize that journaling the moments is so meaningful. Now I find a common day more precious than before.” (participant 57)

- Self-development (40%):
  “I could see myself more objective while writing a blog. And I could arrange and organize the things around myself better.” (participant 60)

  “I feel that the range of perspective or thoughts became broader.” (participant 14)

- Social relationships (15%):
  “My relationship with friends and colleagues is more extended and deepened since I could stay in touch with them using blogs.” (participant 61)

  “Sharing my thoughts and feelings by blogging led to another level of social relationships and I actually became more extrovert.” (participant 63)

Meanwhile, 24 participants (34.3%) reported that blogging had no influence on their ways of thinking or on their life as a whole and explained that they used blogs in a limited way simply for sharing information or for fun.

Figure 1. The degree of agreement on blogging as learning process in relation to four perspectives of learning processes

No matter whether they recognized any changes in their life after using blogs, the majority of participants (90.0%) agreed that they had experienced some kind of learning through their blogging activities. For further analysis of their responses in terms of learning, the following section will describe their perceptions of the relationship between
blogging and learning based on Fenwick and Tennant’s (2004) four perspectives on adult learning discussed in the first section of this paper.

Perception of the Usefulness of Blogging for Learning

To understand bloggers’ perception of the usefulness of blogging for learning, the results of the questionnaire asking about the relationship between blogging and learning (refer to Table 2) were analyzed. In Figure 1, the X-axis indicates the four perspectives of adult learning process: Learning as an acquisition process, a reflection process, a practice-based community process, and an embodied co-emergent process. The Y-axis shows how strongly the survey participants agreed with each perspective on learning in relation to blogging.

These results revealed that the majority of participants believe that blogging is most valuable in acquiring specific knowledge, expressing thoughts and opinions, and maintaining their interests. However, the analysis reveals, at the same time, that the participants were not sure of the value of blogs on other perspectives such as community-based learning and co-emergent learning processes. It implies that the blog is considered more as a personal online space in which individuals’ learning can occur as distinct from a group-based learning space, such as an online community or online discussion forum which can be created in the blogosphere, the community of blogs.

More specifically, Table 5 presents the degree of agreement on each item across the learning perspectives.

<table>
<thead>
<tr>
<th>Items</th>
<th>Scores</th>
<th>Averages</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Blogging can be useful in acquiring various kinds of knowledge and information.</td>
<td>4.15</td>
<td>3.97</td>
</tr>
<tr>
<td>2. Blogging can help me develop my own expertise in some areas.</td>
<td>3.76</td>
<td></td>
</tr>
<tr>
<td>3. Blogging can help me engage more actively in my fields of interests.</td>
<td>4.00</td>
<td></td>
</tr>
<tr>
<td>4. Blogging can help me experience the ‘a-ha’ moment that transforms my old views to a new one.</td>
<td>3.79</td>
<td>3.75</td>
</tr>
<tr>
<td>5. Blogging can provide me opportunities to grow by looking back on my own thoughts, views and experiences.</td>
<td>3.82</td>
<td></td>
</tr>
<tr>
<td>6. Blogging can be useful to describe and/or express my thoughts and views.</td>
<td>4.13</td>
<td></td>
</tr>
<tr>
<td>7. Blogging can help me gain new awareness and set up plans on the basis of it.</td>
<td>3.25</td>
<td></td>
</tr>
<tr>
<td>8. Blogging can be useful to build up some social networks around me.</td>
<td>3.65</td>
<td>3.51</td>
</tr>
<tr>
<td>9. Blogging can help me realize the influence of other bloggers on me.</td>
<td>3.49</td>
<td></td>
</tr>
<tr>
<td>10. Blogging can help me realize the importance of it as a collective activity in a community.</td>
<td>3.40</td>
<td></td>
</tr>
<tr>
<td>11. Blogging can make me communicate with the world and can influence every area of my life.</td>
<td>3.68</td>
<td>3.61</td>
</tr>
<tr>
<td>12. Blogging can help me create new knowledge and I can share this with others as an expert.</td>
<td>3.54</td>
<td></td>
</tr>
</tbody>
</table>

Overall, the three aspects of blogging for learning that participants most strongly agree with are as follows:
(1) Blogging can be useful in acquiring various kinds of knowledge and information. (4.15)
(6) Blogging can be useful to describe and/or express my thoughts and views. (4.13)
(3) Blogging can help me engage more actively in my fields of interests. (4.00)

Most participants agreed strongly that blogging would be the most useful in knowledge-acquisition but that it would be in pursuit of general information rather than seeking expertise-focused knowledge. Participants also agreed that blogging would be very useful in reflective learning that leads to transforming old perspectives or even generate new ones, but that building specific action plans for these tasks is less related to blogging. Next, the participants remained neutral or slightly tended to agree that blogging would head learning as a practice-based community process. The results indicate that individual bloggers hardly consider the sense of belonging to a community since they do not intend to participate in collective activities and to build collective knowledge but rather they are interested in fulfilling their own intellectual desires and needs. Bloggers seem to identify blogging mainly as acquisition and/or reflection-oriented learning processes based on a self-centered rather than a community-centered perspective. Further insights on this are mentioned in the discussion section.
Links between Adult Informal Learning and Blogging

To clarify some characteristics of blogging as informal learning, the survey participants were asked to describe and compare it with learning in school, that is formal education. Their responses to each type of learning are presented visually by using a “word clouds” application (http://www.wordle.net), which enables the frequency of used words visualized. As seen in Figure 2 and 3, the words (characteristics) indicated more frequently are shown with larger font size and darker color.

These characteristics were categorized generally into three themes: (a) learners’ role, (b) contents of learning, and (c) learning process. The large amount of descriptions emphasized what roles learners would take when they were engaged in blogging, what types of contents/information they were dealing with, and how their experiences encountering contents/information (learning) was processed.

Speaking of learners’ role in blogging, ‘self-directed’ was most highlighted. Bloggers believed that blogging helps users active and self-regulated. The contents of learning, including more practical information, are seen as being generated from individuals’ own experiences, thoughts, or views, even information not yet authorized as approved facts or knowledge.

![Figure 2. Descriptions of the characteristics of informal learning through blogging](image)

![Figure 3. Descriptions of the characteristics of formal learning in school](image)

Figure 3 demonstrates the characteristics of learning in school. Learners in formal education settings are seen as passive and less motivated since they are mainly led by authorities such as school systems or teachers. The characteristics of contents from school are also considered as very specific, systematic, and structured, which may contain both positive and negative perspectives. The learning process is also viewed as delivered by authority
(teachers or schools) and fixed. In sum, their various descriptions of learning through blogging in comparison with formal education were summarized in Table 6.

### Table 6. Difference of characteristics between informal learning through blogging and formal education at schools

<table>
<thead>
<tr>
<th>Themes</th>
<th>Learning through blogging</th>
<th>Learning in school</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learner’s role</td>
<td>Self-directed</td>
<td>Passive</td>
</tr>
<tr>
<td></td>
<td>Self-meaning making</td>
<td>Non voluntary</td>
</tr>
<tr>
<td></td>
<td>Self-motivated</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Active</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Voluntary</td>
<td></td>
</tr>
<tr>
<td>Characteristics of learning contents</td>
<td>Practical and tacit knowledge</td>
<td>Theoretical knowledge</td>
</tr>
<tr>
<td></td>
<td>Social and everyday life</td>
<td>Structured and organized</td>
</tr>
<tr>
<td></td>
<td>Situated</td>
<td>Curriculum-based</td>
</tr>
<tr>
<td></td>
<td>Subjective</td>
<td>Disciplinary</td>
</tr>
<tr>
<td></td>
<td>Unlimited</td>
<td>Non-practical</td>
</tr>
<tr>
<td></td>
<td>Multiple directions</td>
<td>Fixed</td>
</tr>
<tr>
<td>Learning process</td>
<td>Self-regulated</td>
<td>Guided</td>
</tr>
<tr>
<td></td>
<td>Open</td>
<td>Structured and organized</td>
</tr>
<tr>
<td></td>
<td>Flexible</td>
<td>Fixed</td>
</tr>
<tr>
<td></td>
<td>Process-oriented</td>
<td>Outcome-oriented</td>
</tr>
</tbody>
</table>

The below quotations highlight the distinctiveness of learning through blogging as informal learning process:

“Until now, our learning at school forces us to be passive and teachers-led, but once you are involved at blogging, you can follow your curiosity on your own, re-construct the knowledge you searched and upload them on your space. In this perspective, learning through blogging seems to be more active and voluntary.” (participant 16)

“You can learn something as much as you want by picking up a route you like. But at school, the subjects are chosen by the school curriculum and you have to prove what you have learned even if you do not want to. There is a big difference between school and blogging. It is like enforcement and autonomy.” (participant 49)

“Blogging is like swimming in sea widely open to any direction while schooling is like a ship having a single specific direction.” (participant 55)

Overall, the findings show that the characteristics of blogging match well with those of adult informal learning, such as self-directed, self-regulated, and learner-centered learning. The adult bloggers seem to understand the notions of informal learning and to gain the benefits through blogging.

### Discussion and Conclusions

The study illustrates certain ways in which a blog is a contemporary web-based environment that can make a difference in adult informal learning practice, as perceived by a sample of adult bloggers. In this study, the majority of participants became aware of positive changes, including learning experiences, in everyday life after blogging. The changes were not physical but intangible such as ways to deal with information and knowledge, personal ways of thinking, self-development, and social relationships. In examining the usefulness of blogging in the learning process, the majority of participants believed that blogging is valuable in acquiring specific knowledge, expressing thoughts and opinions, and expanding one’s interests. Yet the blogging was not perceived as an activity that can play an important role in creating membership in communities or building new fields of knowledge/expertise. Third, adult bloggers identified the learning through blogging largely as ‘self-directed,’ ‘practical,’ ‘situated,’ ‘unlimited and accessible,’ and ‘self-regulated.’ The participants seemed to agree that blogging would generate ideal learning environments, particularly for adult learners who want to learn informally.
These findings provide us several important insights. First, blogging may be useful helping learners’ knowledge acquisition and reflection processes. It is not a surprise since bloggers can easily access unlimited resources through the Internet to discover whatever they need and express their views and thoughts through reflective writing on blogs.

However, the bloggers, particularly the participants in this study, hardly consider their blogging activities as a community-oriented learning practice. This finding need to be interpreted with caution, as much of it depends on the strategy used in recruiting the participants, as individual bloggers and not as members of certain communities. It is possible that different findings would obtain if the participants were recruited within a community of bloggers, such as a classroom-based community or a collaborative learning community, in which blogging either is the main activity or plays a complementary role.

Second, the findings of this study indicate that blogging is a significant factor in making informal learning more enriching and fulfilling for adults. Adults learn more efficiently if learning can be self-directed, practical, and reflection-oriented and blogging helps adults to have that kind of learning materialized more easily in their lives.

Moreover, with the current emphasis on multi-skilling and continuous professional development, the meaning of adult learning becomes more important. Blogging is used to share specific knowledge and help promote learning.

So far, the nature of learning through blogging has been investigated mostly in formal education settings. In order to maximize its potentials, however, as insights emerge from this investigation, it can be expanded through adults informal learning. Many aspects of blogging can strengthen adult informal learning and blogging can be seamlessly embedded to adult informal learning environments.

Since the target participants of this study were Korean using a Korean blogging site, it would be noteworthy to apply the study to different cultural groups of participants and blogging sites, which may expand the findings of this study.

Furthermore, innovative social networking, such as Web 2.0 and mobile systems, can influence effective adult informal learning. Using advanced mobile technology could lead to more spontaneous and frequent interactions and hence become the future type of blogging. The proliferation of social networking in society will aid this notion of blogging from merely one of alternative learning environments to one that integrates core learning across disciplines, ages, or types of learning.

Overall, the extent to which blogging is utilized for adult informal learning will depend mainly on the further guidelines and studies on the broader context of learning and social networking technology.

References


Effects of Cognitive Styles on an MSN Virtual Learning Companion System as an Adjunct to Classroom Instructions

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ABSTRACT
This study designed a chatbot system, Confucius, as a MSN virtual learning companion to examine how specific application design variables within educational software affect the learning process of subjects as defined by the cognitive continuum of field-dependent and field-independent learners. 104 college students participated in a 12 week Microsoft certification course that used Confucius as an adjunct to classroom instruction. The study considered to what extent the two distinct learning modes offered by Confucius would affect the learning gains of two distinct cognitive styles. Each of the two learning modes available within the Confucius was designed to conform to the specific requirements of field-independent or field-dependent learners. The results of this study reveal that a discussion mode offers far greater benefit to field-dependent learners than to those whose cognitive style is field-independent. Conversely, a lecture mode is substantially more beneficial to field-independent learners than to field-dependent learners.

Keywords
Virtual learning companion, Individual cognitive style, MSN platform, Microsoft certification course

Introduction
Instant Message (IM) based instruction is increasingly used in many e-learning programs, and the reported benefits include higher learner interest, increased participation in coursework and improved outcomes (Du & Li, 2010; Lu, Chiou, Day, Ong, & Hsu, 2006; Lan & Jiang, 2009; Sotillo, 2006). IM based instruction is generally most effective when used as a supplement to, rather than a replacement for, traditional education (Sotillo, 2006), and there is certainly increased interest in using IM based instruction in this fashion. As an integrated curriculum component, IM based instruction can be used in the instructional process, as a Virtual Learning Companion (VLC), including individual tutorial practice, and testing. For example, Lu et al. (2006) used chatbot technique to design a VLC based on IM based instruction for student on-line coaching in English learning. Lan and Jiang (2009) also designed a VLC to improve undergraduate programming courses. Du and Li (2010) used and designed an IM based instruction VLC as collaborative supporting tools in e-learning program.

Figure 1. An instructional framework for e-learning programs (Johnson & Aragon, 2003)

In view of the above, the goal of the present work was to develop a VLC that incorporated emerging best practices for IM based instruction development and that could also be used as a prototype for other e-learning programs.
However, those studies focus on the VLCs’ conversation ability (Brennan, 2006), instead of paying much attention to users’ cognitive differences in e-learning programs. Johnson and Aragon (2003) contend that powerful instructional framework for e-learning need to contain a combination of seven principles (see Figure 1). According to their study, recognition of individual differences has, for the most part, been taken into account in e-learning. Individual differences specific to learning and instruction can be found within cognitive styles, learning styles, cognitive controls, intelligence, etc. (Jonassen & Grabowski, 1993).

Individual cognitive differences among learners mean that no one instructional method is appropriate for the array of cognitive styles. Contemporary researchers suggest that instructors need to learn a different set of teaching skills for teaching online (Brower, 2003; Easton, 2003). The limitation imposed by the presentation of learning materials that are not based on learners’ needs can result in an opposite effect. Drummond (2000) believed that one of the main reasons that situations in which opposite learning effects came into play was the disregard of learners’ cognitive styles. Dunn and Dunn (1994) found that when the teaching methods and formats of materials fit learners’ cognitive styles, it improved not only the student’s learning performance but also their attitude toward learning. Any well-designed IM based instruction system must be adaptive to learners’ cognitive styles so as to increase both the efficacy and the satisfaction of the learning experience.

This paper designed a VLC using chatbot system technique and considered individual cognitive difference in IM based instruction environment. Cognitive theory has presented a very broad and useful classification for understanding individual cognitive difference. This is Dillon and Gabbard’s (1988) construct of Field Dependence-Independence (FD-I). FD-I places learners on spectrum that designates one end as field-dependent (FD), and the other end as field-independent (FI). This model has been successfully utilized in studies regarding more traditional educational environments, but the results of research that have used this model to study the performance of learners interacting with new technologies to accomplish a learning task are still inconclusive (Davis, 1991; Dillon & Gabbard, 1998), and, at times, contradictory. Understanding the different cognitive styles of learners, and which instruction method is most beneficial to that style remains open to much greater research.

According to the statistics of InsightXplorer Ltd. in March, 2008, MSN Messenger with over eight million users was the most popular IM system in Taiwan. Because of MSN Messenger popularity (Hsu, 2007; Kinzie, Whitaker, & Hofer, 2005) and its ease of use and recognition factor, this study designed a VLC system, Confucius, using chatbot technique based on the MSN Messenger platform. Created specifically for this study, Confucius can enhance traditional classroom instruction by offering a learning format that is ideally matched to the user’s individual cognitive style.

Literature Review

Virtual learning companion (VLC)

Chan and Baskin (1988) first proposed the concept of VLCs to be a partner that can accompany learners in the e-learning environment. Beyond the traditional binary relationship of the instructor and the learner, a VLC is a third participant in the learning project. Because the VLC is Internet-based, it can facilitate the acquisition of knowledge at any time and from almost any location.

Webb (1982) discovered that the guidance and information supplied among learning companions can increase learning performance. Through the interaction with VLCs, learners often become more immersed in their learning situation which increases their concentration, engagement, and attention (Hsu et al., 2007). When there is the absence of interaction with learning companions in an e-learning environment, learners feel isolated (Hong, 2002) and their sense of learning satisfaction decreases (Hiltz & Wellman, 1997; Rovai, 2002; Rovai & Wighting, 2005). Arbaugh (2002) also elucidated the positive relationship between learning satisfaction and the interaction among the learners, the instructor and VLCs. Numerous studies (El-Bishouty, Ogata & Yano, 2007; Kim & Baylor, 2006; Hooper, 1992; Slavin, 1995) and common sense suggest that the encouragement, explanation, interpretation, instruction and demonstration available from the interactive relationships among learning companions make it easier to reach study goals. The inclusion of a VLC component in any learning project is not vital to a learner’s success, but it can significantly increase a learner’s acquisition of knowledge and skills by offering related material and alternative approaches to concepts that cannot be covered within the classroom because of time constraints.
A key consideration in designing a VLC environment is the recognition that there are vast differences of cognitive styles among learners. The format of a successful VLC system that is applicable to all learners cannot rely on only one method of assistance. Renzulli (1994) showed that when the instruction format and the learner's cognitive style are consistent with each other, knowledge is more easily acquired, the process is more enjoyable, and the learner’s attitude toward the project is positively affected (Dunn & Dunn, 1994). Drummond (2000) is emphatic in stating that offering a variety of formats, suitable to a variety of cognitive styles, will not decrease learning performance. She and Fisher (2003) found that if the instruction methods correspond to learners' cognitive styles, they will affect the learner’s concept of the subject more than any other factor. It is apparent that efficacy of any VLC system is highly dependent on the inclusion of a variety of formats so that users can choose the format best suited to their cognitive style.

**Cognitive style**

Messick (1984) defined cognitive style as "characteristic self-consistencies in information processing that develop in congenial ways around the underlying personality trends". Witkin, Moore, Goodenough and Cox (1977) referred cognitive style to the individual differences in perception, thinking, problem solving and learning. Cognitive style is a hypothetical construct. It is the special individual style or method used when engaging in cognitive activities (Witkin & Goodenough, 1981; Riding & Cheema, 1991; Morgan, 1997). Within the field of cognition studies, a continuum defined as FI and FD is very prominent. This division of cognitive style was first purposed by Witkin et al. in 1954 and was also named psychological differentiation (Witkin et al., 1962) or field articulation. This cognitive style is also an important learner characteristic for educational technologies (Chinien & Boutin, 1992/1993). This division of cognitive styles uses the Embedded Figures Test (EFT) as the measurement instrument to measure the field independency degree of the subjects (Messick, 1962). Field independency of FD-I describes learners along a continuum, such that learners who fall in the two extremes of the continuum are characterized as FD and FI. Field independency is the cognitive characteristic in which the subject overcomes the influence of the irrelevant field elements while recognizing the relevant aspects in a specific situation. The less a person is influenced by the irrelevant elements, the more analytical or FI the person is. Subjects that fall under the other end of the spectrum are more influenced by irrelevant elements and considered more global or FD (Wu, 1987).

Chapelle and Roberts (1986) found that FI learners are not as influenced by social orientation or extrinsic motives as FD learners, and prefer analytical learning and independent study. FI learners believe they can learn more, faster and easier through independent study, whereas FD learners are more influenced by the external environment, social orientation and extrinsic motives. The latter prefer global and collaborative learning, and enjoy the peer guidance which can reduce learning anxiety and foster greater learning interest. Garger and Guild (1984) also found that FD learners prefer a learning environment in which they can interact and discuss with others, and that FI learners prefer a teaching method that is purely a dissemination of the facts. In short, cognitive style is the individual’s form of perception during information processing and is equally apparent in the manner that an individual approaches and solves a given problem. It is a non-intelligence personal characteristic but it can significantly influence the process and thereby the results of learning (Johnson & Aragon, 2003). Any comparative discussion of learning performance in e-learning environment should consider the influence of cognitive styles.

**Chatbot system**

A chatbot system is the software that can “chat” with a human user in natural language (Mauldin, 1994). Different terms have been used to denote chatbot systems: machine conversation system, virtual agent and chatterbot. Brennan (2006) defined a chatbot system as "an artificial construct that is designed to converse with human beings using natural language as input and output". The aim of a chatbot system is to simulate a human conversation; the chatbot architecture integrates a language model and computational algorithms to emulate informal communication between a computer and a user. Initially, developers built and used chatbots for fun, and used simple keyword matching techniques to find a match to a user input, such as ELIZA (Weizenbaum, 1966) and PARRY (Colby, Weber, & Hilf, 1971). A large body of text and natural-language interface research was conducted in the seventies and eighties before the advent of graphical user interfaces such as Cliff and Atwell (1987), and Wilensky et al. (1988). Since that time, a range of new chatbot architectures have been developed, such as CONVERSE (Batacharia et al., 1999), ELIZABETH (Abu Shawar & Atwell, 2002), Jabberwacky (Fryer & Carpenter, 2006) and ALICE (2010). As the design of chatbots became increasingly sophisticated, their use was adopted for learning support. For example,
Kerfoot et al. (2006) used chatbots for training medical students. Fryer and Carpenter (2006) used a chatbot for language acquisition and Robin (2007) used one to assist listening comprehension.

**Research Method**

**Experiment system - Confucius**

Confucius, a VLC chatbot system interacts with others either by recognizing certain commands tied to its statistical information gathering or by conversational pattern-matching techniques. Confucius can assist instructors in the provision of extra-class assistance for their students. As it is an Internet-based program it is neither limited by location nor by time. Confucius helps learners practice class content through real-time two-way interaction. The
program is designed around a Question and Answer (Q&A) format. If a user chooses an incorrect answer to a given question, Confucius provides two modes, a lecture mode and a discussion mode, that will help users to find and comprehend the correct answer.

The lecture mode supplies information and content related to the question that was erroneously answered. As shown in Figure 2, when Confucius poses a question to the user (block A) and the learner gives a wrong answer, Confucius will provide the correct answer (block B) and a webpage of supplementary related materials that have been prepared by the instructor (block C). The discussion mode provides peer discussion opportunities when learners give erroneous answers. As shown in the Figure 3, when Confucius poses a question to the user (block D) and the user subsequently gives a wrong answer, Confucius will search the database to find the online learners who have the correct answer and randomly choose some of them to be listed for potential peer-to-peer (P2P) discussion (block E). The learner, at this time, can then choose one of the listed peers and initiate a discussion of the topic in question. Confucius will then inquire if the selected peer learner agrees to participate in an interactive discussion (block F) and if so, connect them to the discussion window (block G).

Experiment design

This study uses the Microsoft technical specialist certification examination 70620 (Exam-70620) (Microsoft, 2010), as the basis for the instruction goals and the students’ examination results as a measurement tool, to explore how different guidance modes offered by a VLC system influence learning performance. The experiment consisted of four stages. In the first stage, students received a prior knowledge test of Exam-70620 (Prior-test) and the computerized EFT to determine their cognitive styles. In the second stage, students were divided according to their cognitive styles and were then randomly assigned to one of two guidance methods of VLC. They were then introduced to the Confucius VLC system in Microsoft certification training project. This project was tough by one instructor and students were asked to use the VLC system after class. In the third stage, students took the official examination of Exam-70620 (Official-exam) held at PROMETRIC test center (http://www.prometric.com) and answered a questionnaire of subject-reported satisfaction levels (SRSL). In the final stage, another self developed examination based on the contents of the official Exam-70620 was used as a follow-up examination (Follow-up exam) to evaluate students’ ability to recall the course content.

The independent variable of the study was the different guidance methods of VLC and the dependent variables were the learning performance (i.e. grades of Official-exam, grades of Follow-up exam and SRSL). Although a user’s SRSL with a given system is likely tied to their level of success within a given project, satisfaction is not merely a derivation of results. A user’s sense of satisfaction or dissatisfaction of a certain system can be better captured through a direct questionnaire. Using SRSL to determine the success of an information system remains a vibrant discussion (DeLone & McLean, 1992; Zviran & Erlich, 2003). Contemporary research on the impact of e-learning environments in higher education has adopted SRSL as an integral measure of success (Bekele & Menchaca, 2008; Bekele, 2010). The operational definition of satisfaction for this paper is the measurement of learners’ holistic perspective towards their experience of using the VLC system. A questionnaire modified according to the related literature of satisfaction, as shown in Table 1, was used in this study to determine users’ perception towards the Confucius system (please see appendix A).

<table>
<thead>
<tr>
<th>Authors</th>
<th>Dependent Variable</th>
<th>Information System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negash, Ryan, &amp; Igbaria (2003)</td>
<td>Customer satisfaction</td>
<td>Customer support system</td>
</tr>
<tr>
<td>Rodgers, Negash, &amp; Suk (2005)</td>
<td>User Satisfaction</td>
<td>Online experience</td>
</tr>
<tr>
<td>Lin, Huang, Joe, &amp; Ma (2008)</td>
<td>User Satisfaction</td>
<td>IM System</td>
</tr>
<tr>
<td>Sahin &amp; Shelley (2008)</td>
<td>User Satisfaction</td>
<td>Distance Learning</td>
</tr>
</tbody>
</table>

Experiment Content

Exam-70620 is used as the instruction content in the experiment and it became available in 2007. Exam-70620, which includes testing descriptive and procedure knowledge, measures the ability to resolve issues concerning

The participants

The experiment subjects were selected from the students who had participated in the Microsoft certification training project and had not taken the Microsoft certification examination before. In order to maximize the heterogeneity of the sample populations, this training project was accessible to different grades and classes. The subjects of the study consisted of 192 randomly selected volunteers (simple random sampling) as the experiment subjects, which included four different grades at a university in Taiwan. Sixty-one point five percent of them were male students and 38.5% were female students; 30.7% of the students were 19 years or younger, 21.4% of the students were 20 years old, 27.6% of the students were 21 years old, and 20.3% of the students were 22 years or older.

At the beginning of the experiment, participants took the EFT to classify their cognitive styles. The main measurement in the EFT included two parts and each part had 16 items in which the subjects attempted to find simple figures embedded in complicated figures within ten minutes. Because the EFT identifies cognitive styles along a continuum which is scored between the ranges of 0 (FD) to 32 (FI) depending on the number of figures traced correctly, this study has followed the statistical procedure of using the upper and lower 27% of the EFT scores to identify extreme FD and FI subjects (Spanier & Tate, 1988). Fifty-two out of the 192 subjects who took the EFT are considered as FD (their EFT scores are located at the lower 27% and their average score is 5.38). Fifty-two subjects are considered as FI (their EFT scores are located at the upper 27% and their average score is 22.14). Each cognitive style learners were randomly assigned to the two guidance methods of VLC. The grouping of students is presented in Table 2.

<table>
<thead>
<tr>
<th>Cognitive styles</th>
<th>Guidance methods of VLC</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>FD</td>
<td>Discussion mode</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td>Lecture mode</td>
<td>26</td>
</tr>
<tr>
<td>FI</td>
<td>Discussion mode</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td>Lecture mode</td>
<td>26</td>
</tr>
</tbody>
</table>

Research Results and Discussions

The effect of Prior-test

In order to examine if their prior knowledge of Exam-70620 was significantly different, a self developed examination based on the contents of the official Exam-70620 was adopted as a prior-test. The prior-test grades were analyzed by one-way ANOVA to determine if the grouping of students had significantly different prior knowledge related to the knowledge of Exam-70620, as shown in Table 3. The result shows that their prior knowledge was not significantly different, $F(3,100)=2.114$, $p=.103$. That is, the students had equivalent prior knowledge of Exam-70620 before participating in the learning activity.

<table>
<thead>
<tr>
<th>Cognitive styles</th>
<th>Guidance methods of VLC</th>
<th>Prior-test (mean / S.D.)</th>
<th>F-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>FD</td>
<td>Discussion mode</td>
<td>349.231/88.450</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lecture mode</td>
<td>350.769/86.576</td>
<td></td>
</tr>
<tr>
<td>FI</td>
<td>Discussion mode</td>
<td>301.154/91.186</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lecture mode</td>
<td>318.462/73.031</td>
<td></td>
</tr>
</tbody>
</table>
Learning performance on Official-exam, Follow-up exam and SRSL

Descriptive statistics of students’ learning performance were shown in Table 4. Since this study discusses how, if any, the variables of different guidance methods offered in a VLC and the variables of students’ cognitive styles affect learning performance. Hence, we used cognitive styles and guidance methods of VLC as independent variables; and learning performance as dependent variable to conduct the two-way ANOVA, as shown in Table 5-7.

<table>
<thead>
<tr>
<th>Cognitive styles</th>
<th>Guidance methods of VLC</th>
<th>Official-exam mean / S.D.</th>
<th>Follow-up exam mean / S.D.</th>
<th>SRSL mean / S.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>FD</td>
<td>Discussion mode</td>
<td>818.462/82.996</td>
<td>746.731/75.955</td>
<td>3.577/0.481</td>
</tr>
<tr>
<td></td>
<td>Lecture mode</td>
<td>780.192/95.544</td>
<td>706.385/97.881</td>
<td>3.413/0.385</td>
</tr>
<tr>
<td>FI</td>
<td>Discussion mode</td>
<td>770.615/75.020</td>
<td>700.462/76.142</td>
<td>3.314/0.353</td>
</tr>
<tr>
<td></td>
<td>Lecture mode</td>
<td>839.115/88.105</td>
<td>782.808/107.351</td>
<td>3.490/0.331</td>
</tr>
</tbody>
</table>

**Table 5. Two-way ANOVA of students’ learning performance on Official-exam**

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cognitive styles</td>
<td>797.538</td>
<td>1</td>
<td>797.538</td>
<td>0.108</td>
</tr>
<tr>
<td>Guidance methods of VLC</td>
<td>5940.346</td>
<td>1</td>
<td>5940.346</td>
<td>0.808</td>
</tr>
<tr>
<td>Cognitive styles × Guidance methods of VLC</td>
<td>74097.846</td>
<td>1</td>
<td>74097.846</td>
<td>10.079**</td>
</tr>
<tr>
<td>Error</td>
<td>735183.308</td>
<td>100</td>
<td>7351.833</td>
<td></td>
</tr>
</tbody>
</table>

**p < .01.

**Table 6. Two-way ANOVA of students’ learning performance on Follow-up exam**

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cognitive styles</td>
<td>5910.154</td>
<td>1</td>
<td>5910.154</td>
<td>0.724</td>
</tr>
<tr>
<td>Guidance methods of VLC</td>
<td>11466.000</td>
<td>1</td>
<td>11466.000</td>
<td>1.404</td>
</tr>
<tr>
<td>Cognitive styles × Guidance methods of VLC</td>
<td>97847.115</td>
<td>1</td>
<td>97847.115</td>
<td>11.979**</td>
</tr>
<tr>
<td>Error</td>
<td>816789.769</td>
<td>100</td>
<td>8167.898</td>
<td></td>
</tr>
</tbody>
</table>

**p < .01.

**Table 7. Two-way ANOVA of students’ learning performance on SRSL**

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cognitive styles</td>
<td>0.222</td>
<td>1</td>
<td>0.222</td>
<td>1.448</td>
</tr>
<tr>
<td>Guidance methods of VLC</td>
<td>0.001</td>
<td>1</td>
<td>0.001</td>
<td>0.006</td>
</tr>
<tr>
<td>Cognitive styles × Guidance methods of VLC</td>
<td>0.753</td>
<td>1</td>
<td>0.753</td>
<td>4.903*</td>
</tr>
<tr>
<td>Error</td>
<td>15.361</td>
<td>100</td>
<td>0.154</td>
<td></td>
</tr>
</tbody>
</table>

*p < .05.

The results shown in Table 5-7 illustrate that both the main effects of cognitive styles on Official-exam, Follow-up exam and SRSL \( F(1,100)=0.108, p=0.743; F(1,100)=0.724, p=0.397; F(1,100)=1.448, p=0.232 \) and guidance methods of VLC on Official-exam, Follow-up exam and SRSL \( F(1,100)=0.808, p=0.371; F(1,100)=1.404, p=0.239; F(1,100)=0.006, p=0.938 \) were not statistically significant. The effect of the interaction between cognitive styles and guidance methods of VLC on Official-exam, Follow-up exam and SRSL were significant \( F(1,100)=10.079, p=0.002; F(1,100)=11.979, p=0.001; F(1,100)=4.903, p=0.029. \) The interaction effects could also be found at the estimated marginal means plot in Figure 4. These results showed that the cognitive styles or guidance methods of VLC had an interactive effect on learning performance.

A statistical interaction occurs when the effect of one independent variable (cognitive styles) on the dependent variable (learning performance) changes depending on the level of another independent variable (guidance methods of VLC). In our current design, this is equivalent to asking whether the effect of guidance methods of VLC changes depending on the cognitive styles of learners. To determine if this is the case, we need to look at the simple main effects (Weinberg & Abramowitz, 2002).
In order to further understand the interactive effect between cognitive styles and guidance methods of VLC, this study used simple main effect as the post-hoc analysis, as shown in Table 8-9. Table 8 showed that when the guidance method of VLC was discussion mode, the learning performance (Official-exam, Follow-up exam and SRSL) of FD and FI was significantly different [$F(1,50)=4.755, p=.034$; $F(1,50)=4.812, p=.033$; $F(1,50)=5.035, p=.029$]. It showed that when the guidance method of VLC was discussion mode, learning performance of FD learners was higher than that of FI learners.
When the guidance method of VLC was lecture mode, the learning performance (Official-exam and Follow-up exam) of FD and FI was significantly different \[ F(1,50)=5.344, p=.025; F(1,50)=7.195, p=.010 \]. It showed that when the guidance method of VLC was lecture mode, learning performance of FI learners was higher than that of FD learners.

*Table 8. Simple main effects of Cognitive Styles (CS) at each level of guidance methods of VLC*

<table>
<thead>
<tr>
<th>Learning performance</th>
<th>Source</th>
<th>FD Marginal Mean/S.E.</th>
<th>FI Marginal Mean/S.E.</th>
<th>F-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CS at discussion mode</td>
<td>818.462/15.514</td>
<td>779.615/15.514</td>
<td>4.755*</td>
</tr>
<tr>
<td>Official-exam</td>
<td>CS at lecture mode</td>
<td>780.192/18.023</td>
<td>839.115/18.023</td>
<td>5.344*</td>
</tr>
<tr>
<td>Follow-up exam</td>
<td>CS at discussion mode</td>
<td>746.731/14.914</td>
<td>700.462/14.914</td>
<td>4.812*</td>
</tr>
<tr>
<td></td>
<td>CS at lecture mode</td>
<td>706.385/20.146</td>
<td>782.808/20.146</td>
<td>7.195*</td>
</tr>
<tr>
<td>SRL</td>
<td>CS at discussion mode</td>
<td>3.577/0.083</td>
<td>3.314/0.083</td>
<td>5.035*</td>
</tr>
<tr>
<td></td>
<td>CS at lecture mode</td>
<td>3.413/0.070</td>
<td>3.490/0.070</td>
<td>0.608</td>
</tr>
</tbody>
</table>

*p < .05.

Table 9 also showed that the learning performance (Official-exam and Follow-up exam) of FI learners in discussion mode and lecture mode was significantly different \[ F(1,50)=9.111, p=.004; F(1,50)=10.178, p=.002 \]. It showed that the learning performance (Official-exam and Follow-up exam) of FI learners in lecture mode was higher than in discussion mode.

*Table 9. Simple main effects of Guidance Methods (GM) of VLC at each level of cognitive styles*

<table>
<thead>
<tr>
<th>Learning performance</th>
<th>Source</th>
<th>Discussion mode Marginal Mean/S.E.</th>
<th>Lecture mode Marginal Mean/S.E.</th>
<th>F-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>GM at FI</td>
<td>770.615/16.047</td>
<td>839.115/16.047</td>
<td>9.111**</td>
</tr>
<tr>
<td>Follow-up exam</td>
<td>GM at FD</td>
<td>746.731/17.181</td>
<td>706.385/17.181</td>
<td>2.757</td>
</tr>
<tr>
<td></td>
<td>GM at FI</td>
<td>700.642/18.251</td>
<td>782.808/18.251</td>
<td>10.178**</td>
</tr>
<tr>
<td>SRL</td>
<td>GM at FD</td>
<td>3.577/0.085</td>
<td>3.413/0.085</td>
<td>1.845</td>
</tr>
<tr>
<td></td>
<td>GM at FI</td>
<td>3.314/0.067</td>
<td>3.490/0.067</td>
<td>3.442</td>
</tr>
</tbody>
</table>

** p < .01.

**Learning performance of Adaptive/Non-adaptive groups**

These results are similar to the findings of Garger and Guild (1984). Based on Garger and Guild’s (1984) suggestions regarding the matching of cognitive styles and guidance methods of VLC, the combination of cognitive styles and guidance methods of VLC was classified into Adaptive/Non-adaptive groups. Learners in the Adaptive group were FD learners guided with discussion mode, and FI learners guided with lecture mode. Learners assigned to the Non-adaptive group were FD learners who were guided by using lecture mode, and FI learners who were guided by using discussion mode.

*Table 10. Descriptive data and ANOVA of the learning performance*

<table>
<thead>
<tr>
<th>Learning performance</th>
<th>Groups</th>
<th>Adaptive Groupb mean / S.D.</th>
<th>Non-adaptive Groupb mean / S.D.</th>
<th>F-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>N</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>Official-exam</td>
<td></td>
<td>52  828.788/85.384</td>
<td>52  775.404/85.188</td>
<td>10.187**</td>
</tr>
<tr>
<td>Follow-up exam</td>
<td></td>
<td>52  764.769/93.856</td>
<td>52  703.423/86.875</td>
<td>11.965**</td>
</tr>
<tr>
<td>SRL</td>
<td></td>
<td>52  3.534/0.411</td>
<td>52  3.363/0.369</td>
<td>4.929*</td>
</tr>
</tbody>
</table>

*p < .05. **p < .01.

a. Adaptive Group: Within this group students received the matched guidance method. That is, the group of students with FD style received the “discussion mode” guidance method. And, those who are characteristic with FI style received the “lecture mode” guidance method.

b. Non-adaptive Group: Within this group students received the mismatched guidance method. That is, the group of students with FD style received the “lecture mode” guidance method. And, those who are characteristic with FI style received the “discussion mode” guidance method.
A one-way ANOVA was used to test the learners’ learning performance of the Adaptive and Non-adaptive groups, as shown in Table 10. The result suggested that learners involving in the Adaptive group had significantly better learning performance on Official-exam than those in the Non-adaptive groups, \( F(1,102)=10.187, \ p=.002 \). That is, matching the cognitive styles of learners with the associated guidance methods will significantly improve the learners’ scores of Official-exam within a VLC learning context. The Follow-up exam \( [F(1,102)=11.965, \ p=.001] \) and SRSL \( [F(1,102)=4.929, \ p=.029] \) also showed that the learning performance of the adaptive group was significantly higher than that of the non-adaptive group.

**Conclusion**

The role of technology is becoming increasingly prominent in the provision of extra-classroom learning assistance. Starting with the preposition that all learners utilize distinct cognitive approaches to information gathering and comprehension, and that one of the most common classifications of cognitive styles uses a scale of FD versus FI, this study sought to undertake a quantitative analysis of the role of multi-mode functions in a VLC system. Specifically, it analyzed whether offering the user choices of modes, in this case lecture versus P2P discussion, produces measurable effects on the user’s ability to ingest and understand information. The goal of this study was to better understand how the design features of a VLC affect the efficacy of learning. The VLC system used in this study, Confucius, was created specifically for this purpose and designed to help students that were studying for the Exam-70620. Confucius offers two distinct modes that can assist the user. These two modes, lecture and discussion, are designed to meet the cognitive styles of FI and FD learners respectively. The findings are summarized as below:

1. When the instruction mode of the VLC is restricted to the discussion, or P2P, mode for both FD and FI learners, the former achieve substantially higher test results.
2. When the instruction mode of the VLC is restricted to the lecture mode for both FD and FI learners, the latter achieve substantially higher test results.
3. The learning performance of the adaptive group is significantly higher than that of the non-adaptive group.

The findings suggest that when the guidance methods of the VLC, lecture or discussion mode, correspond to the learner’s specific cognitive style, the program can increase their learning performance. Previous studies based on traditional instruction formats (not Internet-based), like that of Dunn and Dunn (1994), also found that when the instruction and teaching resources correspond to learners’ unique cognitive styles, their learning performance will be elevated and their attitude toward learning become more positive.

The results generated by this study are unequivocal and parallel the findings of Meyer (2003) that successful learning within an Internet environment is highly related to learners’ cognitive styles. Any VLC system that seeks to assist learners in the most efficient and productive manner must recognize and incorporate design features that are appropriate for different cognitive styles. Learners that are offered a learning platform that appeals to their individual cognitive style are able to derive greater benefits from a VLC system and experience greater levels of satisfaction while participating in the system. Increased comprehension of a given knowledge set and increased satisfaction with the use and generated results of a system are to an extent mutually reinforcing. The more comfortable users feel when using a VLC system the more they are likely to use and thereby benefit from the system. Vice versa, the more benefit users derive from a system the more likely they are to use that system.

As educators increasingly utilize e-learning technology as an adjunct to their classroom instruction they must be cognizant that the format of that technology will have a profound effect on the learning performance of their students. While establishing an after class on-line P2P support group will inevitably be of great assistance to some students, the benefits of participation for another group will be extremely limited. Conversely, simply offering links to similar web-based information will benefit one group of students, but it will neither be of interest nor great assistance to another group of students.

This exploratory study shows that educators could create, design and offer redundant formats of the same information for each type of user to engage in the format that best suits their cognitive styles. By doing so facilitators will make learning more enjoyable, rewarding, and ultimately more productive for each of their students. The future confirmatory study of this research should include increasing the sample size to increase the power of the found effects. In addition, many studies are explicitly in demonstrating numerous factors which affect learning, such as IQ.
gender, and personal characteristics. The exploration of learning in MSN VLC environments should also take these factors into consideration in a holistic way to make learning as well as enjoyable and more productive experience.

Acknowledgments

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References


Appendix A: The Questionnaire

<table>
<thead>
<tr>
<th>S. No</th>
<th>Statement</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>I think the satisfaction of using the virtual learning companion guidance is higher than I expect.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>I think the quality of virtual learning companions is better than I imagined.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>I think the function of virtual learning companions is more helpful than I expected.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>I think the use of virtual learning companions makes me learn faster and I am satisfied with the results.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>I think the use of virtual learning companions makes me learning easier and I am satisfied with the results.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Gender</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>19 or below</td>
<td>20</td>
</tr>
<tr>
<td>Internet Experience</td>
<td>Under 4 years</td>
<td>4-5 years</td>
</tr>
</tbody>
</table>
Anonymity in Blended Learning: Who Would You Like to Be?

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*Corresponding author

ABSTRACT

This paper examines the learning outcomes associated with implementing discussion forums and blog writings using pseudonyms in blended learning. Although anonymity or masking one’s identity has been used as a teaching strategy designed to induce higher writing production and lowering anxiety in face-to-face writing instruction, little research has been reported investigating whether this strategy enhances learning outcomes in blended learning. This paper provides a research framework to clarify the position of anonymity in writing instruction. Through this, field-related research questions are identified. The study found that online writing assignments using pseudonyms can be an effective teaching strategy that induces higher online participation, especially among students who are hesitant to participate in a traditional classroom setting. In this anonymous context, students prefer gender-free pseudonyms, assuming no human identities online, in contrast to a previous research that considers pseudonyms as a form of expression of one’s preferred identity.

Keywords

Anonymity, gender, culture factor, blended learning

Introduction

This paper aims to highlight the issue of online anonymity as a viable instructional and research topic in blended learning. It examines the learning outcomes of implementing discussion forums and blog writings using pseudonyms in blended learning. Anonymity or masking one’s identity has been used as a teaching strategy designed to induce higher writing production and to lower anxiety in face-to-face writing instruction (Hosack, 2004; Chester & Gwynne, 1998). However, little research has been conducted investigating how this strategy works in online or in blended learning, where both real and online identities co-exist in the course design. For this reason, this paper focuses on the issue of online identities using pseudonyms, or anonymity in online writing, in order to investigate the design factors that induce higher learning in online and blended courses.

Research Background

This paper examines the learning outcomes associated with implementing discussion in forums and blogs, which are two asynchronous computer-mediated writing tools that can be configured for either personally identifiable or pseudonym authorship. This section first defines the notion and use of anonymity as a pedagogical intervention in writing instruction and then provides an overview of the relevant research.

Anonymity in writing instruction

Anonymity results when the real identity of the author of text is not known; therefore, both using a pseudonym (invented name different from the author’s real name) and not using a name at all are considered sub-sets of anonymity. In writing instruction, anonymity is often associated with peer feedback (or peer-review) because anonymous peer feedback is used as a minimally threatening common teaching strategy in the revision process (Lu & Bol, 2007; Hosack, 1998). Typically, a teacher asks students to exchange their draft papers with and give comments to each other without providing their names. This is the simplest and still most practical use of anonymity in writing instruction. Anonymity is also used in online education (blended and completely online). For example, 95 percent of blog sites in an academic community are run under alternate or pseudonymous identities (Dennen, 2009)—though they typically also contain clues to the person’s real identity and 55 percent of people fake their identity, at least occasionally, on the web (MacManus, 2007). Thus, anonymity is common in the real world beyond formal education.
In order to aide ourselves and others in understanding the conceptual ideas, actors, and technologies involved we provide a tentative framework that articulates the necessary components that interact in online anonymity research. Increasing attention has been given to the potential of online writing tools in language education (Lamy & Hampel, 2007; Hyland, 2009; Miyazoe & Anderson, 2010a). In the field of writing instruction, we have abundant studies on the effectiveness of peer feedback. Peer feedback is the extension of the process writing approach that is considered to be a shift from teaching writing to interactive writing in the history of writing instruction (Raimes, 1983; Johnson & Johnson, 1998). Process writing involves higher interaction between the author and the text, and the input of reviewers. Process writing aims to be an interactive product of writing, and thus feedback and revisions are expected. Conversely, the teaching strategy of free writing invites learners to write extensively without worrying too much about correctness. In this sense, process writing is formal, whereas free writing is informal. Human and interactive components such as audience (author corrects his/her draft, teacher helps, peers give comments), identity (usage of real name, pseudonym, or no indication), and media (oral, paper-based, different digital tools) are used in both strategies. Realizing the benefits of these components is dependent on the course design of the writing instructor as on-and-off elements, wherein each element can be implemented or non-implemented according the course design, that is, each element can lead to the development of a new learning context and research design-question for further studies.

<table>
<thead>
<tr>
<th>Identity</th>
<th>Anonymity in writing instruction</th>
<th>Modes</th>
<th>Media</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identifiable</td>
<td>Real name</td>
<td>Teacher</td>
<td>Oral</td>
</tr>
<tr>
<td>Pseudonym</td>
<td></td>
<td>Author</td>
<td>Paper</td>
</tr>
<tr>
<td>Anonymous</td>
<td>Pseudonym</td>
<td>Peer(s)</td>
<td>E-mode</td>
</tr>
<tr>
<td>No name</td>
<td></td>
<td>Face-to-face</td>
<td>E-mail</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Chat</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Forum</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Blog (Journal)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Wiki</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Others</td>
</tr>
</tbody>
</table>

All these factors help enable the positioning of the research focus of previous studies. For example, the research design of comparing the effects of peer and teacher feedback in writing curriculum (Gielen et al., 2010) is under the audience category. The study by Yang (2010) comparing the effects of self-correction and peer-review also falls under the same category, with e-mode, originally made as an electronic system and with journal or informal writing as its final product. However, both studies did not explicitly plan the identity to be pseudonymous. Therefore, these studies are not in the category of anonymity research in this paper.

Anonymity and learner identity are two sides of a single coin. In online learning, anonymity, or hiding real identities, has been shown to foster a higher and more balanced participation among learners of varied backgrounds (Chester & Gwynne, 1998) by masking various social barriers such as age, gender, social status, and language proficiencies. This provides a rationale for the use of anonymity when new technologies (e-modes) are introduced into our online and writing instruction. If identity is pseudonymous, learners may enjoy the greater freedom, but may misuse this freedom by flaming, not contributing at all or being mischievous in other ways. The problem of lurking (Beaudoin, 2002) in online learning also deserves attention because students who prefer to be invisible while learning may change their participation style to be more visible if they could hide their real identities.

**Anonymity research in online writing**

Anonymity studies are those with the identity element turned off, that is, the identity is anonymous. However, very little research covers all the various and diverse elements of writing instruction, e-modes, and anonymity in the field.

E-feedback, that is, feedback using digital writing tools, like other areas of online learning is a new research area that is attracting considerable attention as online learning becomes more pervasive in formal education. Several studies compare the effects of feedback between and among face-to-face and different e-modes. These studies include synchronous conversation on multi-user domains object-oriented (MOO) (Liu & Sadler, 2003), forum discussions on LMS (Guardado & Shi, 2007), blogs (Wu, 2006), and wikis (Franco, 2008). These were conducted in English as
foreign language (EFL)/English as second language (ESL) contexts; however, the anonymity factor was not the focus of these studies. Bloch (2008) predicted a growing trend in the use of blogs and wikis for peer-review purposes in his book, *Technologies in the Second Language Composition Classroom*, which gives a comprehensive overview of online writing in language education. Despite the difference in identity disclosure, these types of research are relevant because once any e-mode is incorporated into the course design, planning the identity elements (i.e., real name, number, pseudonym, no name, etc.) becomes necessary when deciding on login and other identity disclosure protocols.

Even with the absence of an e-component, the study by Hosack (2004) is relevant to this study as it examined anonymous peer-review from a cultural perspective. It pointed out the *affective disadvantage* of peer-review (for a series of dialogues regarding this topic, refer to Jacobs et al., 1998; Zhang, 1995; Zhang, 1999). This is commonly observed among learners with Asian origins (e.g., China, Taiwan, and Hong Kong) who refuse to criticize the writing of others to preserve group harmony (Carson & Nelson, 1996). Two surveys were conducted on peer-reviews using both anonymous and real names. Participants of this study were tertiary-level Japanese students similar to the sample in this study. The majority of the participants preferred to give anonymous comments as they had less fear of hurting others.

Lu and Bol (2007) in a rare study compared the effect of identifiable and anonymous feedback in an e-mode. Data were obtained from 92 undergraduate students in general English writing classes in college. Subjects were randomly divided into identifiable and anonymous groups and met for regular classes separately. E-feedback, which involved critical comments and peer-rating, was administered using Blackboard software and integrated throughout the semester. Pre- and post-writing proficiency tests (400–500 words in 75 minutes) were conducted. The anonymity group exhibited better writing performance and was more critical in giving peer feedback than the identifiable group. Both groups acknowledged the merits of e-peer review system.

The findings on pseudonyms and gender differences are also relevant to the research in this study. Jaffe, Lee, Huang, & Oshagan (1999) studied 75 students of “upper level lecture class” (p. 225) who were divided into two parallel online conferences and used either real names and pseudonyms of their choice. Content analysis of the conference transcripts showed that women chose gender-masking names and had the tendency to develop more socially interdependent communication than men. In a study by Pagnucci and Mauriello (1999), 47 students participated in a college writing project. The students were allowed to use real names or pseudonyms of their choice when posting on the web. Thirty-six students chose pseudonyms; five women chose male identities, but none of the men used female names. The study also observed that the posts by male-sounding pseudonyms received more comments and more attention. Interviews with the subjects also revealed that females believed that using male names was necessary to make their statements credible.

To summarize, although research has been made on anonymity in formal academic writing, little has been conducted on anonymity either in the use of different digital writing tools or in the area of free writing, such as journals and blogs in formal educational context. Increasing attention is being given to the use of blogs in language teaching and learning (Thomas, 2009), and this is understandable given that the interface is easily accessible on the web and is consistent with our other traditional writing instruction approach of journal writing. However, the use of one e-learning tool likely does not necessarily generalize to other e-mode media, with many gaps to fill with further research. As partially discussed in prior studies, anonymity in different online writing tools with focus on a variety of discourse modes (Bloch, 2008; Myers, 2010), measurement issues in learning outcomes (Lu & Bol, 2007), and multiple learner factors (gender, culture, learning styles, etc.) are all in need of further research in our educational practice.

**Research Questions**

Research on this subject is still in its exploratory stage, thus the exploratory nature of these research questions. To bridge the knowledge gaps found in previous research, this study addresses the following questions: 1) What are the participatory behaviors of students’ in face-to-face (with real names) and online (with pseudonyms) in blended course designs? 2) How did the students perceive and evaluate the different online writing tools using pseudonyms? and 3) What are the students’ learning outcomes?
Research Methodology

Context

A total of 63 students (males 37; females 26) from three different classes in one university participated in the study. These students were taught by the same instructor. The course lasted for one 15-week semester in the spring of 2008. The class meetings were held in a classroom where one computer per student was provided.

The course content was an introduction to English for Academic Purposes (EAP), covering reading, listening, speaking, and writing skills. Students who participated in this research presented an unbalanced English language skill set of generally high-level reading skills but poor speaking and writing skills when entering the university.

The course followed a blended format: face-to-face meetings were planned for content-based reading, topic-based speaking, and video presentations, whereas online portions were reserved for writing. Students were given two opportunities for topical discussions using online forums as grade-bearing assignments and blog writing as optional activities. Both blog and forum components were developed and presented on Moodle—a popular open source learning management system (LMS). The students decided on a topic for discussion by voting on a choice from the course text. Choices were formulated as questions, such as “One trend described in the lecture is that people feel overly busy because they have to juggle many responsibilities. Is this true for you?” Students were required to write in English on the system. One or two volunteer students were asked to moderate the forum discussions. The teacher merely observed the online activities throughout the semester so as not to interfere with the students’ natural interactions.

Students were allowed to use pseudonyms of their choice on the LMS. They were first given random identification numbers to create their login accounts. They could change these numbers to a pseudonym upon login. The LMS system allowed users to change their names anytime during the semester. Students’ identities were concealed from the instructor throughout the semester, but at the end of the semester, they were asked to report their pseudonyms (to the instructor) for grading purposes. Both forum and blog writings were visible only to the instructor and members of the class.

Methods

This research was patterned as a design-based research study (Anderson, 2005; Brown, 1992; Collins, 1992) that aims to develop and integrate theory and practice in natural educational settings. Design-based researcher insures relevance and potential for adoption by partnering researchers and practitioners in the design, development, and analysis of the research data. The first researcher was also the designer and teacher while the second author informed the research design and method. A mixed-method of quantitative and qualitative approaches was applied to balance the interpretation without interfering with the students’ learning as much as possible (Creswell, 2003; Creswell & Plano Clark, 2007).

Five data sources were used for triangulation: 1) pre-/post-course English proficiency tests, 2) paper-based survey regarding one’s pseudonym and online writing experiences, 3) semi-structured interview on the course experience including pseudonym usage, 4) students’ writings on the LMS, and 5) attendance records of the students and teacher’s notes on class management. Only the data obtained from the students’ written agreements were included in the analysis and publication of this paper.

To measure the students’ English proficiency, the paper-and-pen version of the new “quick placement test” (Oxford University Press, 2003) was used and validated for statistic pre-/post-comparison. The test was administered at the beginning (Test 1) and at the end (Test 2) of the semester. Each test consists of 60 questions ranging from beginner to advanced levels.

A total of 15 students (five from each class) volunteered for the interview, which was conducted by the instructor/researcher a week after the final examination day. Eight specific questions, starting with “How do you feel…” were prepared to solicit spontaneous responses. One of the questions the present study focused on was “How did you feel about the usage of your real name and a pseudonym on Moodle?” The students’ responses were
recorded and transcribed for analysis. Taking into account the contextual constraints, each interview was expected to be completed in about 10 minutes.

The survey was administered at the end of the course using a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree) for statistical conversion (Appendix A).

**Results**

Noteworthy findings are chosen and selectively summarized in this paper. As gender differences were present in many aspects of the data, the results are presented from this perspective as well.

**Physical and online participation**

To capture the online behavior of students, their participation in the online activities was analyzed in comparison with their physical attendance in class meetings. There were 15 class sessions and 6 discussion forums, with optional blog writing, in each semester. A high average attendance rate of 13.3 classes was achieved (n = 63). The students were encouraged to post their opinions and comment on others. However, the average number of forum posting per student remained at 4.21, which merely satisfied the minimum requirement (one post for each of the four discussion topics) for the grade-bearing assignments. Blog posting averaged 3.57 posts per student. A total of 15 or 24.6% of the 61 students did not post at all for this optional activity, whereas 12 or 19.6% voluntarily posted more than 7 times throughout the semester.

The correlation between class attendance and posts in forums and blogs was also computed. Correlation among these three activities was high enough (r = .327, p < .01 between class attendance and forms, r = .398, p < .05 between class attendance and blogs, r = .392, p < .05 between forums and blogs). This may confirm the traditional argument of extrinsic versus intrinsic motivation (Driscoll, 2005); that is, regardless of an activity being face-to-face or online, those students who did the optional assignments did so because of their internal motivation for learning and likewise attended almost all classes.

**Perceptions on the forum, blog, and pseudonym**

Table 1 summarizes the results of the series of questions differentiating between forum and blog posts 1) the students wrote, 2) read, 3) preferred, and 4) found useful. The number of students who preferred writing forums/blogs and those who preferred reading forums/blogs were almost at the same level (about 50 percent). Majority of the students preferred to use blogs (67.3 percent) than forums but found forums more useful (72.5 percent) than blogs. The results seem congruent with the objectives of the course design that required each activity: forums should be serious topic-based discussions and must be challenging but educational, whereas blogs should contain personal and/or reflective writing.

<table>
<thead>
<tr>
<th></th>
<th>Wrote more</th>
<th>Read more</th>
<th>Like more</th>
<th>More useful</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Frequency</td>
<td>%</td>
<td>Frequency</td>
<td>%</td>
</tr>
<tr>
<td>Forum</td>
<td>27</td>
<td>51.9</td>
<td>26</td>
<td>51.0</td>
</tr>
<tr>
<td>Blog</td>
<td>25</td>
<td>48.1</td>
<td>25</td>
<td>49.0</td>
</tr>
<tr>
<td>Total</td>
<td>52</td>
<td>100.0</td>
<td>51</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Table 2 shows the results of the degree by which forums and blogs were enjoyed by gender. Male students enjoyed blogs more than forums, whereas female students enjoyed both activities at the same level and recorded a higher level of enjoyment than their male counterparts.
Table 2. Forum and blog enjoyment by gender

<table>
<thead>
<tr>
<th>Gender</th>
<th>Enjoyed forum</th>
<th>N</th>
<th>Min</th>
<th>Max</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td></td>
<td>28</td>
<td>1</td>
<td>4</td>
<td>2.93</td>
<td>.813</td>
</tr>
<tr>
<td></td>
<td>Enjoyed blog</td>
<td>27</td>
<td>1</td>
<td>5</td>
<td>3.22</td>
<td>.934</td>
</tr>
<tr>
<td>Female</td>
<td></td>
<td>24</td>
<td>1</td>
<td>5</td>
<td>3.42</td>
<td>1.176</td>
</tr>
<tr>
<td></td>
<td>Enjoyed blog</td>
<td>24</td>
<td>1</td>
<td>5</td>
<td>3.42</td>
<td>1.176</td>
</tr>
</tbody>
</table>

Figure 1 summarizes the replies to the questions about the specific utility the students considered in both forums and blogs. Students were asked to rate the usefulness of forums in terms of 1) improving English writing (m = 3.62), 2) understanding chapter topics and content (m = 3.63), and 3) interacting with classmates (m = 3.18). They were asked to rate blog utility using the following criteria: 1) improving English writing (m = 3.88), 2) thinking ability in English (m = 3.98), and 3) interacting with classmates (m = 3.07). These findings show that the students acknowledged the moderately high utility of improving English writing and cognitive ability in both forum and blog writings. However, they were neutral on the value of activities being helpful in interacting with others. This result is understandable given that many posts on LMS did not receive active comments and remained monologic.

Table 3. Pseudonym choice by gender

<table>
<thead>
<tr>
<th>Gender shifting</th>
<th>M→M</th>
<th>M→F</th>
<th>M→N</th>
<th>F→F</th>
<th>F→M</th>
<th>F→N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of students</td>
<td>7</td>
<td>3</td>
<td>22</td>
<td>2</td>
<td>0</td>
<td>22</td>
</tr>
</tbody>
</table>

* M: Male, F: Female, N: Neutral

Two questions were posed in the survey relating to choice of real names and pseudonyms: 1) participants felt easier to participate in the activities and 2) they preferred to write English. Majority (90 percent) answered that pseudonym were better for both tasks. A student left a message as an open comment to the question suggesting that pseudonyms...
were good but it took away the perspective of linking a person’s opinions orally expressed in class to those expressed online. This explains why some students did not feel that pseudonyms were useful for the class.

Table 4. Pseudonym versus real name usage

<table>
<thead>
<tr>
<th></th>
<th>Ease of participation</th>
<th>Preference for writing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Frequency</td>
<td>Percent</td>
</tr>
<tr>
<td>Real name</td>
<td>2</td>
<td>3.8</td>
</tr>
<tr>
<td>Pseudonym</td>
<td>51</td>
<td>96.2</td>
</tr>
<tr>
<td>Total</td>
<td>53</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Interview results showing that 12 out of 15 students preferred pseudonyms overlapped with the survey results. The interviews also provided information on why pseudonyms were preferable. The identification “I + number” signifies “Interviewee + number 1 to 15” in the following statements.

The reasons largely fell into two themes relating writing and reading the online activities; that is, from the writing perspective, the points of freeing themselves from others’ eyes and evaluations (I.3, I.7, and I.13), from making mistakes in front of others (I.4), and from becoming too aggressive with others (I.8) were raised.

“Japanese people…worry about others’ opinions…therefore, stating opinions in the unidentifiable situation…is better.” (I.3)

“…when there are friends you know…you cannot state what you really feel and think…so anonymity largely helped me to say things openly.” (I.7)

“…when discussing, if your name is masked, it’s easier to state your opinion freely…say your opinions more frankly.” (I.13)

“…it’s easy to state opinions when one is anonymous…I feel embarrassed that others see me making mistakes in English.” (I.4)

“…[with my real name] I feel I should not speak too strongly…” (I.8)

From the reading perspective, four students (I.2, I.6, I.10, and I.14) noted that the pseudonym helped them concentrate on and appreciate the content of others’ posts rather than focus on who said what.

“…when you judge your own or other’s opinions…my judgement might change depending on who says what; the content is important but the evaluation may change depending on who says what. With anonymity, we did not do so.” (I.2)

“…with anonymous blogs, people look at me objectively, without any preconception that my character should be this and that, so it’s very good. (I.6)

“…with anonymity, when I state my opinions, you do not know who might read them, so private emotions would not probably come in. No prejudice…and we can be more objective to find others.” (I.10)

“…with anonymity, when discussing, you do not reply because they are your friends but without discrimination, you think this person is good so you want to reply to the comments. I think this is good.” (I.14)

Japanese society requires students to follow certain social rules in the face-to-face class space. Their participation is dependent on the social context where they find themselves, making it more difficult for them to produce as freely as they may wish. Therefore, the pseudonyms freed them from the social customs to write more and openly in this research study.
Learning outcomes

Table 5 summarizes the results of the English tests administered twice. Results show that the mean difference from pre-test (Test 1) to post-test (Test 2) improved modestly from 29.60 to 31.27 or 1.67 points higher out of the 60 points in total. This improvement is statistically significant (p < .05). Therefore, progress in terms of English proficiency occurred over the semester.

<table>
<thead>
<tr>
<th></th>
<th>Pre-test results out of 60</th>
<th>Post-test results out of 60</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>Males</td>
</tr>
<tr>
<td>Max</td>
<td>40</td>
<td>39</td>
</tr>
<tr>
<td>Min</td>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td>Mean</td>
<td>29.60</td>
<td>29.05</td>
</tr>
</tbody>
</table>

Table 6 summarizes the changes in the English tests and the word count results for both forum and blog posts per student by gender. Word counts in the table were adjusted. Words collated due to wrong spacing were corrected before the automatic word count function was applied. Finally, the mean word count per student, including only the students who actually posted, was computed to obtain the accurate reflection of their activities.

The word count by gender analysis shows that female students wrote more than their male counterparts. However, for unknown reasons, male students made a higher progress by 2.03 points as a group than the female students by .07.

<table>
<thead>
<tr>
<th>Gender</th>
<th>N</th>
<th>Min</th>
<th>Max</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>37</td>
<td>-12</td>
<td>14</td>
<td>2.34</td>
<td>5.645</td>
</tr>
<tr>
<td>Forum (words)</td>
<td>32</td>
<td>8</td>
<td>751</td>
<td>309.03</td>
<td>193.020</td>
</tr>
<tr>
<td>Blog (words)</td>
<td>23</td>
<td>8</td>
<td>562</td>
<td>220.65</td>
<td>160.157</td>
</tr>
<tr>
<td>Forum + Blog (words)</td>
<td>33</td>
<td>19</td>
<td>938</td>
<td>453.45</td>
<td>280.520</td>
</tr>
<tr>
<td>Female</td>
<td>26</td>
<td>-7</td>
<td>13</td>
<td>0.72</td>
<td>5.277</td>
</tr>
<tr>
<td>Forum (words)</td>
<td>25</td>
<td>53</td>
<td>1029</td>
<td>341.84</td>
<td>237.106</td>
</tr>
<tr>
<td>Blog (words)</td>
<td>23</td>
<td>82</td>
<td>1104</td>
<td>396.70</td>
<td>266.220</td>
</tr>
<tr>
<td>Forum + blog (words)</td>
<td>25</td>
<td>154</td>
<td>2133</td>
<td>706.80</td>
<td>475.191</td>
</tr>
</tbody>
</table>

Figure 2. Gender, online participation, and English change by word count
Figure 2 summarizes the relations between the English test results, amount of online writing, and gender. The vertical axis shows the total number of adjusted word count for both forums and blogs, whereas the horizontal axe shows the change in scores from English Test 1 to Test 2. As some students made a slight regression in the test scores even if more students made progress, the vertical axis runs from left minus to right plus. This figure and the correlation between the amount of writing and improvement in English proficiency show that these two factors are not significantly related ($r = .044$, $p < .01$). Moreover, seven students, as shown on the zero change line vertically running through the middle of the figure, showed no change from Test 1 to Test 2, whereas the amount of writing differed largely. All these suggest that quantity of writing in this study was not directly related to the level of progress made in English proficiency.

Implications

In a blended course design environment, this study found that student participation in face-to-face attendance and online activities were similar. The students also perceived that both forum and blog writings were useful in improving their writing skills and strengthening their ability to comprehend forums and reflect on blogs. The opportunity to use pseudonyms was also highly appreciated. This means that using pseudonyms can be a useful strategy to induce higher participation in online writing. A slight improvement in the overall English proficiency of students was recorded. However, the amount of writing and the degree of improving English proficiency were not significantly correlated in this study.

One of the unexpected findings of this study concerns gender difference in participatory behavior. In this study, higher participation from female students than male students was observed. Further, the total word count in forums and blogs, and the word count in blogs are significantly different that is, statistically, female students wrote more than the male students as a group. This result is consistent with other studies on pseudonyms and gender (Jaffe et al., 1999; Pagnucci & Mauriello, 1999). By using pseudonyms, female students may enjoy more freedom in their production. However, as Figure 2 presents, two female students who wrote far more than the other students (two pink dots on the 2,000 words line) and with the limit of about 60 students’ writing samples, we need to conclude that the amount of writing and the change in English proficiency are not correlated with each other. However, presumably, the quality of writing may also have increased in this study: to clarify this point, both the quality and quantity aspects of writing measurement should be taken into account in the future study (this point was further clarified in another study by Miyazoe and Anderson, 2010a). Rather, it may be more advisable to set a limit to the length of each writing piece in order to condense their content and structure, especially at this stage of the students’ English proficiency.

Due to contextual constraints, English proficiency tests were not specifically designed to measure academic English writing ability or confidence, but to determine general English proficiency. This limited the scope of the study. Conducting pre-/post-English writing tests under the same research conditions may reveal higher progress in English language ability. If the course was designed exclusively for writing, then the research may have produced even more salient results (Miyazoe, 2005). This leads to other research questions related to how we could measure learning outcomes by implementing online writing tools such as discussions and blogs. Further study investigating learning outcomes should be done following up in this exploratory work.

When introducing interactive elements to writing and thinking processes online, the nature of discourse changes from writing to speaking, to what is referred to as writing speech (Crystal, 2001). Therefore, our research should shift from whether the online discourse confirms to past customs to investigating ways learners act and in what ways they learn in a new learning environment. Especially in writing instruction, our efforts in reproducing classroom strategies may not work with online writing tools. Comments intended for discussions or drafts belong to a meta-level of language (language on language). Thus it is challenging to differentiate the two different levels of written language in an online learning environment, where no apparent contexts in written discourse are provided. For this reason, we suggest that planning different objectives for different writing tools, such as forums for discussions, blogs for reflections, wikis for collaborative work can help learners understand what should be done and how to act. This may eventually reduce their cognitive load in differentiating and adopting appropriate writing styles (Miyazoe & Anderson, 2011).

The analysis of pseudonyms in terms of gender shift revealed that a large percentage of students chose gender-free pseudonyms and regardless of gender, appreciated the merits of pseudonyms. These observations show that students
are selective in their choice of pseudonym. Instead of choosing a totally anonymous identity, many students prefer to choose an identity that does not suggest gender, that is, an identity free from being a gendered human in the social context. Thus pseudonym use is a nuanced form of anonymity, as students in the current research seemed to consider choosing a pseudonym not as a chance to create a new identity (as in the study by Dennen, 2009) but as a chance to deindividuate themselves (Lu & Bol, 2007; Connolly, 1990). This may be the reflection of a duality that pseudonyms present: pseudonym for identity and pseudonym for anonymity. This may be the reason why pseudonym was categorized into identifiable and anonymous identities above. Further study is needed to clarify in which way a learner could realize a higher learning performance and if this differentiation is socio-culturally specific or a common phenominal in other contexts.

Finally, the reason online anonymity has been widely discussed, yet detailed research data in the formal education context remain scarce, may come from the contradictory demands to mask students’ identities and track each student’s learning performance, especially in an online situation that lacks visual information. In particular the growing interest and capacity to engage in learning analytics (Siemens, 2010) in which online behaviour is tracked and analyzed may confound interest and use of anonymous identity. In blended learning, where real and online identities intersect, re-conceptualization of the research design may be needed because of the complexities multiplied by factors coming from both face-to-face and online modes.

Conclusion

This paper concludes that online pseudonym-based activities are an effective strategy to induce higher production of written content with less stress and fear for foreign language learners. It also considers that the treatment of anonymity can be a crucial factor in increasing the amount of content and effort expended by EFL students. More research on different digital writing tools for varied purposes of writing and for different learner needs is warranted.

References


Appendix

Survey: Extract questions regarding anonymity, forum discussions (BBS), and blogs

These questions are about you. Please circle the correct item or fill in the appropriate number.

<table>
<thead>
<tr>
<th>Gender</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>years old (in integer number)</td>
<td></td>
</tr>
<tr>
<td>Academic year</td>
<td>year</td>
<td></td>
</tr>
<tr>
<td>Mother tongue (Ex. Japanese)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cultural identity (Ex. Japanese)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PC use (approximate indication)</td>
<td>For years (in integer number)</td>
<td></td>
</tr>
<tr>
<td>Studying English (approximate indication)</td>
<td>For years (in integer number)</td>
<td></td>
</tr>
</tbody>
</table>

To the meeting classes in spring (2008 April 2008 July),
I rarely attended. 1 -- 2 -- 3 -- 4 – 5 I mostly attended.
(A three on the scale indicates attending approximately 7 times out of the total 14 meeting classes.)

Below are questions regarding the forum discussions on Moodle in the Practical English II course. During the course, approximately one topic was set every two weeks.

1. To the forum discussions,
   I rarely made posts. 1 -- 2 -- 3 -- 4 – 5 I made posts on almost all topics.
   I rarely read posts. 1 -- 2 -- 3 -- 4 – 5 I read almost all of them.
   I rarely enjoyed them. 1 -- 2 -- 3 -- 4 – 5 I enjoyed them.

2. Forum discussions were,
   for improving English writing not helpful. 1 -- 2 -- 3 -- 4 – 5 helpful.
   for understand chapter topics and content not helpful. 1 -- 2 -- 3 -- 4 – 5 helpful.
   for communication with classmates not helpful. 1 -- 2 -- 3 -- 4 – 5 helpful.

Besides these, in what areas do you think that the forum discussions were, for you yourself, helpful (or not helpful). Write freely.

3. Regarding the forum discussions in the Practical English II course, feel free to write any comments you may have.

Below are questions regarding English blog writing on Moodle in Practical English II. The activity was optional and bonus-point-based.

1. On the English blog,
   I rarely made posts. 1 -- 2 -- 3 -- 4 – 5 I often made posts.
   I rarely read them. 1 -- 2 -- 3 -- 4 – 5 I read almost all of them.
I rarely enjoyed them. 1 -- 2 -- 3 -- 4 -- 5 I enjoyed them.

2. (Answer those who participated in the English blog writing.) The English blog was

for English writing not useful. 1 -- 2 -- 3 -- 4 -- 5 useful. for the ability to think in English not useful. 1 -- 2 -- 3 -- 4 -- 5 useful. for communicating with classmates not useful. 1 -- 2 -- 3 -- 4 -- 5 useful.

3. Besides these, in what areas do you think that the English blog writing was, for you yourself, helpful (or not helpful). Write freely.

----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------Below are questions regarding both discussion forums and blog writing in Practical English II.

1. If you compare discussions and blog,

Writing: more in discussions. more on the blog. (circle one) Reading: more in discussions. more on the blog. (circle one) Preference: I prefer discussions. I prefer blogs. (circle one) usefulness for English learning: discussions are more useful. blogs are more useful. (circle one)

2. Regarding discussions and blog assignments, write freely any opinions and any points of improvement for future implementation you may have.

----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------Below are questions regarding the usage of real names and pseudonyms.

1. When comparing real name usage and pseudonym usage, I felt easier to participate

with a real name. with a pseudonym. (circle one) I prefer using my real name. I prefer using a pseudonym. (circle one)

Write freely whatever you think about the usage of a pseudonym.
A Comparison of Single- and Dual-Screen Environment in Programming Language: Cognitive Loads and Learning Effects

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*Corresponding author

ABSTRACT

A learning environment having more than one screen enables users to display and compare various sources of learning information with two adjacent screens illustrating the development of interrelated concepts and showing their relationships. This proposed technique could provide higher quality resources for learners by addressing physical and psychological factors. However, attention is a limited mental resource meaning that humans cannot always focus on simultaneous presentations of information. Cognitive load in humans may become profoundly heavy while processing rich information from multiple sources simultaneously. Therefore, the aim of this study is to investigate the split-attention effect, worked examples effect, and learning achievement of using single- and dual-screen learning environments in a programming language course. Results of this study showed significant differences of two learning effects and learning achievement of learners between two learning environments. To conclude, this study may provide evidence toward explaining the influences of split attention of learners and their learning with worked examples and the effects of learning in a dual-screen environment, as well as in providing users with another suggestion for using two adjacent screens in teaching and learning.

Keywords

Split-attention effect, worked examples effect, cognitive load theory, dual-screen learning environment, programming language instruction

Introduction

The ability of technology to facilitate the availability of information effectively and offer a convenient learning environment has long been discussed and developed. However, in such a learning environment, the results of related studies depend on the information processing approach to explain individual cognitive abilities (Lee, 2004; Moreno & Mayer, 2000). Colvin et al. (2007) stated that the use of multiple screens was more beneficial than single screens on task performance and usability of users. They also indicated that the three-screen display showed no significant advance over the two-screen condition. The study of Hutchings and Stasko (2007) pointed that the advantages of using the integrated extension of an additional screen were to support tasks, execute applications, and present images simultaneously. Setting an additional screen in a learning environment should provide teachers more display space to teach more learning materials simultaneously.

The learning environment in this study provides teachers additional instructional space to instruct multiple materials simultaneously in a programming language course through the use of two adjacent projection screens. That is, multiple materials instructing programming skills can be presented on screens, such as instructional slides, programming language codes, or executable programming instances of working examples. Through displaying multiple materials on two adjacent screens simultaneously, teachers could instruct the concepts of a programming language by demonstrating programming examples and learners might learn intuitively the programming concepts from these examples. Perrin (1969) stated that the multi-image presentation with an effective information density allows learners to process larger amounts of information in a short time. If the density of presented information is increased, learners will effectively obtain the increased information. Smith (2001) stated that, given the presenting complexity of multimedia and its close relationship to cognitive and information processing theories, it is helpful to review a perspective known as cognitive load theory to understand the possible implications of multiple-channel processing on cognitive structures. Based on the suggestions of cognitive load theory, the split-attention (Clark & Mayer, 2008; Cierniak et al., 2009; Florax & Ploetzner, 2010) and worked example effects (Renkl & Atkinson, 2003; Renkl, 2005; Sweller, 2006) should be applied to design the instructional materials to avoid the effects of cognitive loads. However, few studies exist on these learning effects of programming language instruction using various teaching materials in the environments with single or dual screens.
Two learning environments have been designed in this study in a computer classroom for programming language instruction. The teacher instructs a programming language course in a single-screen learning environment (SSLE), and he/she must repeatedly swap the instructional view between learning content and operational procedures of programming development software in order to make a connection reference of them. That is, if the teacher is instructing on the view of the learning materials, the other view of operating programming development software for demonstration will be temporarily unavailable, and vice versa. The other is a dual-screen learning environment, called DSLE. The DSLE is designed to show the two views of learning content and operating programming development software. That is, if the teacher is instructing one view of these two screens, he/she must stand in the front of that screen to attract the attention of the learners.

The main purpose of this study is to investigate the significant effects of learning programming language in a dual-screen environment. The question then arises about cognitive loads of learners and learning achievement: both might be affected by processing separate or integrated information on dual screens. From the perspective of the split-attention effect, the instructional slides with a series of popup objects and corresponding programming view are presented to highlight learning focal points and to attract learners' attention. From the perspective of the worked examples effect, the experimental materials provide proper examples to learners. Specific research questions in this study are identified as follows. How will the learning materials be designed in split-attention and worked examples formats affect the learning in a programming language course between SSLE and DSLE? What are the differences among levels of learning achievement in a programming language course between SSLE and DSLE? To investigate the learning effects, levels of learning achievement, and their differences between SSLE and DSLE in an experimental course, Windows Programming in Microsoft Visual Studio .Net 2005, was used in this study.

Literature review

This literature review of this study focuses on the multi-image presentation of multiple-channel communication to explain the effects of information presented in separate and integrated formats to humans. The information processing approach to human cognition hypothesizes that several information storage areas are used to convert stimuli to information (Miller, 1956). The review of multi-image presentation addresses theoretical aspects and current findings of using multi-image presentations in multimedia learning. Moreover, the split-attention and worked examples effects based on cognitive load theory involve the evidence of eliminating the cognitive loads when designing multimedia materials. The cognitive load theory provides explanations toward understanding the multiple-channel processing on cognitive structures.

Multi-image presentation of Multiple-channel communications

The theories and effects related to multiple-channel communication addressed in the following previous studies involve the information processing view of the cognitive theory. Broadbent (1965) suggested that one reason for the reduction of learning in multiple-channel presentations is a result of the filtering process that occurs in individual information processing. Whatever the amount of information presented in visual or verbal modality from sensory channels, learners are able to accept only limited amounts using the information processing approach (Jacobson, 1951). Dwyer (1978) identified nineteen factors that complicate interpretation and cause contradictory results of the single-channel and multiple-channel communications research studies. To recognize information simultaneously, the different sensory channels must process a great variety of different cues. The cue summation of learning theory predicts that learning is increased as a number of available cues or stimuli are increased.

The research issue of multi-image presentation is relevant to the properties of cue summation research, which suggests using more cues within a single channel or using more cues across multiple channels. The multi-image presentations in the previous studies (Atherton, 1971; Bollman, 1970) have referred to the use of more than one image on single or multiple projection screens. Low (1968) stated that no single image can establish certain memory combinations, but a multi-image presentation with a group of images perceived simultaneously often recalls long forgotten memories. Perrin (1969) adopted a multi-image presentation to present multiple and relevant images simultaneously. He identified three major factors for multi-image presentation: larger screen, simultaneous images, and information density. A larger screen can display many various concepts and many complicated ideas simultaneously. Simultaneous images can increase the information density while presenting from a larger screen.
The effective information allows users to process the rich information in a very short time. A number of instances available to the learner to be associated by visual comparison with simultaneously presented images are greater than with images presented sequentially. Westwater (1973) also showed that presenting multiple images in wide-screen environments had some significant differences between linear and simultaneous formats. Therefore, the simultaneous materials should follow the cognitive theory to construct their presenting structures. The multi-image presentation developed according to a well-known phenomenon in multimedia learning which is learning from multiple sources of information simultaneously (Florax & Ploetzner, 2010). Ayres and Sweller (2005) explained that this type of presentation having split-attention effect followed the cognitive load theory. It means that learners obtain better learning performance by integrated information. Mayer (2005b) proposed similar design principle for multimedia learning theory called the temporal contiguity principle. It means that learners learn better when corresponding verbs and visual content are presented simultaneously rather than successively.

**Cognitive load theory**

Cognitive load refers to the resources used by working memory at a given point in time. Mayer’s (2005a) discussion of the limited capacity assumptions suggested that humans are limited in the amount of information that can be processed in each channel at one time. According to the limited capacity of the working memory, two types of cognitive load have been identified in particular: intrinsic cognitive load; and extraneous cognitive load (Sweller et al., 1998; Mayer, 2005b). Intrinsic cognitive load refers to the load placed on the working memory by the degree of difficulty of learning content. This load depends on the inherent difficulty of learning materials. Extraneous cognitive load is caused by the designed instructional learning materials, and depends on the presentation of instructional messages that are designed, organized, and presented. The third cognitive load, germane cognitive load, is associated with the processes and construction of presentation from learning material and environment (Sweller et al., 1998). Instructional designers are suggested to reduce the extraneous cognitive load and transfer learners’ attention to cognitive processes that should be considered with regard to the constructions of instructional learning materials. Schnotz and Kürschner (2007) also argued that intrinsic and germane loads should be related to a certain extent. Cognitive load theory explains that the split-attention and worked-examples effects in the information processing approach are to emphasize the limitations of working memory capacity (Ayres & Sweller, 2005; Renkl, 2005).

The empirical methods to measure the construct of cognitive load have been used in three mainly techniques: rating scale, psycho-physiological technique, and secondary task technique (Paas, et al., 2003). It is a common technique using the rating scale to gather subjective data of learners in cognitive load researches. Although someone argued that the measurement of self-rating was not exactly precise, it has been demonstrated that learners are quite capable of giving a numerical indication of their perceived mental effort (Gopher & Braune, 1984). Paas (1992) was the first to use this finding by using rating scale to determine the cognitive load. Cognitive load theory researchers have shown that this kind of technique could obtain the reliable measures (Paas, 1992; Pollock, et al., 2002).

**Split-attention effect**

Attention is speculated to be a very limited mental resource (Anderson, 1985). However, it is difficult for learners to concentrate learning attention on two simultaneous instructional presentations. Norman (1969) also stated that this type of recognition involves paying attention while receiving the relevant information. The split-attention effect may occur when instructional materials cause learners to split their attention among the integrated multiple sources of information in multiple channel communication (Smith, 2001). If the effective working memory can be increased by using dual-modality presentation techniques, it may be effective in facilitating learning as physically integrating two sources presenting visual information. Therefore, the two separated visual sources (screens) of information should be physically integrated to reduce the load for mental integration (Ayres & Sweller, 2005).

Tarmizi and Sweller (1988) were one of the first to use graphics that demonstrated comparison of different levels of learning performance with split and integrated forms. In their other two experiments, they argued that learners receiving worked examples designed in separate and integrated formats at the beginning of cognitive skill acquisition will gain a deep understanding of subject domain. Redesigning instructional materials with integrated information to highlight the teaching focal points can help the learners to eliminate the unnecessary information searches (Chandler & Sweller, 1996). It can also enhance their learning processes through gaining meaningful learning. Instructional
split-attention may be occurred when learners are required to split their attention among multiple integrated sources of physically or temporally disparate information, where each source of learning information is for understanding the learning content (Ayres & Sweller, 2005; Owens & Sweller, 2008). The split-attention effect happens when learners studying integrated information outperform learners studying the same information presented in the split-attention format. To avoid split-attention, researchers have successfully employed the strategy of physically integrating various sources of information (Cierniak et al., 2009; Clark & Mayer, 2008; Florax & Ploetzner, 2010).

**Worked examples effect**

Learning by doing and learning by solving complicated problems are frequently discussed in the literature on teaching and learning, particularly on multimedia learning. Demonstrating worked example is an effective method for teachers to instruct learners to obtain the skills of problem solving (Renkl & Atkinson, 2003). The principle of worked examples in multimedia learning declares that learners gain a deeper understanding of a skill domain when they receive worked examples in the beginning of cognitive skill acquisition (Sweller et al., 1990; Renkl, 2005). At the beginning of a learning process for low ability learners or novices, they cannot apply the problem-solving skills required to build meaningful relationships among received information (Moreno, 2004). A worked example consists of problem formulations, solution steps, and the final solutions. Worked examples can be expected to reduce the extraneous cognitive load by acting as an instructional central execution, therefore, reducing the load on working memory (Sweller et al., 1998; Sweller, 2006).

Lewis (2005) proposed an animated form to demonstrate the worked examples. The animated worked examples were primarily useful for training complicated cognitive skills of learners. When learners learn with this type of worked example, they could follow the animated explaining steps to get the right learning without unnecessary visual information search. In this study, the subject matter of using worked examples effect involves providing an executable program as a worked example to the learners. By teaching with the instructional slides and the executable programming instances, the learners expect to perform at a significantly higher level than when learning with the static structured worked examples for solving problems.

Although information processing in human cognition restricts the ability of processing multiple sources from learning environments with a larger screen regardless of single or dual screens, teachers can adopt split-attention and worked examples effects to provide effectively designed multimedia learning materials for learners.

**Environment Design**

In this study, the learning environment primarily involves two adjacent projection systems controlled by a digital table in a computer classroom. Such environment presents information through multiple-channel communication involving simultaneous presentations of stimuli through different sensory channels such as sight, sound, or touch (Moore et al., 2004). We also followed the multimedia principle of temporal contiguity to design instructional materials. This principle argued that it can improve the ability of users to make referential links between the text explanations and corresponding visual objects. Figure 1 shows two adjacent screens (left and right screens) displaying two different multimedia materials from the teacher’s PC and laptop to create a DSLE. With the aim of providing a bright and clear learning environment screens, the setting of projection system in a computer classroom comprises two projectors with 3000 lumens and two 90-inch projection. Alternatively, as shown in Figure 1, the teacher can also use one of these two screens to be an SSLE through the display controller of digital table. The setting of our learning environment allows teachers to display a worked example along with the teaching materials spatially on big screens, which may facilitate the understanding of content for learners.

For example, Figure 2 describes a teacher using one (left) screen to lecture about Windows Programming in instructional slides as text explanations while also using the other (right) screen to display the executed steps of programming development software as corresponding worked examples. In a traditional computer classroom with a single projector (SSLE), the teacher must switch the teaching views between the instructional slides and the programming development environment. In other words, learners only see a single view of the instructional material. Several worked examples of Windows Programming were designed to instruct in the SSLE and DSLE. From two teaching materials displayed on two side-by-side screens, learners can simultaneously see both views of instructional
slides and the programming development environment. Learning by solving complicated worked examples from the teacher is an effective method when the teacher demands learners to demonstrate the skill of problem solving. Through the computer classroom, learning by doing is also an effective way to follow the executed steps of programming development software from the teacher.

Figure 1: Dual-screen system in digital table within the computer classroom

Mayer (2005a) suggested that reading can preserve texts and images in the working memory simultaneously. Learners can easily make referential connections between two views of screens. Therefore, the concept of popup windows was attempted (Erhel & Jamet, 2006) to design popup objects of learning content in instructional slides for highlighting the focal points of learning. That is, popup objects can place the textual explanations as labels near the corresponding graphical object. These popup objects correspond with executed steps of programming development software displayed on the other screen. The limitation of popup objects is that they may obstruct the views of texts and images. Popup objects should be formatted as short texts and small images (Weinreich & Lamersdorf, 2000). This compares different information so that learners use the information to store and recall prior knowledge.

Figure 2: Programming language instruction on DSLE
Our previous study (Chen et al., 2008) indicated that learning achievement could be improved in a statistic course through teaching with the dual-slide mode of DSLE. Regarding the dual-slide mode in a DSLE (shown in Figure 3), the teacher simultaneously uses the left screen to display prepared instructional materials designed in instructional slides and writes additional instructional contents, for example, hand-written statistical formulas, on the blank slides displayed on the right screen to illustrate the steps involved in solving statistical questions and other explanation points that the teacher wants to show learners. Learners can learn from the teacher’s written steps on the right screen while viewing the problem on the left screen without simultaneous hindrance. In this mode, the DSLE also allows materials to be presented side by side; therefore, learners could make the knowledge references among slide by slide materials without going back and forth between particular single slides. The DSLE applies the effect of the temporal contiguity principle (Mayer, 2005b) and split-attention effect (Ayres & Sweller, 2005), as well. Additionally, this mode in the DSLE was also able to present worked examples (Renkl, 2005) and learning content simultaneously, which might facilitate comprehensive learning materials for learners.

![Figure 3: The dual-slide mode of DSLE](image)

**Research Design**

This study designed to find the significant effects of learning programming language between the single- and dual-screen environments. The learners taking the Windows programming course were invited to participate in this experiment. The cognitive loads and learning achievement of participants were collected after learning with the particular subjects of Windows programming. The research design of this study was described as follows in detail.

**Participants**

Forty participants majoring in computer science and enrolled in the Windows Programming using Microsoft Visual Studio course were invited to participate in the experiment. This course was an undergraduate level course and participants were randomly assigned into two experimental conditions. The twenty-one participants (six females and fifteen males) involved in the Single-Screen (SS) group were taught in the SSLE. The nineteen participants (five females and fourteen males) assigned to the Dual-Screen (DS) group were assigned to learn in the DSLE. Their ages ranged from twenty to twenty-two years. All participants only had the basic programming ability of C/C++ programming language. That is, they were novice learners in Windows programming. This course focused on the advanced skills of C/C++ and visualized Windows programming languages. After finishing the course, the
participants could understand complicated designing flows of object-based programming language and data structure of Windows programming, and implement a complete Windows application by themselves.

Data collection instruments

The instruments in this study were used to address the cognitive load measurement and learning achievement. In terms of measuring cognitive load, the degrees of clarity and difficulty investigated learners’ intrinsic and extraneous cognitive loads. This study adopts the experimental measurement modified for previous studies (Paas, 1992; Pollock et al., 2002). The rating scale technique is adopted in this study since it has been widely used to measure the working memory load and mental effort in the literature (Gopher & Braune, 1984; Paas et al., 2003). That is, the rating scale has been proven that it is a very reliable measurement in cognitive load researches according to the analysis of its reliability and validity. The modified measurement in this study consists of four questions on a 7-point Likert-type scale in two domains, the degree of clarity from 1 (strongly clear) to 7 (strongly unclear) and the degree of difficulty from 1 (strongly easy) to 7 (strongly difficult). The degree of clarity represents the highest score as the highest extraneous cognitive load. The degree of difficulty represents the highest score as the highest intrinsic cognitive load. Each degree was divided into two items listed in Table 1: learning content and learning with worked examples. The internal consistency reliabilities assessed by Cronbach’s alpha for rating scales of degrees of clarity and difficulty were .92 and .90 respectively. The item of learning content meant that the materials followed the design principles of the split-attention effect. The item of learning with worked examples presented in an executable programming instance as a worked example according to the suggestions of the worked examples effect.

In terms of the learning achievement, this experiment evaluated learners in scorings of pre-test and post-test as transfer assessments designed by the teacher in this experimental course. Transfer assessment was measured by asking students to solve problems using information presented in the instruction. The pre-test consisted of sixteen choice questions regarding the based knowledge about the rules, logic, and problem skills of the C/C++ programming languages. The post-test consisted of the programming questions asking participants to write answers by filling in the correct programming codes. The purpose of the post-test was to evaluate the participants in Windows programming skills. The Windows programming skills referred to the usage of visual components and the ability of debug the Windows programs. The analysis results between the pre-test and post-test of learners involved determining the germane cognitive load between SS and DS groups. The total scores of the pre-test and the post-test were 16 and 100 respectively.

Procedures

The data collection sessions were conducted at roughly four-week intervals. The participants in each group were administered the pre-test at the beginning of this experiment. At the four-week intervals, the participants were taught the usage of Windows components classes to learn how to use the basic controls in Windows programming through effectively designed worked examples. Each group took four classes of teaching in the four-week intervals, and the time for teaching in each class was approximately 50 minutes. After four-week intervals, they filled out the measurement for cognitive load effects and the post-test for evaluating their learning achievement in Windows programming.

Instructional Materials

Participants of both groups were taught programming skills using basic controls in Windows programming, including eight classes, CView, CDocument, CList, CMap, CButton, CEdit, CListBox, CComboBox, CStatic, and CTime, which are the basic data and user-interface classes of Microsoft Foundation Classes (MFCs) developed by Microsoft. The instructional material displayed in the instructional slides with a series of popup objects was used to illustrate the worked example, which was an executable programming instance to design a basic calculator (as shown in Figure 4). Learners would pay their attention to understand the programming concepts and skills through the animation effects of popup objects.
In the SSLE, the teacher switches instructional screen views and uses programming language software to demonstrate the corresponding programming instances. Learners can see only one instructional view of these two views without information searching, and the teacher must switch the view to a single projection screen. In Figure 5, it assumes that the teacher currently explains the instructional contents at instructional slide. If the teacher wants to demonstrate the corresponding programming sample code, he must swap the teaching screen while using a single projection screen. On the other hand, the teacher can make use of two adjacent screens to simultaneously present the instructional slides and demonstrate a worked example using programming language software without interleaving.
these two instructional contents in the DSLE. Therefore, learners can simultaneously see both screen views as the multi-image presentation, and the teacher can change both screens to instruct immediately. As shown in Figure 6, when the teacher lectures from a page of formed instructional slides, he can also use the nearby projection screen to display the usage of programming language software while demonstrating the worked example simultaneously.

Results

To investigate intrinsic and extraneous cognitive loads of learners, four questionnaire items for learning content and learning with worked examples were designed to find the degrees of clarity and difficulty of understanding multiple materials during their learning processes in this experimental measurement. The degree of clarity referred to the extraneous cognitive load regarding the clarity of multiple information displayed on the screen. The degree of difficulty referred to the intrinsic cognitive load regarding the difficulty of multimedia learning materials learned by the learners. Because the samples of SS and DS group were both less than 30 samples, The Kolmogorov-Smirnov test was used to test the normal distribution between SS and DS groups. The p-values of each item in these two groups were all higher than 0.05. That is, these items in SS and DS groups were all normally distributed and the T-test analysis can be used to test the differences between these groups. The t-test and effect size (Cohen’s d) analyses of degrees of clarity and difficulty show in Table 1.

Regarding the degree of clarity of learning content and learning with worked examples, learners in the DS group answered both clearer than those in the SS group. The t-test of degree of clarity showed that learning content (t(38)=3.347**, p<0.005, d=1.06) and learning with worked examples (t(38)=3.798**, p<0.005, d=1.21) both had significant differences between the SS and DS groups. Cohen (1988, p25) defined effect size as “small, d=0.2”, “medium, d=0.5”, and “large, d=0.8”. The effect sizes of degree of clarity in both items referred to large sizes between these two groups. Regarding the degree of difficulty of learning content and learning with worked examples, learners in the DS group answered both easier than those in the SS group. The t-test of degree of difficulty showed that learning content was significantly different and its effect size was medium within these groups (t(38)=2.093*, p<0.05, d=0.70), but there was no significant difference for the degree of difficulty of teaching with worked examples (t(38)=.946, p>0.05).
### Table 1. T-test and effect size of degrees of clarity and difficulty

<table>
<thead>
<tr>
<th>The Degrees of Clarity and Difficulty</th>
<th>Group(N)</th>
<th>Mean</th>
<th>SD</th>
<th>T-value</th>
<th>Effect size Cohen’s $d$</th>
</tr>
</thead>
<tbody>
<tr>
<td>The degree of clarity of learning content in single/dual-screen learning environment.</td>
<td>SS (21)</td>
<td>3.81</td>
<td>.980</td>
<td>3.347**</td>
<td>1.06^L</td>
</tr>
<tr>
<td></td>
<td>DS (19)</td>
<td>2.74</td>
<td>1.046</td>
<td>1.074</td>
<td>1.06^L</td>
</tr>
<tr>
<td>The degree of clarity of learning with worked examples in sequential/simultaneous time of single/dual-screen learning environment.</td>
<td>SS (21)</td>
<td>3.67</td>
<td>.966</td>
<td>3.798**</td>
<td>1.21^L</td>
</tr>
<tr>
<td></td>
<td>DS (19)</td>
<td>2.47</td>
<td>1.020</td>
<td>1.074</td>
<td>1.21^L</td>
</tr>
<tr>
<td>The degree of difficulty of learning content in single/dual-screen learning environment</td>
<td>SS (21)</td>
<td>4.24</td>
<td>.889</td>
<td>2.093*</td>
<td>0.70^M</td>
</tr>
<tr>
<td></td>
<td>DS (19)</td>
<td>3.47</td>
<td>1.389</td>
<td>1.074</td>
<td>0.70^M</td>
</tr>
<tr>
<td>The degree of difficulty of learning with worked examples in sequential/simultaneous time of single/dual-screen learning environment.</td>
<td>SS (21)</td>
<td>4.05</td>
<td>1.171</td>
<td>0.946*ns</td>
<td>0.36^M</td>
</tr>
<tr>
<td></td>
<td>DS (19)</td>
<td>3.63</td>
<td>1.640</td>
<td>1.074</td>
<td>0.36^M</td>
</tr>
</tbody>
</table>

* $p<0.05$; ** $p<0.005$; ns = no significant; L: large effect size; M: medium effect size

The Kolmogorov-Smirnov test showed that the pre-test and post-test were both normally distributed within each group. For examining the effect on learning achievement of participants in DSLE, the t-test and effect size analyses were used to access the achievement of learners in learning Windows programming between these two groups. Table 2 shows no difference in pre-test of learners ($t(38)=1.064$, $p>0.05$). It meant that the basic knowledge of the learners was no difference between these groups before learning Windows programming in this experimental course. On the learning achievement, there was a main significant effect in post-test of learners ($t(38)=-3.395$, $p<0.005$, $d=1.08$). The effect size of post-test presented a large size between these groups. Learners in the DS group (Mean=88.84, SD=1.83) gained higher scores than those in the SS group (Mean=86.93, SD=1.72). This result reflected that the dual-screen environment was a helpful option to instruct the programming language when teaching instructional slides with worked programming examples.

### Table 2. T-test and effect size for pre-test and post-test

<table>
<thead>
<tr>
<th>Test</th>
<th>Group(N)</th>
<th>Mean</th>
<th>SD</th>
<th>T-value</th>
<th>Effect size Cohen’s $d$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-test</td>
<td>SS (21)</td>
<td>9.10</td>
<td>2.427</td>
<td>1.064*ns</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>DS (19)</td>
<td>8.37</td>
<td>1.862</td>
<td>-</td>
<td>1.06^L</td>
</tr>
<tr>
<td>Post-test</td>
<td>SS (21)</td>
<td>86.93</td>
<td>1.725</td>
<td>-3.395**</td>
<td>1.08^L</td>
</tr>
<tr>
<td></td>
<td>DS (19)</td>
<td>88.84</td>
<td>1.840</td>
<td>-</td>
<td>1.08^L</td>
</tr>
</tbody>
</table>

** $p<0.005$; ns = no significant; L: large effect size

### Discussions and Conclusions

This study presented the results of measuring learners’ cognitive loads and learning achievement in learning programming language between SSLE and DSLE. The cognitive load measurement was designed to investigate the degrees of clarity and difficulty of learning content and learning with worked examples. Learning content referred to the presentation of instructional slides based on the design principles of split-attention effects. The degrees of clarity and difficulty of learning content showed significant differences and larger effect sizes between the SSLE and DSLE, meaning that learning content presented in the DSLE has fewer intrinsic and extraneous cognitive loads for learners than that presented in the SSLE. It could be concluded that the learning of programming language in the DSLE could be more effective in avoiding the split-attention effect than in the SSLE. Learning with worked examples referred to the demonstration of the corresponding programming instance as a worked example. A significant difference and larger effect size were found between these two environments on the degree of clarity of learning with worked examples, meaning that learning content presented in the DSLE has fewer extraneous cognitive loads for learners than that presented in the SSLE. This finding is in accord with the results of the previous studies (Renkl & Atkinson, 2003; Renkl, 2005). Renkl and his colleague found that the integration of text and diagrams within worked examples would reduce the extraneous cognitive load effectively. In other words, while instructing with multiple sources of information that includes instructional slides and executable examples in a programming language course, the DSLE will provide a clear and easy-to-understand learning environment for learners.
Cierniak et al. (2009) also reported that the germane load plays a critical role in mediating the split-attention effect. The analyses of comparing the pre-test and post-test also showed that the germane cognitive load causes significant difference in learning achievement of the learners between the two environments. This finding suggests that the germane cognitive load of DSLE may affect learners in gaining better learning achievement than SSLE. In a brief interview, the instructor of this course mentioned that the DSLE could provide him a clear and useful display space to present the whole materials of this course. Although teaching with two screens made him busy with controlling the classroom, he also suggested that an efficient assisting tool to control dual screens and to design layouts for these screens should be designed. It can therefore be concluded from the above findings that the DSLE can provide the teachers with a larger teaching view to instruct and the learners with an effective learning environment to learn through simultaneously displaying learning content and executable examples in a programming language course. This finding supports the findings of previous studies of multi-image presentation (Perrin, 1969; Atherton, 1971; Bollman, 1970) that a larger screen (as two adjacent screens presented in this study) provides higher quality approximations of real environments by addressing physical and psychological factors necessary for learning and teaching.

The results of this study could be useful to the teachers responsible for instructing programming language courses in multimedia learning environments in classrooms with either single or dual screens. Despite some significant differences of learning effects and levels of learning achievement between the SS and DS groups, the research of the present study is not without limitations. The first limitation concerns the pre-test and post-test used in the current study. These two tests were aimed to identify learners’ basic knowledge and problem solving ability of programming language at the beginning of learning Windows programming and the learning outcomes after the experiment respectively. However, learning achievement of learners in programming language instruction could not be evaluated after only four-week intervals of the experiment. The second limitation is rooted in the small group of participants who were investigated in this experiment. Since the study involved only two small groups, the results could not be generalized as a representative of the population. Thus, generalization of the results to other populations with different instructions may be limited. Future studies should be aware of the limitations of this study.

Although the sample in the current study was small, the following recommendations could serve as suggestions for researchers aiming to experiment with a multiple-screen environment in a similar context. The DSLE is not only suitable to visualize Windows programming courses but also other types of programming languages. For example, when instructing networking programming language courses, one screen can present the view of the learning materials for instructing the programming illustrations. The other screen can display the demonstrated executable examples simultaneously in the web browser. Multiple-screen environments can be designed to extend the windows view of a big map without segmenting displays to introduce the geographic distribution of the whole map. Multiple-screen environments can also be implemented in an online video-conference room with triple screens. One screen could display the video view of the speaker. The second could present the speaking slides, and the third could present the introductory slides of the speaker or supplements of the conference, such as the slides for translation. In conclusion, the use of multiple-screen environments might provide an efficient and usable environment for teaching and learning.

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References


On the Changing Nature of Learning Context: Anticipating the Virtual Extensions of the World

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ABSTRACT
Contextual learning starts from the premise that learning cannot take place in a vacuum, but should somehow be connected with real world attributes to make sense to learners. Today, digital media tend to bring about new dimensions of context: internet connections and mobile devices enable learners to overcome restrictions of time and location, and neglect the physical boundaries and limitations of the learning environment. This calls for reconsidering contextual learning. This paper takes a theoretical stand by conceptualising the notion of learning context in the light of its virtualised extensions. It explains the historical and pedagogical backgrounds of contextual learning and reviews existing models that deal with context parameters. The paper identifies and discusses the constituting components of context for learning and it demonstrates how attributes of virtual representations affect the nature of context. The overall purpose of the paper is re-establishing the notion of contextual learning in the light of emerging digital media and making explicit the various dimensions involved.

Keywords
Contextual learning, Mobile learning, Virtual learning, Context, Experiential learning

Introduction

Today, it is widely accepted by teachers and researchers that learning becomes more effective and meaningful when it takes place within an appropriate context that displays real world attributes. Topical pedagogies like problem-based learning (Barrows & Tamblyn, 1980), action learning (McGill & Beaty, 1995), situated cognition (Brown, Collins & Duguid, 1989; Lave & Wenger, 1991), and experiential learning (Kolb, 1984) all stress the importance of context for learning. Such context enables learners to directly link concepts with their real world counterparts and put knowledge into action. Dynamic memory theory (Schank & Cleary, 1995) stresses the importance of the extra-linguistic information that is implicitly carried by the context and that provokes subconscious learning. Also, the more general model of competence-based learning that is highly topical today supports this, since it deals with the combined application of knowledge, skills, and attitudes within real world contexts (Westera et al, 1999; Westera, 2001).

Contexts for learning can be established in many different ways, for instance by arranging a fully immersive internship where learners are challenged to adopt professional roles under real world conditions, or, alternatively, by simply providing the learners with a written case description. These approaches are not of equal standing: the context for learning is highly dependent on the mode of delivery. Today, new learning technologies are an utmost driver for context, while they enable the effortless cross linking between different locations, different resources, and different users and organisations. Indeed, internet connections overcome the restrictions of time and location, and neglect the physical boundaries and limitations of the learning environment. The arrangement of learning context is no longer under the exclusive control of teachers. Abundant, new online tools, web services and resources are usually not well integrated within official school practice, even though learners dedicate most of their time to them (Cannata, 2009). These tools can be accessed by learners without any principal barriers and produce a great diversity of the individual contexts of learning, while at the same time their impact on the processes of learning remains unclear.

Digital media tend to bring about new dimensions of context. It is of great importance to establish the nature of this digitally enhanced context and its importance for learning. Importantly, digital media not just act as neutral communication channels, but also provide important attributes of context themselves. The basic premise underlying this claim is that media cannot be regarded as simple, exchangeable tools (cf. the instrumental view on technology) but, following Borgmann (1984), Heidegger (1977), McLuhan (1964), and many others, different media produce different modes of expressions in their own right, and hence they greatly contribute to the process of making meaning. Each medium reinforces its own communication codes and communication modes. Therefore media cannot be regarded neutral carriers of information, since they inherently produce distortion, filtering or even enhancement of messages. Consequently, media are important determinants of the user’s context.
In view of the ever-growing importance of digital media for learning any approach or theory of context should include the media presentation and delivery attributes. So far, however, no theory or framework that accounts for these virtual extensions of context is available. This paper aims to contribute to the development of such theoretical framework by conceptualising the notion of learning context in the light of its virtualised extensions. First, the paper will explain the historical and pedagogical backgrounds of contextual learning. Next, technology’s role as a driver for contextual learning will be discussed, and existing approaches for describing context will be evaluated. Building on these considerations the paper describes the key characteristics of context, while explaining the ways these characteristics influence learning contexts.

**Background of contextual learning**

The basic premise of contextual learning (or context-based learning) is that learning cannot take place in a vacuum, but should somehow be connected with real world attributes to make sense to learners. Such practical context allows learners to relate symbolic learning content like concepts and principles to their real world referents. Hull (1993) gave a more general statement about contextual learning, by claiming that learning occurs only when learners are able to connect information to their own frame of reference, which is supposed to reflect their inner world of memory, experience, and response. Naturally, such personal frame of reference is largely fostered by the individual’s experiences and interactions with the real world so far.

Contextual learning is not a new phenomenon: for many thousands of years apprenticeship in real world practice has been the natural and predominant model of human learning: novices in a field learn their craft in the real world workplace under the guidance of an experienced master. However, when human knowledge accumulated over subsequent generations it gradually incorporated higher levels of abstraction, generalised theories, and codified knowledge representations. Disconnections between practice and theory became apparent, possibly amplified by the different skills that were required for these, but probably also supported by the different social classes linked with craftsmen and scientists, respectively. Until today this divide between theory and practice is apparent, for instance via the proverbial distinction between white-collar workers and blue-collar workers.

Various authors (Schank & Cleary, 1995; Resnick, 1987; Johnson, 2002) suggested that the school system that has emerged over the last centuries produces adverse effects on learning, because of the absence of real world context. They argue that school tends to be an internally focused world in itself, which promotes a fundamental separation between the learning and the outside world. As a consequence, large groups of school children are unable to make connections between what they are learning and how that knowledge will be used (CTE, 2007). Gardner (1991) suggested that the dominant pedagogical pattern in school education is drill and response, and that many of the children do not actually understand what they learn. Such de-contextualisation of education tends to produce “armchair scholars”, who may well obtain high marks, but lack the meaningful insights and understanding that are required for using the knowledge in a productive or creative way. This distinction between theory and practice, between abstract and concrete, and between thought and action, is supposed to have become an intrinsic characteristic of the school system and brought about self-establishing pedagogical traditions that equated learning with the one-sided accumulation of knowledge. Indeed, the act of learning has long been considered as the absorption of information rather than acting, engaging, exploring, practicing, and experimenting (Schank & Cleary, 1995).

For over a century, however, there have been efforts to restore this unwanted dichotomy at various levels of education. In the early 1900’s Dewey (1938) developed his theory of experiential learning that stressed the importance of having authentic experiences. He suggested that learning should be contextualised (he probably was the first to use the term contextual learning) and tuned to real-life situations. He also pointed at the interrelatedness of all things (e.g., concepts) and proposed to focus on these interrelationships rather than on the things themselves. This proposition reflects the cautious combination of theory and practice, of content and context, of thinking and action. Actually, Dewey focused on contextualising learning content by embedding it within inquiry and problem solving processes (Innes, 2004).

Based on the theories of constructivism, cognitive apprenticeship, and situated cognition Brown, Collins, and Duguid (1989) stated that realistic learning environments should be taken into account for providing students with meaningful learning experiences. Cognitive apprenticeship argues that implicit processes involved in complex skills
are best addressed when the learning takes place in realistic (working) settings. Situated cognition takes a slightly different stand that the knowledge itself is an inextricable part of the environment and thus the process of thinking is grounded in the interaction between the individual and the environment (Roth, 1995). Kolb (1984) presented a more process-based approach that aims for a better balance between theory and practice. Kolb’s main concern was to reduce the overemphasis on concreteness that would go with real world practice by extending concrete learning experiences with the creation of generalised mental models and theories. Newmann and Wehlage (1993) stressed the importance of authenticity of learning tasks and authenticity of the learning environment because of better learning efficacy and improved learner motivation. Building on Dewey’s very idea of the interconnectedness of things, school gradually adopted new approaches like learning by doing and practical exercises. Also, the educational system itself has literally opened up the gates of their closed system and interconnects with the real world context by involving parents, employers, and other stakeholders (Johnson, 2002). The expansion of computer usage, the internet, and a variety of digital devices in the schools produces new gateways to the outside world. It inevitably brings about that rich and authentic context enters the learning environment in a variety of ways.

While referring to computer games Westera, Nadolski, Hummel, and Wopereis (2008) explain that the required authenticity of the environment is not necessarily related to the ways authenticity is presented. Outstanding graphic sceneries, character animations, and sound in games may certainly contribute to enhance authentic experiences, but various studies (Reeves & Nass, 1996) indicate that only very little representational or technological efforts are necessary to provoke true inter-personal responses. Apparently, what counts is not realism or authenticity, but credibility. Even fictitious, non-existing, non-authentic realities may provide valuable learning experiences and may offer interesting playgrounds for researchers.

**Technology as a driver for contextual learning**

Topical technological developments tend to blur the notion of learning context. Various network and media technologies procure that learning is no longer restricted to fixed locations like schools, but can be widened to include different contexts, while supporting workplace learning, learning at home, location-based learning, or learning on the move. Learners have unrestricted access to any knowledge resource, debates in discussion boards, case study descriptions, topical reports, real world video recordings etc. Firmly grounded in constructivism, exploration-based learning, and inquiry-based learning have gained popularity among teachers. Web 2.0 technologies at large tend to redefine the process chain of content creation while these enable learners to create, share, and adapt their own content and evaluate these in social media networks of peers, colleagues or others that not necessarily share the same lesson or classroom. New information and communication technologies like mobile devices, geo-positioning services, ambient environments, and ubiquitous access literally extend the learner’s physical range of operation by enabling augmented reality layers superimposed on existing contexts. Sensors as well as tracking and tracing technologies provide the inputs for context dynamics through adaptive systems behaviour and personalisation. Due to these developments the context of learning becomes more dynamic and more responsive but also greatly intangible and incontrollable.

While its significance for effective learning remains, the role of context appears to change from an independent variable into a dependent variable of the learning process. Whereas the creation of an appropriate learning context for learners used to be one of the main challenges of teachers and education designers, learning context tend to include more and more emergent components that are induced by the learners themselves, dependent on the media they use and the conditions for learning they create themselves.

**Existing approaches for dealing with context**

Ever since the introduction of information systems context models have been used to define the data flow between the computer and its environment, including the roles of human actors, existing procedures and files, and organisational constraints. A Data Flow Diagram, DFD (DeMarco, 1978; Yourdon, 1989) is one of the first established visualisation methods for structured analysis and system design that is used to describe the flow of information through the system. It necessarily includes the relevant components that make up the context of the system. Renewed interest in context modelling was gained in the domain of ubiquitous (or pervasive) computer systems. Ubiquitous computing, which is generally considered the next paradigm of computing, refers to the
seamless integration of information processing in everyday objects, processes, and activities (Weiser, 1991; Abowd, 2000). It assumes the interconnection of a large number of devices, sensors, and controllers embedded in the environment for supporting human activity in all possible ways. For this, ubiquitous computers need to be context-aware, that is, they need to be able to recognise the users, their needs, and all kinds of situational conditions in order to be able to display adaptive behaviour (Dey & Abowd, 1999; Becker & Nicklas, 2004).

For location-aware computing Becker and Nicklas (2004) explained spatial context models as a means to integrate context information obtained from different resources, e.g. sensors, GIS systems, etc., under local constraints. Such spatial context models constitute a conceptual layer between computer applications and the physical world. Such layer allows a number of applications to make use of the gathered context information and undertake appropriate actions. Key queries for spatial context models are the position of an object (e.g. geo-location, room number), the number of objects within a certain spatial range (the number of printers in building X), and the nearest neighbour objects that are close to the position of a particular object (closest restaurant, police station). Becker and Nicklas noted that context models in practice are usually quite straightforward and made to purpose. For achieving an economy of scales, they propose to add on top of the conceptual context model a separate federation layer and a knowledge reasoning layer, based on a contextual ontology.

Today, various alternative methods and tools for context representation are available. Strang and Linnhoff-Popien (2004) have reviewed different approaches of context modelling for ubiquitous computing: mark-up scheme approaches, which use a hierarchical data structure consisting of mark-up tags with attributes and content, graphical modelling approaches like the general purpose modelling approach Unified Modelling Language (UML), object oriented models that apply encapsulation and inheritance, logic based models for AI-reasoning, and ontology based models specifying concepts and their interrelationships. Each of the approaches displays strengths and weaknesses on various criteria, like richness and quality of information, dealing with incomplete data, or the level of formality. Because of their orientation on ubiquitous computing most of these approaches have a strong technical focus. De Moor and Klee (2004) proposed a social context model for supporting group discussions and collaborative authoring. Their model basically distinguishes 1) process elements like actor roles and objects (e.g. required resources), 2) actions that can be undertaken by participants and, 3) the change process itself, describing the socio-technical system and its alterations during the process. Yang, Huang, Chen, Tseng, and Shen (2006) proposed a context model specifically tuned to learning. They distinguish two different types of context, namely the learner's context and the domain context of learning content itself. Referring to educational games Williamson Shaffer (2006) explained how the overall context of a game environment helps learners to adopt the values, beliefs, habits, vocabulary, culture, and the overall epistemological frame that are associated with the game contents, representing a particular knowledge domain. Therefore games are claimed to greatly support contextual learning. Pedagogical context is partly covered in interoperability specifications like IMS Learning Design (IMS, 2009) that deals with instructional designs and learning arrangements. It includes learner and teacher roles, learning activities, learning objects and tools, learner support actions, and conditional learning paths. In recent years, the promise of mobile learning has lead to various models of context-aware information delivery, supporting location-based learning. Sharples, Taylor, and Vavoula (2007) used action theory which explicitly takes into account both the physical and cultural context for devising a theory for mobile learning. Zimmermann (2007) gave an operational definition of context, covering individuality, the physical environment, time and time range, relationships of entities, and activities (goals, tasks and actions). Based on Zimmermann (2007), De Jong, Specht, and Koper (2008) established a classification model for mobile learning software, which points at various context elements, e.g., pedagogy, content, sender-receiver patterns of information flow, time, and the purpose of the activities. For mobile learning Koole (2009) proposed a context framework representing the learner, the device attributes, and social relationships, while taking into account the mutual connections between these. These models all produce valuable contributions to explaining the notion of context. In many cases, however, the models only have a limited perspective on context and fail to include the role of media at producing these learning contexts.

Explaining mediated context for learning

A definition of context runs the risk to be so general and all-embracing (“all thinkable surroundings that influences the learner’s learning”) that it becomes meaningless. Yet it is necessary to go into the general characteristics of context and its significance for human activity. For this will use the following methodology. First, we will identify different compartments of the world that contribute to learning context, with a particular focus on mediated context
(virtualisation). Secondly, we will go into the different types of entities linked with these compartments, and explain how these entities contribute to learning context. Finally, we will investigate the process of virtualisation, in particular how it can be described by its representational attributes.

**Different compartments of the world**

Context arises from the interactions between an individual and the outside world. To this end different compartments of the world can be distinguished. Figure 1 displays the general layout for this.

![Figure 1. Different compartments of the world affecting the individual's learning context](image)

The individual learner at the centre of the figure is literally surrounded by different contributing parts of the world; the interactions of the learner with these compartments produce the notion of learning context. The most tangible compartment for the individual learner is the concrete operational setting where the individual is acting. This operational setting is the world as we directly perceive it and act upon. It reflects the “here” and “now” of our being, and it may refer to a certain location, a building or a room, and the objects and people near at hand. The compartment of domain knowledge refers to the subject matter that learners engage in. This will be a subset of human knowledge, e.g. language, mathematics, history, engineering, or cooking. Each of these domains will go with its own vocabulary, methods and tools, thus inducing its own context. The compartment of pedagogy refers to the diverse learning and teaching strategies defining the different roles and responsibilities of learners and teachers, the learning activities, and the ways guidance, feedback and testing are arranged. For instance, classroom learning involves a different context of learning than being an apprentice at company (Fuller, Munro & Rainbird, 2004). The outer shell in the diagram refers to the world at large, in particular human culture. It is the all-embracing and interconnected whole of ideas, knowledge, beliefs, arts, laws, morals, skills and customs that has been consolidated across different generations and communities (Cassirer, 2006). Virtual space refers to the digital extensions of the world that are made accessible via digital devices in the operational setting. Virtual space offers digital resources and tools, and allows communications with the outside world. It virtually extends the human horizon of interaction beyond the physical limits of the operational setting. The arrows in figure 1 indicate the tendency of increased virtualisation of the world: the virtual compartment thus assimilates contents originating from the other compartments, but it is also a channel in its own right.

**Concrete and abstract entities of the world**

The world, just like its constituting compartments, is assumed to be composed of concrete entities as well as abstract constructs. Concrete entities include the material components of the world (things, individuals) and the processes or phenomena associated with it. Concrete entities are in principle observable, for instance a tree, a rainbow, a facial expression or the phenomenon of a traffic jam. Abstract constructs are ideas. Ideas are the basis of human culture and
civilisation (Von Mises, 1957). These include theories, language, social relationships, and the concepts that we use to
describe and interpret the world. Note, however, that concrete entities and abstract entities are often closely linked to
each other. Concrete objects (e.g. a house) cannot be viewed without directly inducing the associated cultural
schemas, attributes, and semantics (e.g. “family”, “childhood”, “mortgage”). Generally, observation is known to be
highly theory driven: it is strongly biased by the different cultural concepts and categories of different languages

Context is largely composed by the interactions that individuals have with entities in the different compartments of
the worlds. Table 1 presents an overview of diverse constituents of learning context by providing some practical
examples.

<table>
<thead>
<tr>
<th>World entities</th>
<th>Human culture</th>
<th>Knowledge domain</th>
<th>Pedagogy</th>
<th>Virtual space</th>
<th>Operational setting</th>
<th>Individual</th>
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<td>Objects</td>
<td>Paintings</td>
<td>Tools</td>
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<td>Any virtual</td>
<td>Machines</td>
<td>Personal</td>
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<td>People</td>
<td>Groups</td>
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<td>Teachers</td>
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<td>Processes</td>
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<td>Learning</td>
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The columns of table 1 differentiate between the various world compartments; the rows identify the world’s entities,
subdivided into objects, people, processes, and ideas. The table will be explained below in more detail.

**Context induced by human culture**

Human culture is the accumulation of ideas: these are abstract in kind, like social structures, love, economic systems,
and moral values (Cassirer, 2006; Von Mises, 1957). The expression of ideas, however, gives rise to concrete
observable artefacts, like books, buildings, pieces of art, products or processes. Culture is such an immanent and
manifest characteristic of mankind: all human activity is imbued with cultural bias. Cultural differences entail
different contexts, different behaviours, and different meanings. Either wittingly or unwittingly any learner or learner
will comply with existing socio-cultural frameworks and behave accordingly (Vygotsy, 1978). These socio-cultural
frameworks are major contributors to learning context.

**Context induced by the knowledge domain**

Naturally, any learning refers to mastering a (sub-)domain of human knowledge. The domain itself cannot avoid
contributing to context. Apart from the domain’s content it basically conveys the epistemic frame (Williamson
Shaffer, 2006) that is attached to the domain, including the domain’s vocabulary, its methods, its tools, its key actors,
its social structure, its challenges, its attainments, it working practice, and many more. For example, tools for a
health care worker would include infusion systems, hypodermic needles, blood pressure measurement instruments.
The epistemic frame of the health domain refers to existing socio-cultural traditions and requirements, like power
relationships, professional attitudes and role perceptions. These epistemic frames may differ across different
domains: obviously, medical ethics would produce a different context than ballroom dancing.
Context induced by pedagogy

Next to the knowledge domain, pedagogy itself is a powerful contextual agent. Marton and Ramsden (1988) claim that pedagogical context strongly determines the learning strategies of students. For instance, the way testing and grading is arranged appears to be a most critical situational influence on learners. Also, enforced high workload in a curriculum promotes rote learning. As has been explained above, pedagogical approaches imply various principles and beliefs as to what requirements the learning context should meet. Notwithstanding the variety of pedagogical approaches available, they all share the basic pedagogical concern of addressing certain learning needs or goals by providing appropriate learning tasks, learning scenarios, learning content and tools, learner testing, learner guidance, and feedback. The involved pedagogical approaches and the associated boundary conditions have a strong contextual impact (Elton & Laurillard, 1979).

Context induced by virtual spaces

Increasingly, learning environments include digital communication media (virtual spaces). These media contribute to learning context in two different ways. First, interaction with real world objects, phenomena, ideas, and subjects is replaced with accessing digital representations. Communicating via an avatar rather than face-to-face would be an example of such replacement. Digital media offer new opportunities for individuals to include entities from the outside world, and hence procure the extension of context. Second, digital media actively contribute to context themselves because of their distorting and filtering nature and their potential of enhancement and augmentation (Baudrillard, 1995). The progressing virtualisation of life thus changes the modes of interaction and produces a media context which not only provides new communication opportunities but also creates its self-induced constraints (Borgmann, 1984; McLuhan, 1964). Salomon (1979) found that symbol systems in media play an important role in cognition and cognitive processing: symbolic operations help learning since they have a direct impact on the underlying mental structures. Not taking into account the context of media would make it impossible to compare different pedagogical approaches (Westera, 2005).

Context induced by operational setting

Naturally, the operational setting where the learning takes place (viz., the learner’s location) contributes to context. It includes relevant objects (room, furniture, computers) and possible constraints. Also time, geo-location, and location derivatives (temperature, sound conditions) are linked with the operational setting. In many cases the operational setting is directly linked with a socio-cultural context, for instance “school”, “work”, or “home” that have wider significance than the operational level. The context of workplace learning (e.g., learning in a factory) would not only include specific physical conditions, products and machines, but also the socio-cultural patterns associated with it, like the functional purpose of the location, fellow workers, customers and the underlying viewpoints and behavioural codes that are carried by these.

Context induced by the individual

While learning is essentially the growth of individual capabilities, the individual’s characteristics greatly influence the process and conditions of learning. These characteristics include both the physical and mental profile of the learner, for instance age, personal goals and ambitions, prior knowledge, school history, or physiological constraints (colour blindness, weight) (Allen, 2009). These data may also be dynamic (mood changes, fatigue). Moreover, the learner’s intrinsic socio-cultural background and identity profile contribute to learning context (family conditions, beliefs, hobbies, nationality, religion). Beside these basic profile and background data, the individual context will be greatly determined by the dynamics of actual learning activities and performances. These data not only determine the individual’s contexts of learning, but also can be forwarded to a student model for achieving adaptive learning environments, reflecting the intelligent and productive personalisation of learning context (Brusilovsky, 1999).
Interacting with context

The different compartments of the worlds constitute the context in which we operate. This context becomes meaningful for us mainly through the interactions we have with it, thus enabling contextual learning. The interaction between the individual and the world is conceived as the continual process of encoding and decoding of the messages that are exchanged. Messages are natural or artificial signals that can be captured and processed. Nowadays, direct observation of the signs and signals of the world is increasingly being replaced with their indirect observation using (digital) media. Hence, more and more our relationship with the world is shaped by the media we use (Borgmann, 1984). Since all media tend to add noise and distortions to the original messages, perceived contexts inevitably change accordingly.

The process of attaching meaning to messages is essentially mental in kind as it takes place in the head of the individual. This is what truly defines the process of experiential learning: ceaselessly probing one’s context by interpreting the messages that are exchanged with the environment.

Two principal attributes of messages have to be considered: 1) the representational code, and 2) the message carrier. For instance, a book would be the material carrier of the story it conveys via the representational code of written text.

1. Representational code

   The representational code corresponds with the symbol systems, conventions, and methods that are used for expressing the message. According to Saussure’s semiotic theory (1960) message representation always involves two components: on the one hand the “signifier” (e.g. the term “house”) and on the other hand the “signified” (or referent, e.g. the material construct that people are supposed to live in). So for the purpose of communication the entities of the world (the signified) are represented by signifiers.

   Representation can either be iconic or symbolic (Pierce, 1938; Wollen, 1972). Iconic representation holds when there is a great deal of similarity between the signifier and the signified: a picture of a house would be an iconic (or analogical) representation of the actual house. Understanding such a picture would be largely a matter of recognition. For symbolic representation the signifier has no clear connection to the signified, for instance in the case of using the sequence of five symbols “h-o-u-s-e” for reference to the actual house. Interpretation of symbolic representations is a matter of knowledge about the conventions of the symbol system rather than recognition. Consequently, interpreting symbolic representations would require more mental efforts than iconic ones.

2. Message carrier

   Although message carriers used to be material in kind (e.g. the book), virtual carriers are largely taking over: a cell phone connection, a webpage, a game environment, a video conference. Essentially, each type of message carrier goes with its own bias, distortions and restrictions, affecting to contents of the message: a web page carrying a text message conveys different meaning than a print version of the very same text (Cassirer, 2006).

A meaningful context is inferred from a diversity of messages. Figure 2 displays some examples laid out on a grid of these two message attributes.

The first quadrant in figure 2 contains iconic messages on material carriers: a photo print carries the analogical representation of a real entity on paper. Also non-mediated entities, like the rainbow, or the person who is a teacher are in this quadrant (null mediation, which is a special case of iconic representation). Likewise, quadrant II covers physical objects with symbolically encoded messages. Quadrant III, comprises virtual carriers for symbolic information, while quadrant IV does the same for iconic information. Note that the virtual representations in III and IV may reflect real world counterparts, for instance the teacher may be part of the video, or may operate an avatar. Sometimes, however, virtual objects exist independent of any real world entity, for instance software code, a 3d-gaming space craft, subtitles or buildings in Second Life.

In addition to figure 2 the modality and the dynamics of interaction should be considered. Modality refers to the channel by which messages are transmitted (oral, pictorial, gesture, written). It is essentially different from a symbol system or code. For instance, the symbol system of English language may either be used in the modality of printed text or spoken words. The dynamics of interaction would include different characteristics of the transfer processes,
like public channel versus private channel, controller devices, people involved, real time versus condensed time, synchronicity, responsiveness, adaptiveness, and artificial intelligence. Also the underlying relationships between the various components of context (for instance narratives in the case of sequential relationships) are not covered by figure 2.

![Diagram of Media and the relationship between message representation and message carrier](image)

**Figure 2.** Media and the relationship between message representation and message carrier

**Concluding remarks**

This paper has explained the increased richness and complexity of learning context that is induced by new digital media technologies. These new technologies break through the confinements of school buildings and lecture halls by including extensive digital resources and real world representations. Understanding the intrinsic complexity of these digitally induced contexts is a precondition for preserving the effectiveness and efficiency of contextual learning. The mechanisms for contextualisation of human activity (including human learning) are summarised in figure 3.

Four different cases are distinguished. Individual A interacts directly with the world, without any mediating technologies. Individual B displays mediated interactions with the world via (digital) representations (e.g. a webcam image, a web page, email). Individual C interacts with virtual extensions of the world that lack any counterparts in the physical world, for example an email message or a fantasy game. Individual D assumes that all virtual artefacts have become self-evident, integrated parts of the world, so that they aren’t perceived as virtual artefacts anymore: for instance, today a phone conversation is experienced much like a common face to face conversation. The sequence A-B-C-D explains how digital context is gradually accepted and incorporated as an integral part of our world. In the end, there is hardly any difference between case A and case D, be it that the latter deals with a mediated and virtually extended world.

Mediated representations inevitably go along with the restrictions and distortions reinforced by the media attributes, and tend to produce a truncated (or enriched) view of the world. Also, any mediated utterance, be it a web text or a video, may be subject of deliberate technical manipulation, thus affecting our view of the world. Therefore, media literacy competences are of utmost importance for making adequate inferences about the world (Christ & Potter, 1998). Distortion of messages is even amplified by the occurrence that messages often require cumulative conversions from one representation to another before being transferred to the learner (Cassirer, 2006). For instance,
using a website or forum for collecting comments on a photo of a rainbow would define a trajectory via quadrants I, I, IV, and III in figure 2.

![Image of quadrants I, IV, and III](image)

**Figure 3.** Separate modes of contextualisation

The continuous flow of emerging digital media keeps adding new dimensions to learning context. The present study is a first step in identifying the constituents of context and the mechanisms involved. It explained how different compartments of the world contribute to context. It explained the representational implications of the entities of the world (objects, people, processes and ideas) by distinguishing between representational codes and message carriers, by referring to different modes of interaction dynamics and modalities, and by stressing the importance of user models. Unfortunately, no methodologies or tools are available yet that treat the virtualisation of context in an explicit way. Further research is needed to develop a sustainable, descriptive framework for learning contexts and incorporating this in instructional design approaches and the associated tools. Also the progressive use of digital media urges for systematic inquiry of the learner’s experiences, appreciations, and needs with respect to these expanding learning contexts.

**References**


Factors Affecting Information Seeking and Evaluation in a Distributed Learning Environment

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ABSTRACT

The purpose of this study was to identify and analyze the processes of seeking information online and evaluating this information. We hypothesized that individuals’ social network, in-out group categorization, and cultural proclivity would influence their online information-seeking behavior. Also, we tested whether individuals differentiated information values based on the information source. A total of 78 students from two universities in different geographical regions of Singapore participated in a collaborative information-seeking exercise using a computer-mediated collaborative system. The information-seeking data were analyzed with multivariate network analysis. The findings of this study showed that interpersonal social networks, in-out group distinctions, and individuals’ cultural proclivity significantly affected the information exchange process between different groups. However, it was found that individuals did not differentiate the values of information according to whether the source of the information was within their social network or school.

Keywords
Social network, CMC, Information sharing, Cultural proclivity, Social categorization, Information evaluation

Introduction

Computer-supported collaborative learning (CSCL) involves interpersonal processes by which students work together to complete a learning task designed to promote learning and intellectual discovery (Alavi, Wheeler, & Valacich, 1995). The distinguishing feature of CSCL is interaction among distributed learners. Peer-to-peer sharing of information, ideas, and knowledge is important for learners in increasing exposure to diverse problem-solving approaches, conflicting viewpoints, and different sets of knowledge. Each of these points enhances an individual’s ability to recognize opportunities, to adapt, and to learn (Cohen & Levinthal, 1990). From this perspective, learning is an active, social process involving knowledge construction by community members rather than a cognitive process involving the acquisition of knowledge or skills by individuals.

Because of the fast development of communication technologies in recent decades, computer-mediated communication (CMC) has become an essential element in mediated learning environments such as distance learning (Lee, Cho, Gay, Davidson, & Ingraffea, 2003; Yeh, 2010). One of the underlying assumptions of using CMC tools in education is that learners with diverse pieces of information and multiple perspectives will interact with each other more efficiently with the help of CMC. That is, CMC participants are believed to be less bound by geographical and time barriers or other social contextual elements, and this greater freedom creates conditions for rapid information exchange among learners with diverse information and multiple perspectives.

In practice, however, previous research has consistently reported that using CMC tools in distributed learning does not always produce the expected results (Cho & Lee, 2008). For instance, distributed learning environments such as CSCL often fail to provide students with learning environments that have shared social contexts, which foster a seamless engagement in social interactions and learning (Cho, Lee, Stefanone, & Gay, 2005). This is largely because of the nature of the distributed learning environment, which prevents distributed learners from establishing a shared learning context (Huang, Jeng, & Huang, 2009).

Often, multiple-level social, psychical, and cultural boundaries divide distributed learners into discrete subgroups. These boundaries create substantial challenges for distributed learners who need to bridge the “discontinuities” (Watson-Manheim, Chudoba, & Crowston, 2002). With more of these boundaries, the “virtuality” of the team increases, creating “fault lines.” “Fault lines” are hypothetical dividing lines that split a group into subgroups according to one or more social or cultural attributes such as demographic attributes, organizational affiliations, or nationalities (Lau & Murnighan, 1998).
A salient fault line causes people to categorize members of their own subgroup as an in-group and view other subgroups as out-groups. This can cause group members to communicate and share information within rather than across their subgroups (Katz & Allen, 1982). Such segregated communication and information sharing can degrade a group’s ability to learn, perform, and satisfactorily. As social network studies have demonstrated, strong social ties within groups can create a social circle/barrier that prevents group members from acquiring innovative and creative ideas from out-group members (Granovetter, 1973). When team members’ interactions are confined to subgroups, they tend to exchange overlapping, redundant, or local information. Consequently, the existence of fault lines can significantly limit the effective exchange of information and reduce the opportunity for collaborative learning and knowledge construction.

In addition, individuals’ characteristics play a significant role in the explanation and prediction of learning behavior (Jensen, 2003). Different learners have different instructional preferences, information processing styles, and personality types, which have significant impacts on the ways in which learners engage in various learning activities (Jones, Reichard, & Mokhtari, 2003). For instance, personality types and cognitive styles affect participation in a networked learning environment, collaboration method, and instructional media preferences (Sadler-Smith & Riding, 1999).

Hence, in order to develop an effective CSCL environment, one must consider both the individual characteristics of distributed learners and multiple-level social barriers that divide these people into subgroups. However, research examining the influences of multiple-level social boundaries (e.g., group and relational boundaries) together with individual traits on the learning practice in a distributed learning environment is difficult to find. That is, scholars have seldom attempted to investigate the interactions among pre-existing group- and individual-level social boundaries and individual characteristics or the simultaneous influence they have on students’ learning practices in CSCL. Given the increasing proliferation of CSCL, this line of research will not only contribute to the related literature but will also provide practitioners with useful guidelines for successful CSCL.

We undertook this research to empirically examine how students separated by physical distance share and transfer information using a CMC system. We tried to identify social and individual factors affecting the information-seeking processes within and across two different locations. Students from two universities in different geographic regions of Singapore participated in a collaborative learning exercise using a computer-mediated collaborative system. We tested how social contexts such as interpersonal social networks, social categorization, and individuals’ cultural proclivity facilitated or constrained the flow of information across CMC groups. In addition, we tested whether social and individual factors affect the information-evaluation process.

Background

The social nature of information sharing using CMC

Theories of collaborative learning such as the developmental theories of Vygotsky and Piaget, cognitive-elaboration theory (Brandon & Hollingshead, 1999; Webb & Palincsar, 1996), and situated learning theory (Lave & Wenger, 1991) state that peer interaction is a key mechanism whereby learners construct knowledge. For instance, situated learning theory holds that learning, both outside and inside school, proceeds through collaborative social interaction and the social construction of knowledge. From this perspective, the success of CSCL is more than just a matter of delivering information from one source to another (e.g., an instructor to students). The emphasis for teachers should be on how to provide a learning environment in which distributed learners can seamlessly engage in social interactions and community-based learning practices (Ajayi, 2009).

A number of researchers and practitioners have envisioned the possibility of creating effective online learning environments in which distributed learners co-construct knowledge through CSCL. CMC tools such as online discussion boards, instant messaging, video-audio conferencing, and email listservs are regarded as appropriate tools with which to support such collaborative knowledge sharing and learning practices (Lee et al., 2003). The high interactivity and connectivity afforded by CMC systems can also facilitate community-based learning by enabling active peer interaction, evaluation, and cooperation (Hiltz & Wellman, 1997). Moreover, a local transfer of knowledge (Joshi, Sarker, & Sarker, 2007) is less important, because CMC systems connect people across time and geographic barriers.
It has been suggested that the perceived quality of information and source expertise should be the main criteria guiding individuals’ information-seeking behaviors. For instance, CMC participants will select information from sources perceived to offer the highest quality information in terms of relevancy, accuracy, reliability, and timeliness (El-Shinnawy & Vinze, 1998). However, it was argued that CMC environments which lack social cues reinforce the salience of inter-group differences and group identity compared with face-to-face settings, thereby strengthening the impacts of various social boundaries on the communication process (Lea & Spears, 1991).

Theoretically, studies on source credibility have suggested that the choice of information should be determined by its origin rather than by its face value, especially when individuals have difficulties determining which messages are valuable (Griffin, 1967). Similarly, the transactive memory (TM) theory explains that close interpersonal relationships often function as a form of transactive memory; that is, they constitute a repository containing information about “who knows what” (Wegner, 1986). Hence, when individuals approach information-seeking tasks, they may turn to the information from their social circle because they believe that these sources have expertise (Yuan, Fulk, & Monge, 2007). Previous research has reported that, especially in the context of a small group, such meta-memory influences the information exchange process (Palazzolo, 2005).

In summary, it is expected that the in-out group membership of an information source might act as a strong heuristic cue, especially when individuals face difficulty evaluating the quality of information and the expertise of sources in an online information space. In this case, interpersonal closeness and group membership may have more significant impacts on how individuals choose information than does the face value of the information. On the basis of these discussions, we suggest the following hypotheses.

Hypothesis 1: The possibility of information exchange between individual $i$ and $j$ will increase if $i$ and $j$ belong to the same group.

Hypothesis 2: The possibility of information exchange between individual $i$ and $j$ will increase if $i$ has interpersonal social relationship with $j$.

Cultural proclivity and information exchange

Individuals’ cultural proclivity is reportedly an important contingent factor that reinforces or mitigates the influence of interpersonal and group effects on information exchange (Pook & Fustos, 1999). Culture is the “collective programming of the mind that distinguishes the members of one group or category of people from another,” and manifests usually in one’s values, behaviors, and actions (Hofstede, 2001, p. 9). Of the many dimensions of cultural beliefs identified in previous studies, individualism/collectivism (I/C) is commonly regarded as a fundamental element that distinguishes members of different cultural orientations (Hofstede, 1991). Individualistic people base their self-understanding on their own actions, which are usually understood independently of what others think (Earley, 1993). For this category of people, individual goals and self-actualization take precedence over group goals. In contrast, collectivistic people are easily integrated into strong cohesive groups such that they base their self-understanding on the reactions of others (Bond & Hwang, 1986). One attribute of collectivism is a “we” consciousness and an orientation to the collectivity (Triandis, 1995). For collectivistic individuals, belonging takes precedence over egoistic needs, and they have a supreme need for actualizing their in-group interactions to maintain group harmony.

The I/C construct has been identified in cross-cultural studies to explain similarities and differences in information sharing (Pook & Fustos, 1999) and information technology usage (Calhoun, Teng, & Cheon, 2002). With regard to information exchange, Cho and Lee (2008) recently reported that individuals from an individualistic culture show a greater tendency toward accepting information from out-group members than do those from collectivistic culture. Their finding suggests that individuals from different national cultures display some discernable behavioral patterns in terms of information seeking and sharing.

Although Hofstede’s (1991) I/C culture model has been adopted by many scholars, it has been criticized because it treats all individuals in a nation as homogeneous, sharing the same cultural values. Schwartz (1994) argued that individuals within a given society may deviate substantially from other members of the society in their personal values and may not hold similar values to those endorsed by their culture. As such, the main difference between individualistic and collectivistic cultures is that the probability of the individualistic attitudes, norms, values, and
behaviors being espoused or used is higher in the former type of person than in the latter (Triandis, 1994). It is more appropriate then to treat the I/C dimension as an indicator of the likelihood that a person or a group of people will behave in an individualistic or collectivistic way in various situations. Following Triandis’s argument, in the current study, the I/C dimension is considered an individual trait, and an individual’s I/C proclivity is operationalized as the likelihood that a person or a group of people will behave in an individualistic or collectivistic way.

Individuals with individualistic proclivities tend to belong to many groups. They consider interactions with others restricted to a particular purpose and time and experience little difficulty joining or leaving such groups on the basis of their ability to satisfy their goals and tasks (Triandis, Bontempo, Villareal, Asai, & Lucca, 1988). As for information sharing, we expect that individuals with individualistic proclivities are more likely to focus on the task at hand and on the value and quality of information. Hence, their information search would be more heterogeneous and open, because personal preferences and style, among other factors, guide their search. From these considerations, we hypothesize as follows:

Hypothesis 3: Individuals’ cultural proclivity will influence the way individuals seek information from within or across boundaries.

Information evaluation

Information-seeking is the first step in information exchange and knowledge transfer. To be used meaningfully, shared knowledge must be coupled with mechanisms for acquisition, retention, retrieval, evaluation, and the application of the information. In terms of information evaluation, studies suggest that people have a strong tendency to judge the value of information on the basis of the (often irrelevant) characteristics of information sources. Research on source credibility indicates that the perceived expertise and trustworthiness of the source influence the acceptance of information (Beebe & Beebe, 2005; Griffin, 1967). As mentioned previously, research on TM theory also suggests that individuals often rely on information from known sources because they believe that these sources have expertise (Yuan et al., 1986), especially in group settings (Palazzolo, 2005). This tendency applies even to what might be considered a prototypical information retrieval scenario. In a study about “desk officers” at the International Monetary Fund (IMF), for example, Harper (1999) concluded that it is the overall social texture of the information that determines its value.

With regard to CMC, the early prediction was that CMC participants would be more likely to judge the value of information according to the content value, referring to such factors as persuasiveness, novelty, validity, and accuracy. Because of the social-cues-filtered-out nature of CMC interactions, the contextual cues play less significant roles in the information-evaluation process (El-Shinnawy & Vinze, 1998). Consistent with this argument, the study of Constant, Sproull, and Kiesler (1996) discovered that people assigned higher values to information from “electronic weak ties” than to strong ties, since the weak ties provide more unique and locally unavailable knowledge. Soininen and Suikola (2000), however, showed that social aspects moderate almost every step of the information retrieval process, ranging from problem formulation to the evaluation of the retrieved items. Hence, we propose to test empirically the degree to which social factors influence the way individuals determine the value of information when they exchange information using CMC channels.

RQ1: Will school membership or pre-existing social relations influence the perceived quality of information?

Methods

Participants and procedure

To test the hypotheses and the research question, we conducted a field experiment in an educational setting. Undergraduate students taking an introductory communication classes at two universities (hereon they will be called U1 and U2) in two different geographical areas participated in this study. The total number of participants was 78 (30 from U1 and 48 from U2; 57 females and 21 males). At the beginning of the semester, instructors at both universities announced in class that an online collaborative learning exercise with students from another university would take place during the semester. In the middle of the semester, students were asked to participate in the
collaboration practice to find useful information about current issues in communication technologies. Participation in the practice was voluntary, and participants received extra credit.

An online discussion forum was developed and used for the exercise. Participants were provided with the web address, at which they had to log in to read and write messages. The collaboration exercise consisted of two phases, each of which lasted two weeks. During the first phase, participants attempted to find an online article describing current issues in communication technologies. In addition, they had to post a brief summary of the article together with its online address, so that other participants could visit the webpage and read the article.

During the second phase, students were asked to browse all the summaries posted by other students, select one or two summaries, read the original article by visiting the webpage, and then leave a reply with his or her own opinion about the article. Students were not allowed to leave a reply until the end of the first phase so that all postings could have an equal chance of receiving replies.

As shown in Figure 1, the design of the discussion forum allowed participants to recognize who replied to whose posting. When students left replies to the initial postings during the second phase, they were also asked to evaluate the quality of the information on a five-item scale (criteria included whether the information was unique, useful, interesting, of good quality, and recommendable to others) ranging from 1 to 7, one being “strongly disagree” and 7 being “strongly agree” (α = .86). The rating scores were saved in a data file, and students did not have access to the scores at any time. The poster of a message was not allowed to rate his or her own message.

Figure 1. Setting of the discussion forum

Measurements

To test Hypothesis 2, two kinds of networks, social and information sharing networks, needed to be constructed. As for the social network, we conducted a social network survey before the experiment in which students were asked to report three to five names of their close friends. The closeness of each friend reported was measured on a seven-point Likert-type scale, one being “not close at all” and seven being “very close.” Students had access to the class rosters of the respective schools to aid them in recalling the names of their classmates. The resulting two social networks of each school (30 by 30 for U1 and 48 by 48 for U2) were merged into one 78 by 78 overall social network. Note that cross-school social relationships were not assumed in the final social network.

A 78 by 78 information-sharing network was constructed by identifying whether student i wrote a reply to a message posted by student j. In other words, if student i selected and read a message posted by student j and wrote a reply to it, it was assumed that the two students have shared information. If students i and j shared information, the cell was coded as 1; and if they did not share, as 0.

Hypothesis 3 concerns whether individuals’ cultural proclivity fosters within- or cross-boundary information-seeking. To test Hypothesis 3, we divided the information sharing network into two components, within- and between-school information sharing. As for the within-school information sharing network, information sharing between students in the same school was maintained, but all cross-boundary information sharing was coded as 0. Conversely, in the between-school information-sharing network, information-sharing between students from two schools was maintained, but all local information sharing was coded as 0. As a result, we constructed two 78 by 78 information-sharing networks, which contained within- and between-school information sharing, respectively.

Finally, individuals’ cultural proclivity (the I/C index) was measured on a seven-point Likert-type scale composed of eight items (α = .72) developed and validated by Erez and Earley (1987). Examples of the items include “If the group is slowing down, it is better to leave it and work alone”; “To be superior a man must stand alone”; and “I would rather struggle through a personal problem by myself than discuss it with my friends.” A higher score on this scale indicates a higher individualistic proclivity. This measurement was administered on the social network survey as described above.
Analysis and results

Table 1 shows the descriptive results of the initial message postings and the I/C index scale. During the first phase of the social recommendation practice, 81 messages were posted. Of these, 30 messages came from U1 and 51 from U2. As for individualistic proclivity, no significant difference was found between the two schools ($F = 3.7, p > .05$).

<table>
<thead>
<tr>
<th></th>
<th>U1</th>
<th>U2</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of participants</td>
<td>30</td>
<td>48</td>
<td>78</td>
</tr>
<tr>
<td>Number of initial postings</td>
<td>30</td>
<td>51</td>
<td>81</td>
</tr>
<tr>
<td>Individualistic proclivity</td>
<td>4.6 (1.2)*</td>
<td>4.2 (1.3)</td>
<td>4.4(1.3)</td>
</tr>
</tbody>
</table>

*Numbers in parentheses represent standard deviations.

During the second phase, 80 replies were posted. Of these, the number of within-school replies (i.e., U1→U1 and U2→U2) was 52 (65%) and that of between-school replies (i.e., U1→U2 and U2→U1) was 28 (35%), as shown in Table 2. To test Hypothesis 1, a chi-square analysis was performed. The results show that the difference between the numbers of cross- and within-school postings was significant ($\chi^2 = 7.5, df = 1, p < .01$), meaning that participants tended to write replies to messages from the same school, which supports Hypothesis 1.

Table 2. Number of replies to initial postings

<table>
<thead>
<tr>
<th>From</th>
<th>To</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>U1</td>
<td>U1</td>
<td>22</td>
</tr>
<tr>
<td>U2</td>
<td>U2</td>
<td>18</td>
</tr>
</tbody>
</table>

To test Hypothesis 2 and 3, we ran multivariate p* (MVP) logistic network regression analyses (Wasserman & Pattison, 1996). The benefit of using MVP analysis is twofold. First, MVP treats a pair of actors $i$ and $j$ as a single case, which dramatically increases the number of cases from $N$ to $N*(N - 1)$ ($78*77 = 6,006$ in the case of this study) and thus the power of the analysis. Second, MVP analysis allows the dependent variable to be in a matrix format and the independent variables in vector and matrix formats. In other words, attributes such as individuals’ cultural proclivity and networks such as a social network can be used as independent variables simultaneously. Because it is beyond the scope of the current study to review MVP analysis in detail, readers are referred to previous studies (e.g., Monge & Contractor, 2003; Wasserman & Pattison, 1996).

Based on the hypotheses and research question, we developed two MVP regression models. In the first model, the within-school information-sharing network was used as the dependent variable. The social network and individuals’ cultural proclivity were entered as independent variables. In the second model, the between-school information-sharing network was used as the dependent variable. Note that although the social network was used as an independent variable, it should not affect the dependent variable (i.e., between-school information exchange), because there were no pre-existing between-school social relationships. To control for gender effects, we entered participants’ gender as a control variable in both equations. For analysis, we used MultiNet (Richards & Seary, 2005), which reports the model fit in the form of $-2\log (\text{likelihood})$, the “badness of fit,” meaning that the smaller the value, the better the result.

When performing MVP analysis with MultiNet, the fit of each research model was compared with those of basic network models in which inherent structural properties of the network (e.g., choice, reciprocity, and transitivity) were used as independent variables (Monge & Contractor, 2003). Note that the inherent structural properties used in basic network models are different from the exogenous attributes of network nodes used as independent variables in the research models. We fitted the basic network models in which various combinations of inherent properties were entered. We then compared the results with the fit of each research model to determine which had the best output. In other words, we tested whether the observed network patterns are determined by inherent endogenous attributes of a network or by exogenous attributes of network nodes (e.g., in-out group categorization).
First, we examined the basic network models. All of the basic models tested produced $-2\log (\text{likelihood})$ values larger than 550. In addition, none of the endogenous properties used in basic network models were significantly associated with the dependent variables. Second, we fitted two research models, and the results are presented in Table 3. As Table 3 shows, the research models produced significantly smaller $-2\log (\text{likelihood})$ values (within-school: 363.816; between-school: 457.028) than all of the basic models (> 550). These results illustrate that the research models explained the participants’ information-seeking behavior substantially better than did the models with inherent network properties. This means that the observed results of the information-seeking networks were not due to the structural tendencies of the networks but rather the effects of independent variables utilized in this study. Hence, we concluded that the two research models composed of exogenous attributes were parsimonious and appropriate models for use in the current study.

As shown in Table 3, male students, unlike female students, preferred local information sharing, but this difference was not observed for between-school information sharing. Individuals’ pre-existing social networks significantly increased local information sharing as predicted by Hypothesis 2, but they did not influence between-school information sharing as expected. Participants’ individualistic proclivity did not influence within-school information sharing, but significantly increased between-school information sharing, which is consistent with Hypothesis 3.

**Table 3. Results of $p^*$ Logistic Regression Analysis**

<table>
<thead>
<tr>
<th>Dependent Variables</th>
<th>Within-school</th>
<th>Between-school</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$b$</td>
<td>$\text{Exp}(b)$</td>
</tr>
<tr>
<td>Gender (female = 0, male = 1)</td>
<td>1.88**</td>
<td>6.56</td>
</tr>
<tr>
<td>Social network</td>
<td>.354**</td>
<td>1.42</td>
</tr>
<tr>
<td>Individualistic proclivity</td>
<td>.037</td>
<td>1.04</td>
</tr>
<tr>
<td>Model Fit [$-2\log(\text{Likelihood})$]</td>
<td>362.816</td>
<td>457.028</td>
</tr>
</tbody>
</table>

** $p < .01$.**

For RQ1, we tested the degree to which social contexts influenced the evaluation of information. As mentioned, when students replied to postings, they were asked to assess the quality of the information provided by the postings. Using the rating scores, we ran ANOVA tests to examine whether postings from the same school received higher scores than others. The results showed that the participants did not differentiate the value of the information according to whether the information provider was within their social network ($M_{\text{within}} = 4.98$, $SD = .86$, $M_{\text{out}} = 4.65$, $SD = .94$, $F = 2.40$, $p > .05$) or at the same school ($M_{\text{same}} = 4.69$, $SD = .86$, $M_{\text{diff}} = 4.93$, $SD = .90$, $F = .914$, $p > .05$).

**Discussion**

In this study, we examined the process of collaborative information sharing through CMC within and across different locations. Overall, this study’s findings demonstrated the socially bounded nature of computer-mediated information-sharing and seeking behaviors. More specifically, we found that three factors significantly influenced the way individuals seek and exchange online information in a collaborative learning environment: 1) the group level in-out group categorization, 2) the relational level social network, and 3) the individual-level cultural proclivity.

At the school level, we hypothesized that online information-seeking behavior would be significantly affected by the in- and out-group categorization. The result of the chi-square test clearly illustrated that participants’ social categorization behavior supported Hypothesis 1. School membership increased the tendency of within-school information sharing and decreased that of between-school information sharing. The results imply that participants in the study preferred information from local sources to that from external sources. At the relational level, we hypothesized that online information-seeking behavior would be significantly affected by pre-existing social relationships. MVP analysis results show that pre-existing social networks are closely related to within-school information sharing, which supports Hypothesis 2. Taken together, these results demonstrate the socially bounded nature of online information sharing in a distributed educational setting.

Previous research has reported that the type and quality of information acquired through interpersonal networks is inversely related to the strength of ties (Granovetter, 1973). In this study, we measured the strength of pre-existing social ties and found that their influence on online information seeking arose more significantly from strong social ties instead of weak ties. This finding is consistent with the contention that the volume and extent of communication
are the basis of knowledge transfer (Sarker, Sarker, Nicholson, & Joshi, 2005). It has been hypothesized that frequent communication decreases misunderstanding and increases interaction, which leads to the creation of shared meaning and knowledge transfer. This suggests that strong interpersonal ties tend to influence individuals’ online information-seeking behaviors. The results of this study imply that information is “sticky” (Szulanski, 1996) and captive in strong social ties, even in a virtual setting, implying further that individuals are motivated to seek information from groups within the “fault lines,” since they may seem to be more accessible, relevant, and trustworthy.

These results indicate that distributed learners may need to overcome and transcend their social boundaries in order to achieve successful learning. In doing so they would benefit more from online information seeking by exploring various information sources in order to acquire information from different and novel perspectives. Practitioners, especially in education, should be aware of the socially bounded nature of information sharing and the potential weakness of online information sharing. Consequently, they should try to foster cross-boundary information sharing so that more diverse and valuable information can be exchanged. For instance, providing an anonymous information exchange condition in the design of collaborative learning systems may be a useful option to minimize the influences of such subgroup identifications.

At the individual level, although individuals with high collectivistic proclivity (i.e., low individualistic proclivity) did not prefer within-school information sharing, we found that individuals with high individualistic proclivity tended to seek out information from outside the boundaries, which supports Hypothesis 3. This result supports the contention of this study that individuals’ cultural proclivities affect CMC collaboration, at least to the extent that people with a more individualistic nature are more inclined to seek out information from sources outside of their social boundaries.

The finding that people with high individualistic proclivities (i.e., low collectivist proclivity) tend to seek out information across school boundaries can be explained by the fact that highly individualistic people value their own goals and self-actualization over group goals. In other words, for those with high individualistic proclivities, achieving their goal is more important than following group norms, and thus as long as they believe that it is helpful to acquire more diverse and valuable information, they are willing to cross borders to fulfil their needs. Previous research has examined the affects of individual characteristics such as information processing styles (Jones et al., 2003), personality type (Sadler-Smith & Riding, 1999), and outcome expectations (Cho & Lee, 2008) on students’ information-seeking and learning behaviors. This study contributes to this line of education research by identifying another important, but relatively unexplored individual characteristic such as cultural proclivity and by specifying how this particular factor influences information seeking in the context of CSCL.

This result is consistent with the recent finding that individuals from an individualistic country tend more often to accept information from out-group members than people from a collectivistic country (Cho & Lee, 2008). The previous study, however, operationalized culture as a trait of people from a certain country, assuming that individuals in a nation as homogeneous. In this study, culture is considered a trait of an individual through which to investigate potential inconsistencies in behavioral patterns at the micro-level. The results of this study illustrate that the approach of the current study was appropriate and that individuals in a nation do vary in regard to cultural proclivity, which significantly affects their online information-seeking behavior. Hence, practitioners should be aware of different levels of preference to outbound information seeking at the individual level and its influence on information-seeking.

Finally, we tested whether social context influences the way individuals evaluate the value and quality of information. The results showed that individuals did not differentiate the values of information according to whether the source of the information was within their social network or school, which has an interesting research implication. On the basis of our findings, we suggest that social context can strongly influence information sharing in the information acquisition stage but not necessarily in the evaluation stage. This proposition underscores the scope of social influence on the information-sharing process. Individuals may rely on social and contextual heuristic cues to choose information in a large information space. Once they have the information in their hand, however, the assessment of the quality of information is not necessarily influenced by social context. It seems that information processing is a multi-step process, coupled with mechanisms for the acquisition, retention, retrieval, evaluation, and application of information. Researchers need to be aware of the multi-step nature of information processing and try to examine in what manner and to what extent social context affects the different steps of collaborative learning.
Conclusion

Many researchers have touted the power of CMC-based collaborative learning to facilitate cross-border information transfer by extending a person’s reach across the boundaries of time, space, and hierarchies (Starr, 1997). However, this study’s findings suggest that individuals do not necessarily benefit from “the usefulness of electronic weak ties” (Constant et al., 1996). At the very least, the results of this study indicate that information does not move across social network boundaries as readily as previously thought. The results demonstrate that computer-supported collaborative learning should be regarded as a social process and that teachers should be aware of the importance of social context when implementing CMC tools in educational settings.

We believe that the findings of this study make a significant academic contribution to the understanding of online information-seeking behaviors and the factors affecting such behaviors. To our knowledge, research empirically testing the effects of individuals’ cultural proclivity on computer-mediated information-seeking behaviors has been rare. We also discovered that, despite the socially bounded nature of CMC information exchange, the social values attached to the information exchange seldom influence the evaluation of information.

This study’s findings also have practical significance. As mentioned before, we suggest that understanding how individuals’ cultural proclivities and social roles affect CMC-based information processing can offer important insights into how technology can be effectively deployed in various settings. For instance, designers and managers of computer-mediated collaboration practices, such as virtual teams, need to be more proactive when members are engaged in distributed collaborative tasks. For instance, more incentives or rewards for cross-border information sharing can be given to participants with a collectivist proclivity.

This study has some limitations. It confined its focus to a set of variables of interest such as individuals’ cultural proclivity and the social roles in their social network. As a result, other relevant factors such as task characteristics, communications between information source and receiver, and technological features of the CMC environment were not incorporated in model testing. Participants in this study performed a rather simple task within a relatively short period of time. Hence, future research should examine whether the findings of this study can be replicated when distributed learners engage in a more complex learning task (e.g., problem solving) for a longer period of time. As identified by Cross and his colleagues (2001), information sharing provides at least five different types of benefits: solution, legitimatization, meta-knowledge, problem solving, and validation. Future studies should incorporate different types of information and tasks in order to verify the implications of the current study.

References


Assessing the Acceptance of a Blended Learning University Course

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ABSTRACT
Usefulness and ease of use proved to be key determinants of the acceptance and usage of e-learning. On the contrary, little is known about students’ perceptions in a blended learning setting. In this paper, the Technology Acceptance Model (TAM) was utilised, in order to investigate Greek university students’ attitudes toward blended learning. The goal of the study was twofold. First, to investigate whether the students’ perceptions in a blended learning setting were comparable with other studies reporting perceptions in the context of distant learning. Second, to investigate variation in students’ perceptions before and after actual system use. A sample of 130 students before actual system use and 102 students after the end of the semester was used. As derived from the model analysis using partial least squares, the e-learning system was well accepted and the majority of our hypotheses were confirmed. The most notable difference between pre- and post-use scenario was that perceived usefulness did not prove to have a significant effect on behavioral intention before system use, whereas, in the end, it appeared to be significant. The results are compared with similar studies focused on e-learning acceptance. The implications, both for the designer of a blended learning course as well as for the educational community, are also discussed.

Keywords
Technology adoption, technology acceptance model, blended learning, perceptions, usefulness, ease of use, e-learning, partial least squares.

Introduction

During the recent years, a significant volume of research on the effective use and integration of Information and Communication Technologies (ICT) in education practices is observed. The main feature that differentiates the e-learning systems from the 'traditional' learning environments is the degree of technology usage and the gradual shift of control and responsibility of the learning process to the learners, giving them the opportunity to learn anytime, anywhere. This shift of control seems to positively influence the learning effectiveness of learners (Chou & Liu, 2005). In this context, sociocultural theories influence considerably the learning procedure and have strengthened the perceptions of the educational community towards adoption and effective integration of open and distance learning (ODL) systems in the educational process (Duffy & Kirkley, 2004).

In the latter, a series of important questions emerge, mainly related to the study of the appropriate teaching methods, the effective design of the technological infrastructure and the appropriate design of the interaction of students with the e-learning platform (Duffy & Kirkley, 2004; Soloway, Guzdial, & Hay, 1994; Tselios, Avouris, Dimitracopoulou, & Daskalaki, 2001; Tselios, Avouris, & Komis, 2008b; Tselios, Katsanos, Kahrimanis, & Avouris, 2008a). The last dimension depends largely on the earlier representations, attitudes and perceptions of the learning community’s members. In particular, students’ personal beliefs and attitudes towards web-based education constitute a critical factor to the successful incorporation and adoption of such systems in the learning practices of an institution. Not surprisingly, an increasing number of studies have examined various factors that influence users’ attitudes towards using an e-learning system (Liaw, 2008; Liaw, Huang, & Chen, 2007; Lin, 2007; Ong & Lai, 2006; van Raaij & Schepers, 2007; Selim, 2003). The technology acceptance model (TAM, Davis 1989), adapted from the theory of reasoned action (TRA, Fishbein, 1980), has been used as the theoretical basis for many empirical studies of users’ technology acceptance (Behrens, Jamieson, Jones, & Cranston, 2005; Loukis, Georgiou, & Pazalos, 2007; Ngai, Poon, & Chan, 2007). According to TAM the acceptance of an e-learning system could be assessed by examining the perceived usefulness and ease of use. Davis (1989, p. 320) defined perceived usefulness as ‘the degree to which a person believes that using a particular system would enhance his/her job performance’. Perceived ease of use is defined as ‘the degree to which a person believes that using a particular system would be free of physical and mental effort’ (Davis, 1989, p. 320).

Venkatesh and Davis (1996) observed that computer self-efficacy acts as a strong predictor of perceived ease of use both before and after actual system use. However, measured systems’ usability was found to be a predictor of perceived ease of use only after direct experience with a system. As a result, they concluded that users based their
perceptions regarding ease of use on computer self-efficacy before hands-on system use. Usability was also found to be a fundamental factor towards success and adoption of an e-learning system (Liaw, 2008). However, e-learning is relatively new and electronic learners constitute a stakeholder group with specific characteristics. In addition, e-learning has fundamental differences compared to typical productivity software (Soloway et al., 1994). Thus, existing variables of TAM cannot fully reflect learners’ motives, requiring an investigation for additional intrinsic motivation factors. The learners are not domain experts, therefore cannot assess precisely the utility of an e-learning system. Furthermore, even the learners’ motivation to learn should not be taken for granted (Soloway et al., 1994). The latter was investigated by Roca and Gagne’ (2008) which examined the relationships between Self Determination Theory (Ryan & Deci, 2000) and TAM factors. Their model used perceived autonomy, perceived competence and perceived relatedness as determinants of perceived usefulness, perceived playfulness and perceived ease of use. The major implication of their study is that those factors contribute to the learning process while also “when individuals participate in an event or task because it is interesting and enjoyable, they show more engagement in the activity” (Roca & Gagne’, 2008, pp. 1599).

Ong, Lai, and Wang (2004), by using an extended model of TAM and taking into account the dimension of perceived credibility, showed that computer self-efficacy has a significant effect on behavioral intention to use e-learning. In addition, Ong and Lai (2006) surveyed 67 female and 89 male employees in Taiwan to examine influence of gender differences towards e-learning acceptance. They found that men’s perception of perceived usefulness was more significant and more salient than women’s in determining behavioral intention to use e-learning. In addition, they observed that men’s rating of perceptions with respect to computer self-efficacy, perceived usefulness, perceived ease of use, and behavioral intention to use e-learning were higher than women’s. In addition, they report that computer self-efficacy and perceived ease of use were more salient to women. As the findings from Ong and Lai (2006) research suggest, e-learning may be perceived differently by women and men. Sun, Tsai, Finger, Chen, and Yen (2008), proposed a model comprised of 6 dimensions: learners, instructors, courses, technology, design, and environment. A related questionnaire comprised of 13 variables was completed by 295 participants. According to the results reported in Sun et al. (2008) using stepwise multiple regression analysis, 66.1% of the perceived e-learner satisfaction variance can be explained by the following variables: learner computer anxiety, instructor attitude toward e-learning, e-learning course flexibility, quality, perceived usefulness, perceived ease of use, and diversity in assessments. Furthermore, it seems that familiarity with Internet usage is a strong positive predictor of the ODL’s acceptance (Liaw et al., 2007).

Surprisingly, despite the increasing number of studies related to e-learning acceptance, little research has been conducted in the context of blended learning (Keller, Hrastinski, & Carlsson, 2007; Park, 2009; Pituch & Lee, 2006). The concept of blended learning provides the opportunity to integrate the advances offered by online learning with the best practices and benefits of traditional learning. Preliminary findings suggest that in general the learners’ perceptions of ODL as a means of distant learning are no different than the learners’ perception of ODL as a complementary tool for teaching a lesson in the context of a blended learning (Pituch & Lee, 2006). However, students’ attitudes towards usage were substantially affected by the perceived functionality of the system (Pituch & Lee, 2006). In addition, there is a need to conduct studies in various countries to investigate possible cultural and individual differences as well as different educational approaches and goals. For instance, Teo, Lim, and Lai (1999) examined perceived ease of use, enjoyment, and usefulness using TAM related to the World Wide Web in Singapore. Their results found to be consistent with TAM applications in North America. However, Park (2009) in a similar study in higher education of South Korea found that neither perceived usefulness nor perceived ease of use had a significant direct effect on behavioral intention to use e-learning. This result, according to Park (2009), is possibly explained due to high internet skills and self-efficacy of Korean students, which is not always the case in other countries. Moreover, Keller et al. (2007) conducted cross-cultural study exploring the implementation of e-learning environments in the frame of a master course in public health education offered in Sweden and Lithuania. They report that “Lithuanian students were found to experience a substantially higher degree of acceptance of e-learning environments than Nordic students at the Swedish university” (p.395). In addition, the study findings of Keller et al.(2007) revealed that “Lithuanian male students experienced a lower degree of perceived usefulness of the e-learning environment than Lithuanian female students”. Keller et al. (2007) emphasize on the key role of “cultural and organizational” aspects towards acceptance of e-learning initiatives from students (Keller et al., 2007, p.395).

Given the fact that little is known about students’ perceptions in a blended learning setting, especially in the context of Greek higher education, a relative study was designed. The goal of the study was to validate the original TAM in a blended learning setting, by using an open-source e-learning technology platform, Moodle (www.moodle.org). The
goals of the study were (a) to investigate whether the students’ perceptions on the use of course websites in a university course offered in a blended learning setting were comparable with other studies reporting perceptions in the context of e-learning and (b) to investigate variation in students’ perceptions before and after actual system use. It is argued that examination of students’ views about specific blended learning approaches could support effective course and learning technology redesign.

The rest of the paper is organized as follows. First, a detailed discussion on the theoretical framework adopted and the procedure is presented, followed by description of the results obtained. Subsequently, the results are discussed.

Method

Theoretical framework and hypotheses

The research framework of the study was based on TAM as formulated and proposed by Davis (1989). TAM has been widely utilized in past research works from a diversity of disciplines in order to empirically investigate beliefs and attitudes of various stakeholder groups (Katharaki, Daskalakis, & Mantas, 2009; Masrom, 2007; Saadé, Nebebe, & Tan, 2007). Furthermore, a plethora of research efforts attempt either to extend TAM or perform a synthesis with other frameworks, towards new theoretical propositions (Lee, Cheung, & Chen, 2005; Ngai et al., 2007; Ong et al., 2004; Saadé & Bahli, 2005; Selim, 2003).

In this study, the aim is to validate the original TAM in a blended learning setting, by using the Moodle Learning Content Management System (LCMS). Thus, a set of hypotheses were formulated, which were closely related with the TAM model (Table 1).

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>H1</td>
<td>Attitude toward use will have a positive effect on behavioral intention</td>
</tr>
<tr>
<td>H2</td>
<td>Perceived usefulness will have a positive effect on behavioral intention</td>
</tr>
<tr>
<td>H3</td>
<td>Perceived ease of use will have a positive effect on attitude toward use</td>
</tr>
<tr>
<td>H4</td>
<td>Perceived usefulness will have a positive effect on attitude toward use</td>
</tr>
<tr>
<td>H5</td>
<td>Perceived ease of use will have a positive effect on perceived usefulness</td>
</tr>
</tbody>
</table>

Procedure and Measures

The study attempted to systematically investigate the factors which affect the attitudes, perceptions and practices of students in the context of blended learning. The participants were students of the Educational Sciences and Early Childhood Education department at the University of Patras, Greece. They attended a compulsory second year course entitled “ICT in Education”. The goal of the course is to familiarize the students with the main models and approaches of ICT integration in the educational process. The course includes a theory and a laboratory section. Both are supported by the Moodle (LCMS). The students were informed for the course’s goals and the skills that they were expected to acquire at the beginning of the course. The online resources provided to the students through the Moodle infrastructure, were web pages, documents, presentations and educational software (animations, simulations, interactive hypermedia, encyclopedias, glossary and exercises), analysis grids and self-assessment modules. Communication tools, such as forum and chat were also provided as well as complementary services such as calendar indicating course’s events, projects’ submission deadlines, etc. The students had access to the Moodle’s resources both in the laboratory session as well as from their homes throughout the assignment completion process.

A problem based pedagogical framework (Duffy & Kirkley, 2004) was developed. Each week a different mini-project was presented to each student. Related theory was also presented in a three hour lecture. Subsequently, the students attended a weekly 2 hour lab session. In the lab session, representative examples related to the project were discussed. The students had to understand the goals of the project and to identify the useful learning content required to complete it. Each laboratory section consisted of approximately 20-22 students. Each student had to complete an individual project report and submit it through the Moodle environment.
The study comprised of two phases. In the initial phase, the students were asked to participate in the survey before attending the course. In specific, the students were given a 20 minute presentation explaining the basic features of the Moodle environment and how it was integrated to the course, since the students did not have any previous Moodle experience. Similarly, after course completion, students were asked to participate again. The questionnaires were completed during the first and the last session, accordingly.

The formulation of the questionnaire (see Table A.1-Appendix) was based on the original TAM constructs. For each dimension, characteristics were adopted from previous research works, in an attempt to formulate a standardized instrument. In cases where such an adaptation was not applicable, or emphasis on specific aspects had to be given, self-developed questions were introduced, based on the objectives of the study. In addition, the initial part of the instrument contained demographic items such as academic year, gender, the number courses related to ICT currently being taken, skills in using specific ICT applications and the availability of Internet at home. All metrics were modeled in a seven-scale Likert approach and translated from English to Greek accordingly. In order to adjust on the specific study context, relative language customizations occurred, where applicable. The survey was migrated into a Web based environment through the use of the SurveyMonkey tool (www.surveymonkey.com) and students were informed on the Web location of the study. Participation was voluntary.

Data analysis approach

Both scenarios were analyzed using Partial Least Squares (PLS) path modeling. The software package used was SmartPLS version 2.0 M3 (Ringle, Wende & Will, 2005). The use of PLS for ‘predictive’ purposes (Gefen, Straub, & Boudreau, 2000, p. 25; Roldán & Leal, 2003, p.75) in conjunction with the limited requirements in terms of sample size (Chin, 1998), amongst all, signify PLS as a well established data analysis method in the literature, utilized in a plethora of empirical studies related with TAM and its variations or other theoretical frameworks in a diversity of domains (Katharaki et al., 2009; Saadé & Bahli, 2005; Saadé et al., 2007).

Results

Demographics

Regarding the pre-Moodle scenario, 130 students participated (127 female, 3 male, aged 18-32, mean age=19.2, sd=1.30). Concerning the post-Moodle scenario, a total of 102 students participated (99 female, 3 male), aged 18-32, mean=19.1, sd=1.37). The reduced participation at the second phase of the research may be explained by the voluntary nature of the study.

Partial Least Squares analysis

Results interpretation with PLS is related with the investigation of the measurement and the structural model respectively (Roldán & Leal, 2003, p.75). In particular, the measurement model is investigated in the basis of individual item loadings, construct reliability, convergent validity and discriminant validity (Roldán & Leal, 2003, p.75). Subsequently, the structural model is assessed, in order to deduce observations regarding the causal relationships and their significance.

Pre-Moodle Experience

Measurement model

With respect to individual item loadings (Table 2), values should exceed 0.7, as proposed by Chin (1998). The majority of the items exceeded 0.7. Exceptions include the items PU3 and PEOU4 which, however, produced values greater than 0.5, thus considered acceptable (Chin, 1998; Shepherd, Tesch, & Hsu, 2006, p.208). A key finding is the extremely low value of PU2 (0.252).
Table 2. Individual item loadings

<table>
<thead>
<tr>
<th>Item</th>
<th>Perceived Usefulness (PU) Value</th>
<th>Perceived Ease Of Use (PEOU) Value</th>
<th>Attitude Towards Use (ATT) Value</th>
<th>Behavioral Intention (BI) Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>PU1</td>
<td>0.755</td>
<td>PEOU1 0.815</td>
<td>ATT1 0.795</td>
<td>BI1 0.924</td>
</tr>
<tr>
<td>PU2</td>
<td>0.252</td>
<td>PEOU2 0.797</td>
<td>ATT2 0.786</td>
<td>BI2 0.874</td>
</tr>
<tr>
<td>PU3</td>
<td>0.553</td>
<td>PEOU3 0.82</td>
<td>ATT3 0.837</td>
<td>BI3 0.779</td>
</tr>
<tr>
<td>PU4</td>
<td>0.786</td>
<td>PEOU4 0.624</td>
<td>ATT4 0.868</td>
<td></td>
</tr>
<tr>
<td>PU5</td>
<td>0.821</td>
<td>PEOU5 0.703</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Construct reliability was assessed in terms of Cronbach’s alpha and composite reliability (Roldán & Leal, 2003), with emphasis on composite reliability, as described in Henseler, Ringle and Sinkovics (2009, p.299). According to Nunnally (as cited in Roldán & Leal, 2003, p.75), a value of 0.7 should be used as a threshold. All constructs produced satisfactory values for composite reliability while the majority of the constructs exceeded 0.7 in terms of Cronbach’s alpha (Table 3), except perceived usefulness (0.649). Continuously, convergent validity was investigated with regards to the values of the Average Variance Extracted (AVE), being greater than 0.5, as proposed by Fornell and Larcker (1981). In terms of convergent validity, all items produced values greater than 0.5 with the exception of perceived usefulness (0.446).

Table 3. Construct Reliability and Covergent Validity

<table>
<thead>
<tr>
<th>Construct</th>
<th>Cronbach’s alpha (α)</th>
<th>Composite Reliability</th>
<th>Average Variance Extracted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attitude towards Use (ATT)</td>
<td>0.840</td>
<td>0.893</td>
<td>0.676</td>
</tr>
<tr>
<td>Behavioral Intention (BI)</td>
<td>0.824</td>
<td>0.896</td>
<td>0.742</td>
</tr>
<tr>
<td>Perceived Ease Of Use (PEOU)</td>
<td>0.867</td>
<td>0.902</td>
<td>0.607</td>
</tr>
<tr>
<td>Perceived Usefulness (PU)</td>
<td>0.649</td>
<td>0.784</td>
<td>0.446</td>
</tr>
</tbody>
</table>

The assessment of discriminant validity was based on the Fornell and Larcker (1981) “criterion” (Henseler et al., 2009, p.300). As outlined in Table 4, the pre-Moodle scenario produced satisfactory results.

Table 4. Discriminant Validity

<table>
<thead>
<tr>
<th></th>
<th>Attitude towards Use</th>
<th>Behavioral Intention</th>
<th>Perceived Ease of Use</th>
<th>Perceived Usefulness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attitude towards Use</td>
<td>0.822</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Behavioral Intention</td>
<td>0.720</td>
<td>0.861</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Perceived Ease Of Use</td>
<td>0.516</td>
<td>0.438</td>
<td>0.779</td>
<td>0</td>
</tr>
<tr>
<td>Perceived Usefulness</td>
<td>0.636</td>
<td>0.508</td>
<td>0.572</td>
<td>0.668</td>
</tr>
</tbody>
</table>

Structural Model

In order to assess the structural model, a bootstrapping technique was applied (Chin, 1998; Gefen et al., 2000, p.27) (500 resamples). The examination of the t-values was based on a two-tail test with statistically significant levels of p<0.05 (*), p<0.01 (**) and p<0.001 (***)). Results are presented in Figure 1. Dotted lines highlight the insignificant paths.

In particular, the outcomes of the structural model in terms of direct effects, bootstrapping and t-statistics confirmed the majority of hypotheses, at various significance levels (Figure 1). In specific, perceived ease of use (PEOU) is associated with a very strong significant relationship with perceived usefulness (H5 at p<0.001 level). In addition, the relationship (H4) between perceived usefulness (PU) and attitude towards use (ATT) along with the relationship (H1) of attitude towards use and behavioral intention (BI) to use Moodle as an e-learning platform were confirmed with high significance as well (p<0.001). Moreover, perceived ease of use affects positively the attitude towards use with a significant relationship (H3 at p<0.05). Finally, the relationship between perceived usefulness and behavioral intention (H2) did not prove to be significant.
Post-Moodle Experience

Measurement Model

With regards to individual item loadings, the majority of the items produced values greater than 0.7 (Chin, 1998) while item PU2 produced a low value (0.307), putting its reliability under further investigation. Slight variations are also related with the values for PU1, PU3, PEOU4 and BI3 but these are above the value of 0.5 for acceptable results (Shepherd et al., 2006, p. 280) while also either tend to reach or are very close to 0.7 (Table 5).

Table 5. Individual item loadings

<table>
<thead>
<tr>
<th>Perceived Usefulness (PU)</th>
<th>Perceived Ease Of Use (PEOU)</th>
<th>Attitude Towards Use (ATT)</th>
<th>Behavioral Intention (BI)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Item</strong></td>
<td><strong>Value</strong></td>
<td><strong>Item</strong></td>
<td><strong>Value</strong></td>
</tr>
<tr>
<td>PU1</td>
<td>0.643</td>
<td>PEOU1</td>
<td>0.808</td>
</tr>
<tr>
<td>PU2</td>
<td>0.307</td>
<td>PEOU2</td>
<td>0.887</td>
</tr>
<tr>
<td>PU3</td>
<td>0.699</td>
<td>PEOU3</td>
<td>0.819</td>
</tr>
<tr>
<td>PU4</td>
<td>0.771</td>
<td>PEOU4</td>
<td>0.684</td>
</tr>
<tr>
<td>PU5</td>
<td>0.776</td>
<td>PEOU5</td>
<td>0.859</td>
</tr>
<tr>
<td>PEOU6</td>
<td>0.815</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

With regards to internal consistency (Table 6), all constructs produced values greater than 0.7 for both Cronbach’s alpha and composite reliability, according to Nunnally (as cited in Roldán & Leal, 2003, p.75) with the exception of perceived usefulness which retains a value below 0.7 for Cronbach’s alpha (0.654). In terms of convergent validity, the values of the AVE exceeded 0.5, as proposed by Fornell and Larcker (1981), with the exception of perceived usefulness (0.439).

Table 6. Construct Reliability and Convergent Validity

<table>
<thead>
<tr>
<th>Construct</th>
<th>Cronbach’s alpha (α)</th>
<th>Composite Reliability</th>
<th>Average Variance Extracted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attitude towards Use (ATT)</td>
<td>0.808</td>
<td>0.874</td>
<td>0.634</td>
</tr>
<tr>
<td>Behavioral Intention (BI)</td>
<td>0.743</td>
<td>0.856</td>
<td>0.667</td>
</tr>
<tr>
<td>Perceived Ease Of Use (PEOU)</td>
<td>0.906</td>
<td>0.928</td>
<td>0.684</td>
</tr>
<tr>
<td>Perceived Usefulness(PU)</td>
<td>0.654</td>
<td>0.784</td>
<td>0.439</td>
</tr>
</tbody>
</table>

At last, the generated results pinpoint satisfactory discriminant validity, based on the Fornell and Larcker (1981) “criterion” (Henseler et al., 2009, p.300) for the post-Moodle scenario, as outlined in Table 7.

Table 7. Discriminant Validity

<table>
<thead>
<tr>
<th></th>
<th>Attitude towards Use</th>
<th>Behavioral Intention</th>
<th>Perceived Ease of Use</th>
<th>Perceived Usefulness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attitude towards Use</td>
<td>0.796</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Behavioral Intention</td>
<td>0.597</td>
<td>0.817</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Perceived Ease of Use</td>
<td>0.604</td>
<td>0.576</td>
<td>0.827</td>
<td>0</td>
</tr>
<tr>
<td>Perceived Usefulness</td>
<td>0.551</td>
<td>0.482</td>
<td>0.607</td>
<td>0.662</td>
</tr>
</tbody>
</table>
Similarly to the pre-Moodle scenario, the assessment of the structural model was based on a bootstrapping technique (Chin, 1998; Gefen et al., 2000, p.27) (500 resamples). The t-statistics values were also based on a two-tail test with the same significance levels: p<0.05 (*), p<0.01 (**) and p<0.001 (***) . Results are presented in Figure 2. Based on the outcomes, all hypotheses were confirmed in various significant levels. Emphasis should be given, however, to the very strong significant relationship (p<0.001 level) between perceived ease of use and perceived usefulness (H5) and also between attitude towards use and behavioral intention to use Moodle as an e-learning platform (H1). In addition, perceived usefulness proved to have a positive effect on behavioral intention (H2) (significant at p<0.05 level) while also perceived ease of use affects positively the attitude towards use with a significant relationship (H3) (p<0.05). At last, perceived usefulness proved to have a positive effect on attitude toward use (H4) at (p<0.05) level as well.

![Figure 2. Structural model for the post-Moodle scenario](image)

**Comparative analysis and remarks**

The study findings produce certain similarities and differences for the two scenarios, in terms of the assessments of the measurement and the structural model. With regards to the measurement model, the majority of the 18 items produced reliable results in both scenarios. Some items produced certain differentiations but were still considered acceptable whereas a major observation is related with item PU2. This item produced extremely low values at both scenarios, putting its reliability under question and being a candidate for exclusion. However, according to Henseler et al. (2009), special caution is needed in the case of rejecting indicators with low values while such actions should be performed only when achieving “substantial increase of composite reliability” (p.299). A subsequent decision was to leave item PU2 intact, by focusing on the already achieved high values of PU in terms of composite reliability for both scenarios (Tables 3 and 6). At last, with regards to convergent validity, the AVE of PU in both scenarios produced values which were relatively close but below the threshold limit whereas discriminant validity results were satisfactory. Subsequently, the structural model per scenario was assessed, with the assumption that the PU insufficiency at the AVE level is a notable exception amongst satisfactory results for both scenarios (in terms of constructs overall AVE values, satisfactory discriminant validity, composite reliability and individual item loadings). However, the inadequacy observed in relation with PU and its measures is notable and contributes to future work in terms of analysis and experimentation.

In terms of the structural model, observations were deduced in relation to the similarities and differences of the results produced at the two scenarios (Figure 1 and 2). In particular, H1 and H5 were proved to be highly significant (at p<0.001 level) at both scenarios, whereas H3 also retained a significant level of p<0.05 at both pre- and post-Moodle assessments. On the contrary, H4 was characterized by a very strong significant level (p<0.001) at the pre-Moodle session but proved to be significant at p<0.05 at the post-Moodle session. H2 also performed differently between the two sessions, with a non-significant level at the first scenario and a significant level of p<0.05 at the second one respectively.

In terms of predictive strength, the pre-Moodle scenario produced a value of 0.523 for the $R^2$ of behavioral intention, thus explaining 52.3% of the variance in BI. For the post-Moodle scenario, $R^2$ was found to be 0.39, explaining 39% of the variance in behavioral intention. Both values provide consistency with previous results. In specific, Saadé et al. (2007) utilizing TAM for evaluating a multimedia environment, produce a value of 0.38 for the $R^2$ of BI. Other studies that enrich and extend TAM produce values varying from 0.26 (Saadé & Bahli, 2005) to 0.44 (Ong et al., 2004; see also Table 8).
Discussion

As shown previously, in both scenarios students perceived the relation of ease of use and usefulness as a key factor for adopting Moodle (H5). The post-Moodle attitude of students remains intact, providing similarities of the outcomes amongst a variety of research works (Lee et al., 2005; Masrom, 2007; Ngai et al., 2007; Ong et al., 2004; Saadé & Bahli, 2005; Saadé et al., 2007, see Table 8).

Table 8. Findings from previous research works

<table>
<thead>
<tr>
<th>Author(s)</th>
<th>Theoretical model &amp; Data analysis approach</th>
<th>Confirmed hypotheses</th>
<th>Rejected Hypotheses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Katharaki et al., (2009)</td>
<td>TAM. Data analysis performed with PLS.</td>
<td>PU→ATT, ATT→BI</td>
<td>PEOU→ATT, PEOU→PU, PU→BI</td>
</tr>
<tr>
<td>Lee et al. (2005)</td>
<td>Extended TAM with the addition of “Perceived Enjoyment” (coded as ENJOY). Data analysis performed with co-variance based SEM (LISREL)</td>
<td>PU→BI, EOU→PU, PU→ATT, EOU→ENJOY→ATT, ENJOY→BI</td>
<td>EOU→ATT</td>
</tr>
<tr>
<td>Masrom (2007)</td>
<td>TAM. Data analysis performed using separate linear regression analysis.</td>
<td>PEOU→PU, PEOU→ATT, PU→BI, PU→ATT</td>
<td>ATT→BI</td>
</tr>
<tr>
<td>Ngai et al., (2007)</td>
<td>Extended TAM. Data analysis performed with SPSS and AMOS4</td>
<td>PEOU→ATT, PEOU→PU, PEOU→USE*, PU→ATT, PU→USE*</td>
<td>PU→BI, ATT→BI, ATT→USE*</td>
</tr>
<tr>
<td>Ong et al. (2004)</td>
<td>Extended TAM, excluding “Attitude towards Use”. Data analysis performed with co-variance based SEM (LISREL)</td>
<td>PEOU→PU, PU→BI, PEOU→BI</td>
<td>PEOU→BI, PEOU→PU</td>
</tr>
<tr>
<td>Saadé &amp; Bahli (2005)</td>
<td>Extended TAM, excluding “Attitude towards Use”. Data analysis performed with PLS.</td>
<td>PU→BI, PEOU→PU, PEOU→BI</td>
<td></td>
</tr>
<tr>
<td>Saadé et al. (2007)</td>
<td>TAM. Data analysis performed with PLS.</td>
<td>PU→BI, PU→ATT, PEOU→PU, ATT→BI</td>
<td>PEOU→BI</td>
</tr>
</tbody>
</table>

PU=Perceived Usefulness, PEOU/EOU=(Perceived)Ease of Use, ATT=Attitude Towards Use, BI=Behavioral Intention, USE=Use, ENJOY=Enjoyment, n.a.=not applicable, *= not tested at the current study.

Furthermore, the impact of attitude towards using Moodle in behavioral intention proved to have a very strong significant relationship (H1) in both pre-Moodle and post-Moodle settings. Such a finding underlines the fact that if students have an overall positive view of the system, then they intend to use it. This finding is also aligned with outcomes from other researchers (Katharaki et al., 2009; Lee et al., 2005; Saadé et al., 2007; see also Table 8).

Another notable observation is the relation between perceived ease of use and attitude towards use (H3). A significance level of p<0.05 was observed in both scenarios, highlighting the role of ease of use in the attitude towards using a system, in accordance with similar studies (Katharaki et al., 2009; Masrom, 2007; Ngai et al., 2007). However, the relationships of perceived usefulness and behavioral intention along with the one of perceived usefulness and attitude towards use, produced discontinuities in terms of results at the two scenarios. Perceived usefulness did not prove to have a significant effect on behavioral intention at the pre-Moodle setting whereas at the post-Moodle context, it appeared to have a significance at p<0.05 level. Such a finding may be explained by the hypothetical nature of the pre-Moodle assessment. Students did not anticipate the actual e-learning implementation, thus they did not associate usefulness with intention to use. However, such finding contradicts the results obtained for the relationship of perceived usefulness and attitude towards use. At the pre-Moodle scenario, students seem to highly appreciate this relationship whereas at the second scenario, this relationship still remains significant but at a lower level. A possible interpretation may include the deduction that in the pre-Moodle scenario students could not
assess the effect of usefulness to actual intention to use, since they did not have an actual Moodle implementation in mind in order to assess it. However, perceptions regarding usefulness positively influence the attitude towards using such a technology. With regards to the post-Moodle implementation, students’ assessment is based on beliefs and opinions gained through the actual use of the system. Consequently, their observations are pragmatic and provide a more realistic view. This stresses the importance of further dissemination of blended learning’s benefits to encourage increased adoption. Overall, the diversity of the findings in terms of the effect of usefulness to behavioral intention and the attitude towards use may be also related with the inadequacies, in terms of reliability, observed for the dimension of perceived usefulness (mainly related with the low value of PU2 item and the produced AVE values for PU at both scenarios) in the context of the current study, putting this under further investigation.

Conclusions and future work

In this paper, LCMS acceptance in the context of a university course offered using a blended learning approach is investigated. The findings obtained show that both ease of use and perceived usefulness have a positive effect on attitude toward use. The students’ perceptions in a blended learning setting found to be comparable with other studies reporting perceptions in the context of distant learning, with certain differentiations. For instance, Lee et al. (2005) report that perceived ease of use did not posit a significant impact on Hong Kong students’ attitude toward LCMS usage. In the present study, relationships were confirmed for both pre-Moodle and post-Moodle scenarios, except of the effect of perceived usefulness to behavioral intention, resulting as significant only after real experience from the students. This finding stresses that the actual use of a system is a key determinant of its usefulness by users, despite any hypothetical clauses prior to use. This could be also partially attributed to the finding that perceived ease of use seems to be more salient to women (Ong & Lai, 2006), since 126/130 and 99/102 of the participants in the study were females.

The current study is not without limitations. In the pre-Moodle scenario, despite the extensive description and the detailed presentation of features, students could not fully anticipate the added value of such initiatives before they actually use them. Moreover, the mandatory nature of Moodle use during the course, may influence students’ attitudes. Also, the participants were mainly female students and from one university department related to Educational Sciences. Students’ attitudes may vary if a more balanced sample in terms of gender and study objective is taken into account. However, the context of the current study produced certain observations about the relationships of the TAM model in a blended learning setting. The importance of the results obtained is increased by taking into account the consideration that little is known about students’ perceptions in such settings, especially in the context of Greek higher education.

Further studies including more aspects such as credibility, privacy and computer anxiety (Ong et al., 2004; Sun et al., 2008) should be conducted to obtain a deeper understanding of the factors influencing attitudes towards blended learning adoption. For instance, students’ privacy concerns and perceived risks in interacting with LCMS have received little attention. Such an issue requires further research since technological advances offer rich learning possibilities but the educational community may develop privacy concerns during use, thus constraining the aimed benefits (Corritore, Marble, Kracher & Wiedenbeck, 2005; Joinson, Mckenna, Postmes & Reips, 2007). In addition, as derived from this study as well as from related works examining acceptance of e-learning, deep understanding of all learners’ personal cognitive strategies or information processing behaviors is required in order to provide a suitable information architecture that promotes the learning process (Tseliros & Avouris, 2003, Tseliros et al., 2008a,b). Future work will focus on the above issues as well as on understanding of the several attitudes and beliefs with regards to computer-literate participants opposed to people with limited technology background. A series of moderating factors may also be introduced, such as gender, age differences (Venkatesh, Morris, Davis, B., & Davis, D., 2003) and organizational issues.

References


## Appendix Table A.1 – Study Questionnaire

<table>
<thead>
<tr>
<th>Constructs &amp; Items</th>
<th>Question</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Perceived Usefulness (PU)</strong></td>
<td></td>
</tr>
<tr>
<td>PU1</td>
<td>The use of Moodle will enable me/enables me to accomplish tasks more quickly*</td>
</tr>
<tr>
<td>PU2</td>
<td>Using Moodle will reduce/reduces my performance at the lab sessions*</td>
</tr>
<tr>
<td>PU3</td>
<td>Using Moodle will enhance/enhances my effectiveness at the lab sessions*</td>
</tr>
<tr>
<td>PU4</td>
<td>By using Moodle it will be easier/ it is easier for me to follow and study the course material**</td>
</tr>
<tr>
<td>PU5</td>
<td>Overall, I find Moodle useful*</td>
</tr>
<tr>
<td><strong>Perceived Ease Of Use (PEOU)</strong></td>
<td></td>
</tr>
<tr>
<td>PEOU1</td>
<td>Learning to operate Moodle will be/is easy for me*</td>
</tr>
<tr>
<td>PEOU2</td>
<td>Navigating within Moodle will be/is easy for me**</td>
</tr>
<tr>
<td>PEOU3</td>
<td>My interaction with Moodle will be /is clear and understandable*</td>
</tr>
<tr>
<td>PEOU4</td>
<td>I think that Moodle will be /is flexible to interact with* (modeled as a reverse question)</td>
</tr>
<tr>
<td>PEOU5</td>
<td>It will be/it is easy for me to become skillful at using Moodle* (modeled as a reverse question)</td>
</tr>
<tr>
<td>PEOU6</td>
<td>Overall, I find Moodle easy to use*</td>
</tr>
<tr>
<td><strong>Attitude Towards Use (ATT)</strong></td>
<td></td>
</tr>
<tr>
<td>ATT1</td>
<td>The idea of using Moodle is: (very bad _ very good)</td>
</tr>
<tr>
<td>ATT2</td>
<td>The idea of using Moodle is: (very foolish _ very wise)</td>
</tr>
<tr>
<td>ATT3</td>
<td>Using Moodle would be/is: (very unpleasant _ very pleasant)</td>
</tr>
<tr>
<td>ATT4</td>
<td>Using Moodle is an idea: (dislike very much _ like very much)</td>
</tr>
<tr>
<td><strong>Behavioral Intention (BI)</strong></td>
<td></td>
</tr>
<tr>
<td>BI1</td>
<td>Assuming Moodle availability in other courses, I will use it</td>
</tr>
<tr>
<td>BI2</td>
<td>I intend to use frequently Moodle in the frame of other courses using blended learning</td>
</tr>
<tr>
<td>BI3</td>
<td>I intend to choose more courses using Moodle in the next semesters</td>
</tr>
</tbody>
</table>

* Davis (as cited in Legris, Ingham & Collerette, 2003, pp. 197-199)
** Self developed
*** Lee et al. (2005, p.1100)
**** Self-developed, influenced by Venkatesh et al. (2003, p.460) and Lee et al. (2005, p.1100)
Podcasting in Education: Student Attitudes, Behaviour and Self-Efficacy

Andrea Chester, Andrew Buntine, Kathryn Hammond, Lyn Atkinson

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ABSTRACT

The aim of the present study was to describe the characteristics of podcast users, compare uptake across courses, examine preferred modes of use and satisfaction, assess the impact of podcasts on lecture attendance, and evaluate reasons for use and non-use. Participants were 273 undergraduate students enrolled in six diverse courses at a large Australian university. Results suggested differences in uptake and satisfaction across courses, with later year students more satisfied than first year students. Although podcast users were older, worked longer hours in paid employment, and attended fewer lectures than those who did not use podcasts, results also suggest that users had more contact with staff and reported higher levels of academic self-efficacy than non-users. Suggestions for improvements to current podcasting provisions are offered and directions for future research are provided. In particular the need to tap into the use of podcasts for examination revision is highlighted.

Keywords
Podcast, Self-efficacy, Students, Attitudes, Behaviour

Many universities now routinely offer web-based lecture recordings or podcasts. Although recording material for students is not new to education, growing attention has been given to podcasting in the last decade with technological changes that make producing and accessing lecture recordings increasingly easy. The issue occupies a growing slice of the educational literature, with both theoretical and empirical articles on the topic. As Harris and Park (2008) note, educational podcasts can serve a range of purposes from augmenting teaching through to recruiting new students, providing tours of the university, and offering pastoral care. Research has tended to focus on the first of these and within this category studies have examined student behaviour and perceptions of podcasting, the impact of podcasting on student learning, and staff responses. Although these three areas are interrelated, this article focuses on the first: student use and attitudes.

Studies of student use and attitudes towards podcasting began to appear in the literature in 2006 and a picture of student behaviour and satisfaction is beginning to emerge. Generalising from this research, however, needs to be conducted with some caution as studies vary on a range of dimensions including the ways in which podcasts have been incorporated into courses, disciplines examined, size of courses and response rates, the time of semester at which the surveys were conducted, and the methods (paper versus online) of survey administration.

Podcasts have been incorporated into the curriculum in a variety ways to meet a range of learning objectives. The most commonly reported use of podcasts involves recording of face-to-face lectures (e.g., Gosper, McNeill, Woo, Phillips, Preston, & Green, 2007; Lightbody. McCullagh, Hughes, & Hutchison, 2007; McElroy & Blount, 2006; McKenzie, 2008; Maag, 2006; van Zanten, 2008; Williams & Fardom, 2007). Other researchers have reported using podcasts to record tutorials (Tynan & Colbran, 2006) and deliver short recordings or “episodes” of core (Clark, Taylor, & Westcott, 2007; Laing & Wootton, 2007) or supplementary material (Bell, Cockburn, Wingkvist, & Green, 2007). Podcasts have also been used to provide glossaries of key terms (Lightbody et al., 2007) and as a feedback mechanism for lecturers to communicate with individuals and groups on assessment tasks (Maag, 2006; McGregor, Merchant, & Butler, 2008). A smaller number of studies have examined the use of student-generated podcasts (Petrovic, Kennedy, Chang, & Waycott, 2008).

Irrespectively of the form of podcasting, student satisfaction is typically strong and students generally perceive podcasts to have enhanced their learning (Goldberg & McKhann, 2000; Maag, 2006; Soong, Chan, Cheers, & Hu, 2006). For example, in a large Australian study involving four universities, 80% of students indicated that podcasts made it easier for them to learn and two-thirds noted that the recordings helped them achieve better results (Gosper et al., 2007). In smaller studies, podcasts have been rated as an important component of the course (McElroy & Blount, 2006) and as more crucial to the learning experience than attending lectures (McKenzie, 2008). Whether podcasts actually facilitate learning and/or help students achieve better grades is, however, unclear. Assessing the impact of podcasting on learning outcomes is complex given the inherent difficulties in determining the influence of any single variable on the process of learning as well as the logistical and ethical issues involved in experimental research in...
this area. Nevertheless, quasi-experimental research comparing naturally occurring groups of podcast users and non-users may yield some useful information.

Research on student use and satisfaction of podcasts has included a range of disciplines, most typically with a focus on the sciences, including health sciences, as well as business. Disciplines include: computer science, (Bell et al., 2007; Laing & Wootton, 2007; Lightbody et al., 2007; Ogawa & Nickles, 2007), information systems (Janossy, 2007; Laing & Wootton, 2007), marine science (Copley, 2007), medical science (Laing & Wootton, 2007), medicine (Petrovic et al., 2008), nursing (Maag, 2006), psychology (McKenzie, 2008), law (Tynan & Colbran, 2006), accounting (McElroy & Blount, 2006), economics (Clark et al., 2007), and marketing (van Zanten, 2008). Few studies to date have examined differences in uptake or satisfaction between these courses.

Sample size also varies considerably between studies, with an institution-wide study at the University of Western Australia reporting the largest sample of more than 1000 students (Williams & Fardon, 2007) through to relatively small cohorts of less than 50 in studies of a single course (e.g., Lightbody et al., 2007). Similarly response rates differ, with a high of 90% noted by Janossy (2007) in his survey of 83 Information Systems students and a low response rate of 16% reported in the large cross-institutional study of Gosper et al. (2007). The majority of studies list response rates around 30-40%, although unfortunately this information is not always reported.

A further way in which studies differ and a variable that may impact on response rate is the method by which surveys have been administered. Surveys of student attitudes typically use questionnaires administered in lectures or online versions. In some cases (e.g., McKenzie, 2007) both paper and online versions have been used. Although online administration of questionnaires amongst students is often associated with poor response rates (Johnson, 2002), research on podcasting, an online version of the questionnaire makes good sense. Active podcast users may not attend lectures. Questionnaires administered in class may therefore include a skewed sample. Despite this, some studies have only used paper-based surveys conducted in class (e.g., McElroy & Blount, 2006).

Nearly all studies of student attitudes include self-reported use of podcasts. Typically more than 50% of students report using podcasts. For example, Clark et al. (2007) reported 63% use amongst economics students and McElroy and Blount (2007) recorded 79% of the 400 accounting students in their sample using the weekly podcasts. Students report a range of reasons for using podcasts including picking up missing information, revisiting complex material, working through material at one’s own pace, and catching up on a lecture that was missed. Examination revision, however, is typically the most frequently reported reason for using podcasts (Copley, 2007; Gosper et al., 2007; Janossy, 2007; Laing & Wootton, 2007; Williams & Fardon, 2007). Analyses of hit rates support this, revealing an increase in use of recordings in the week prior to examinations (Copley, 2007; Lightbody et al., 2007). The time in semester when students are surveyed is therefore likely to impact on students’ reported use. Surveys conducted at the end of semester before examinations may underestimate actual use as some students may not take advantage of podcasts until they begin studying for examinations.

Most of the studies of student attitudes towards podcasts have been descriptive, building up the picture presented above of the proportion of students using podcasts, their reasons for use, and satisfaction with them. In addition, a number of other variables have been proposed as potentially important in understanding podcast use and satisfaction, including learning styles (Gosper et al., 2007; McKenzie, 2008), non-English speaking background (Copley, 2007; Gosper et al., 2007), impact of delivery mode e.g., external or distance (van Zanten, 2008).

Another variable sometimes thought to impact on podcast use is age. Given suggestions of age-related differences in educational expectations (Oblinger & Oblinger, 2005) and descriptions of Gen Y as “digital natives”, the impact of age on podcasting has been examined. Do younger students have more positive attitudes to podcasting than older students? Research supports few age-related differences. For example, in their large Australian study, Gosper et al. (2007) reported only two age-related differences. Older students were more likely to use podcasts to work through material at their own pace and were less likely than younger students to use the podcasts because the lecturer did not speak clearly. Research on students’ mp3 player use to access lecture recordings, reported no age-related differences (Williams & Fardon, 2007). The failure to find widespread age differences in podcasting attitudes may be explained by emerging research challenging the “digital native” description of young students. Kennedy et al. (2007) noted considerable variation in technology uptake amongst the 2588 first year students surveyed. They conclude “we must be wary of overgeneralising the distinctive features of this generation, as individuals or as a group, their lifestyles or their learning styles based on assumptions about technology use or preferences” (p.522). As a result caution is suggested in assuming young students will be proficient and confident accessing podcasts.
One variable that does not appear to have been examined to date is academic self-efficacy. Academic self-efficacy is a student’s judgment of their ability to perform the actions required for success. Students with higher academic self-efficacy would be expected to put more effort into tasks and be more persistent in their academic pursuits (Sander & Sanders, 2006). Academic self-efficacy predicts academic performance (Elias & MacDonald, 2007; Lent, Brown, & Gore, 1997) and is negatively related to anxiety (Saks, 1994). It is unclear how academic self-efficacy might be related to lecture recording use, but understanding the relationship offers potential insight into the kinds of students who use lecture recordings.

The impact of podcasting on lecture attendance has been examined. Much has been made in the literature about the potential decline in lecture attendance if podcasts are introduced; a concern often raised by staff (Buxton, Jackson, deZwart, Webster, & Lindsay, 2006; Chang, 2007; Phillips, McNeill, Gosper, Woo, Preston, & Green, 2007). Williams and Fardon (2007) reported a perceived decrease in lecture attendance amongst more than 50% of lecturers using recordings. Similarly just over half the lecturers in a study by Phillips et al. (2004) noted that student attendance had decreased following the introduction of lecture recordings. Research using student self-reports tells a different story however. Several studies have failed to note a self-reported reduction in face-to-face attendance (Copley, 2007; Maag, 2006; Mayer, 2006). Further, Williams and Fardon (2007) concluded that those students who used lecture recordings regularly were those most likely to report regular lecture attendance. Although it might be unsurprising to hear that students continue to attend lectures when audio only recordings are available, it is of note that these findings have also been reported for recordings with video content.

One way to resolve the problem of relying on either staff perceptions or student self-reports is to conduct headcounts. Headcounts are not common in the literature, but McElroy and Blount (2006) reported that lecture attendance remained consistently high despite the introduction of podcasts, so presumably headcounts were conducted. McKenzie (2008) had lecturers conduct headcounts in end of semester classes to assess actual attendance and noted that the 28% attendance rate accorded with the 30% of students who said they attended all lectures. Although it not clear to what extent the attendance rate can be attributed to the availability of podcasts, it is of note that the most frequent reason cited for using the audio recordings in this study was “to catch up on a missed lecture”. While there is little support for the idea that podcasts will reduce lecture attendance. There is, however, a shortage of objective data in this area.

In summary, many universities now routinely offer web-based lecture recordings – or podcasts – and the practice is becoming well-represented in the educational literature. Research tends to focus on the use of podcasts to augment classroom teaching. Students generally perceive podcasts to have enhanced their learning, and consider the recordings as more crucial to the learning experience than attending lectures. Whether podcasts actually facilitate learning and/or help students achieve better grades is, however, unclear. Given students’ use of podcasts for examination revision, the time in semester when students are surveyed is therefore likely to impact on students’ reported use. Surveys conducted at the end of semester before examinations may underestimate actual use as some students may not take advantage of podcasts until they begin studying for examinations.

The impact of podcasting on lecture attendance has been examined, and is a concern often raised by academic staff. Research using student self-reports tells a different story, however – those students who used lecture recordings regularly were those most likely to report regular lecture attendance. One way to resolve the problem of relying on either staff perceptions or student self-reports is to conduct headcounts.

A number of variables have been proposed as potentially important in understanding podcast use and satisfaction, including learning styles, non-English speaking background, impact of delivery modality and age. One variable that does not appear to have been examined to date is academic self-efficacy. Understanding the relationship between academic self-efficacy and the use of augmentative resources (such as lecture recordings) may offer potential insight into student preferences and outcomes.

**Purpose**

The current research was undertaken in the first year of the full implementation of Lectopia at RMIT University. This research was part of a larger study examining both staff and student responses to the university-wide initiative. Only student attitudes and use are reported here.
Lectopia was made available in a range of large lecture theatres, providing audio and screen capture. The system operated under an ‘opt-in’ model, with individual lecturers indicating their intention to record lectures (and preferences for individual elements: audio, screen-capture, etc) via an online booking form. Recording was then triggered automatically for the duration of the class, as per the University timetable system. Download and streaming options enabled access to the recordings on demand within a few hours of the face-to-face lecture.

**Research aims**

The aims of the research were to:
- compare podcast users and non-users by demographic variables, as well as course and year level;
- assess student satisfaction with podcasts;
- compare the academic behaviour and academic self-efficacy of podcast users and non-users;
- examine preferred modes of podcast use; and,
- evaluate reasons for podcast use and non-use.

**Method**

**Participants**

The total number of respondents to the first survey, conducted during semester, was 288 (169 female, 118 male, 1 unidentified), representing a response rate of 43.24%. Mean age was 21.7 years ($SD=4.61$), although considerable variability was noted across disciplines, with one first-year course reporting a mean age of 20.01 ($SD=3.90$) and one third-year course a mean of 27.88 ($SD=7.73$). The majority of students (78.8%) spoke English as a first language and studied full-time (95.5%). The students worked, on average, 12 hours a week ($SD=10.24$). Participation in the second survey, conducted following the examination period, was lower than the first, with a total of 81 (44 female, 37 male) respondents, representing a response rate of 12.16%. Demographic characteristics were similar to the first survey.

**Measures**

The two surveys developed for this study used a range of items from previous research (e.g., Clark et al., 2007; Gosper et al., 2007; McElroy & Blount, 2006). The first questionnaire included 26 scale response and open-ended questions covering demographic details, (age, sex, English as a first language), lecture attendance, academic staff contact, knowledge and use of lecture recordings, reasons for using lecture recordings or choosing not to use the lecture recordings, details of where, how and how often recordings were accessed, intention to use lecture recordings for examination revision, and two questions about the perceived usefulness of Lectopia in the specific course and in general. Also included was the Academic Behavioural Confidence Scale (ABC; Sander and Sanders, 2006). This 24-item scale measures academic self-efficacy in six areas: studying, grade achievement, attendance, clarification, understanding, and verbalising. Responses are completed on a five-point Likert scale, from very confident to not at all confident. The scale has adequate psychometric properties and a total ABC score has been used to distinguish between different student groups (Sander & Sanders, 2006). The internal reliability of the ABC in the present study was good; Cronbach’s $\alpha = .92$.

The second questionnaire consisted of 20 questions, focusing on the use of lecture recordings for examination revision. Eleven questions from the first questionnaire were repeated in the second questionnaire, including demographic questions, and reasons for using or choosing not to use lecture recordings. In addition, questions assessed the number of lectures attended, number of recordings accessed for examination revision, perceived usefulness of lecture recordings for examination revision, and grade attained.

**Procedure**

A global email was sent to all course coordinators who were registered to use Lectopia inviting them to participate and a sample of those who volunteered were selected to represent the major campuses of the University, different years of undergraduate study, and all three Colleges: Business; Design and Social Context; and Science, Engineering
and Health. Participants were recruited from 7 undergraduate courses in which lecture recordings were provided via Lectopia. Due to a low response rate (7.59%) to the first survey in one course, this course was removed from the analysis.

The first survey was administered in hard copy in class in Week 10. In addition an electronic version of the questionnaire was provided via the online learning management system for students who did not attend the lecture on that day. The second survey was administered after the examination period and was provided in electronic format only. The URL for the questionnaire was emailed to students. Headcounts were conducted by the experimenters in all courses at Weeks 4, 8 and 12.

Ethics approval for the study was granted by the university.

Results

A small number of missing values were noted. These cases were deleted on a listwise basis.

Comparison of podcast users and non-users by demographic variables, course and year level

Data on self-reported use of podcasts for each course is summarised in Table 1. Overall, 42% of students had used lecture recordings when surveyed during the semester. After completion of examinations, uptake had increased to 70%.

Students who accessed the lecture recordings were significantly older ($M=22.34$, $SD=5.09$) than students who did not access them ($M=20.95$, $SD=3.96$), $t = 2.51$, df $= 264$, $p =.013$, two-tailed. In addition the students who used lecture recordings worked longer hours ($M=13.50$, $SD=10.85$) than those who did not use the recordings ($M=10.87$, $SD=9.76$), $t =1.98$, df $= 242$, $p =.049$, two-tailed. Uptake was unrelated to sex or English as a first language. Courses varied significantly in student self-reported uptake of lecture recordings, from less than one-quarter of students in first year Psychology to 100% of students in Social Work, ($F(5,117)=2.63$, $p<.027$). No differences were noted across year level.

Table 1. Self-Reported Podcast Use and Satisfaction by Course

<table>
<thead>
<tr>
<th>Course</th>
<th>Year</th>
<th>Total enrolled</th>
<th>Sample$^a$</th>
<th>Response rate$^a$</th>
<th>Accessed podcasts (during semester)</th>
<th>Accessed podcasts (for exam revision)</th>
<th>Mean satisfaction$^b$ (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Psychology 1</td>
<td>1</td>
<td>172</td>
<td>103</td>
<td>59.88</td>
<td>22.00</td>
<td>43.00</td>
<td>2.67 (1.55)</td>
</tr>
<tr>
<td>Marketing</td>
<td>1</td>
<td>166</td>
<td>41</td>
<td>24.70</td>
<td>56.10</td>
<td>66.45</td>
<td>3.62 (1.36)</td>
</tr>
<tr>
<td>Psychology 2</td>
<td>2</td>
<td>37</td>
<td>16</td>
<td>43.24</td>
<td>75.00</td>
<td>100</td>
<td>4.15 (1.21)</td>
</tr>
<tr>
<td>Software engineering</td>
<td>2</td>
<td>114</td>
<td>51</td>
<td>44.74</td>
<td>35.29</td>
<td>70.89</td>
<td>3.41 (1.56)</td>
</tr>
<tr>
<td>Chiropractic</td>
<td>3</td>
<td>104</td>
<td>43</td>
<td>41.35</td>
<td>51.16</td>
<td>86.67</td>
<td>3.71 (1.38)</td>
</tr>
<tr>
<td>Social work</td>
<td>3</td>
<td>73</td>
<td>17</td>
<td>23.29</td>
<td>100</td>
<td>66.33</td>
<td>4.29 (.92)</td>
</tr>
<tr>
<td>Total</td>
<td>666</td>
<td>288</td>
<td></td>
<td>43.24</td>
<td>42.00</td>
<td>70.02</td>
<td>3.49 (1.48)</td>
</tr>
</tbody>
</table>

$^a$ first survey  $^b$ scored out of 5

Satisfaction with podcasts

Mean satisfaction with podcasts is presented in Table 1. No sex differences were noted in satisfaction. Although age was related to podcast use, age was not correlated with satisfaction with lecture recordings. Satisfaction was not related to English as a first language. In summary there was no relationship between demographic variables and podcast satisfaction. A moderate positive correlation was noted between Lectopia use and satisfaction ($r=.357$, $N=118$, $p<.01$), suggesting, not surprisingly that students who use the recording more frequently rate them more
highly than students who use them less. In addition, perceived satisfaction varied by course ($F(5,136)=4.43$, $p=.001$) with the highest rates of satisfaction reported in the Social Work course and the lowest noted in first year Psychology. Year level was also related to satisfaction, with second and third year students rating the recordings more useful than first year students ($F(2,139)=8.91$, $p<.001$).

**Academic behaviour and academic self-efficacy**

Students were also asked to estimate their lecture attendance. Nearly half the respondents (48.5%) reported that they attended weekly and another 32.5% reported attending most weeks. Only 5% of students reported never attending lectures. Headcounts, conducted three times during the semester (Figure 1), did not, however, support these self-reports, with attendance rates of around or below 50% noted in all courses by Week 8.

![Figure 1. Headcount as a percentage of number enrolled](image)

A comparison of self-reported lecture attendance by podcast use is presented in Figure 2. Podcast users were less likely to attend lectures every week and more than twice as likely to report never attending lectures as non-users, however, few differences across the other attendance categories were evident. A chi-square analysis revealed no significant differences between podcast users and nonusers on self-reported lecture attendance.

![Figure 2. Lecture attendance by podcast use](image)

In order to explore level of engagement with staff amongst students using the podcasts, a composite score including face-to-face contact with staff, phone, email, and other online interaction, such as use of discussion boards, was calculated. This variable had a total possible score of 25. Contact with staff was higher for the Lectopia users ($M=11.55$, $SD=3.00$) compared to non-users ($M=10.35$, $SD=2.88$), $t(259)=3.27$, $p=.001$, two-tailed.
Students who used lecture recordings also scored significantly higher on academic self-efficacy than those who did not use the recordings (M=91.19, SD=12.58; M=87.21, SD=12.54), \( t(248)=2.48, p=.014 \), two-tailed (Table 2). Lectopia users scored higher than non-users on five of the six sub-scales of the academic self-efficacy measure, indicating greater confidence in their ability to study, understand, achieve good grades, verbalise and clarify compared to those students who did not access the lecture recordings. It is of note that the only area on which users did not demonstrate higher academic self-efficacy was class attendance.

**Table 2. Mean Academic Self-Efficacy Sub-Scale Scores by Podcast Use**

<table>
<thead>
<tr>
<th>Academic self-efficacy subscale</th>
<th>Lectopia use</th>
<th>t</th>
<th>p</th>
<th>d</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Users</td>
<td>Non-users</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>( (n = 121))</td>
<td>( (n = 164))</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Achieve good grades</td>
<td>3.92 (.56)</td>
<td>3.76 (.58)</td>
<td>2.25</td>
<td>.025</td>
<td>0.27</td>
</tr>
<tr>
<td>Attending</td>
<td>4.01 (.69)</td>
<td>3.96 (.68)</td>
<td>0.01</td>
<td>.546</td>
<td>0.07</td>
</tr>
<tr>
<td>Clarifying</td>
<td>3.89 (.61)</td>
<td>3.66 (.62)</td>
<td>2.99</td>
<td>.003</td>
<td>0.25</td>
</tr>
<tr>
<td>Studying</td>
<td>3.79 (.63)</td>
<td>3.59 (.62)</td>
<td>2.51</td>
<td>.013</td>
<td>0.32</td>
</tr>
<tr>
<td>Understanding</td>
<td>3.80 (.58)</td>
<td>3.63 (.63)</td>
<td>2.58</td>
<td>.010</td>
<td>0.28</td>
</tr>
<tr>
<td>Verbalising</td>
<td>3.46 (.83)</td>
<td>3.18 (.76)</td>
<td>2.87</td>
<td>.004</td>
<td>0.35</td>
</tr>
</tbody>
</table>

**Preferred modes of podcast use**

With respect to primary mode of lecture recording access, the majority of students (88.71%) accessed recordings off campus. Although downloading was the most popular method of access, used by 66.95%, it is of note that one-third of students used one of the streaming options. A small proportion of students chose to replay the files on their mp3 player (15.64%) rather than on computer. Even though screen capture was available for all recordings, the audio only option was chosen by 35.77%. During the semester students were more likely to view the entire lecture (67.7%) than access specific segments (32.2%). Students used a similar technique when studying for examinations, although students were more likely to access a specific section (44.10%) at this stage than earlier in the semester. When asked, during semester, when they accessed the recordings, 32.38% of students said they did so the same week of the lecture, 19.69% the following week and 31.50% later in the semester.

**Reasons for podcast use and non-use**

Students who used the lecture recordings indicated their major reasons for doing so (Table 3). During semester students cited examination revision as the most frequent motivation for using the podcasts. More than half the students (54.9%) thought it was likely they would use the podcasts for examination revision (11% more than were using Lectopia during semester). The second questionnaire suggested this was an underestimation; 71.6% of respondents noted they had used the podcasts for examination preparation. Students reported using on average 6.6 out of 12 lecture recordings \( (SD=3.99) \) for examination revision.

**Table 3. Reasons for Using Podcasts**

<table>
<thead>
<tr>
<th>Reason</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>To revise for exams</td>
<td>77</td>
<td>66.38</td>
</tr>
<tr>
<td>To revisit complex material, ideas and concepts</td>
<td>71</td>
<td>61.20</td>
</tr>
<tr>
<td>To work through the material at my own pace</td>
<td>60</td>
<td>51.72</td>
</tr>
<tr>
<td>Short-term illness preventing me attending</td>
<td>24</td>
<td>20.69</td>
</tr>
<tr>
<td>Work commitments keep me from attending</td>
<td>20</td>
<td>17.24</td>
</tr>
<tr>
<td>To better understand the language</td>
<td>19</td>
<td>16.38</td>
</tr>
<tr>
<td>Difficult to travel to attend lectures</td>
<td>16</td>
<td>13.79</td>
</tr>
<tr>
<td>Lecture clashes with another class</td>
<td>10</td>
<td>8.62</td>
</tr>
<tr>
<td>To hear administrative announcements</td>
<td>4</td>
<td>3.45</td>
</tr>
</tbody>
</table>
The 53% of students who had not used the lecture recordings noted their main reasons (Table 4). Of these students most did not think they needed the podcasts, but instead found attending the lectures sufficient for their learning. Nearly two-thirds of students were not sure how to access the podcasts and troublingly, a sizable group (44%) did not even know the podcasts existed. According to self-report, lack of computer access prevented only a small proportion of students using the podcasts.

**Table 4. Reasons for Not Using Podcasts**

<table>
<thead>
<tr>
<th>Reason</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
</tr>
<tr>
<td>The face-to-face lectures are sufficient for my learning</td>
<td>81</td>
</tr>
<tr>
<td>I prefer face-to-face lectures to Lectopia recordings</td>
<td>58</td>
</tr>
<tr>
<td>I am unsure how to access the files</td>
<td>29</td>
</tr>
<tr>
<td>I was not aware the recordings existed</td>
<td>20</td>
</tr>
<tr>
<td>Files are unreliable in terms of quality</td>
<td>13</td>
</tr>
<tr>
<td>Do not have a computer to access the files</td>
<td>3</td>
</tr>
</tbody>
</table>

In order to further explore non-users, the sample was split into three approximately equal groups on the basis of academic self-efficacy scores and reasons for non-use were compared across these three groups. Visual comparison of the groups shows that compared to students with moderate or high levels of academic self-efficacy, students with low academic self-efficacy were less likely to know how to access the podcasts and were most likely to report the files unreliable (Table 5).

**Table 5. Reasons for Not Using Podcasts by Academic Self-Efficacy Score (ASE)**

<table>
<thead>
<tr>
<th>Reason</th>
<th>Low ASE (&lt;84)</th>
<th>Moderate ASE (84-92)</th>
<th>High ASE (&gt;92)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n=93</td>
<td>%</td>
<td>n=79</td>
</tr>
<tr>
<td>The face-to-face lectures are sufficient for my learning</td>
<td>26 27.9</td>
<td>20 25.3</td>
<td>35 36.4</td>
</tr>
<tr>
<td>I prefer face-to-face lectures to Lectopia recordings</td>
<td>16 17.2</td>
<td>20 25.3</td>
<td>22 22.9</td>
</tr>
<tr>
<td>I am unsure how to access the files</td>
<td>16 17.2</td>
<td>9 11.4</td>
<td>4 4.2</td>
</tr>
<tr>
<td>I was not aware the recordings existed</td>
<td>10 9.3</td>
<td>7 8.9</td>
<td>3 3.2</td>
</tr>
<tr>
<td>Files are unreliable in terms of quality</td>
<td>11 11.8</td>
<td>1 1.3</td>
<td>1 1.0</td>
</tr>
<tr>
<td>Do not have a computer to access the files</td>
<td>1 1.1</td>
<td>1 1.3</td>
<td>1 1.0</td>
</tr>
</tbody>
</table>

Students were asked if they could request one change to the Lectopia system what it would be. In response 38% of students provided a comment. Six major themes emerged from these responses covering technical and pedagogical aspects: improvements to quality and reliability of the recordings (some lectures were not properly recorded and on some others lecturers did not wear the lapel microphone); decreased file size; chapterised recordings so the section of interest could more easily be located; the provision of clearer instructions for accessing recordings; including video of the lecturer, and extending the use of Lectopia to all lectures.

**Discussion**

Results of the present study suggest that both uptake and satisfaction with lecture recordings vary across courses, with satisfaction higher in later year courses than first year. Uptake was considerably lower when reported during the semester compared to self-report after examinations, confirming the use of lecture recordings for examination revision as a primary motivation. This finding is consistent with previous research (Copley, 2007; Gosper et al., 2007; Janossy, 2007; Laing & Wootton, 2007; Williams & Fardon, 2007), however, the low response rate to the survey conducted after the examination period means that this result should be interpreted with some caution.

Most demographic variables were unrelated to Lectopia use, including gender and English as a second language; however, age and hours of employment proved significant. Contrary to previous research older students were significantly more likely to report using podcasts than younger students. It is of note that 90% of respondents were
aged under 26, so many “older” students were still in the Generation Y age bracket. Nevertheless, just as Kennedy et al. (2007) cautioned against assuming that Gen Y students are technologically savvy, the results of the present study suggest that we also need to be careful not to assume the opposite of older students, who may in fact be keen to take advantage of learning and teaching innovation.

Hours of employment were related to use of podcasts and almost one-fifth of students noted that they used the podcasts because work commitments prevented them from attending face-to-face lectures. On the whole, however, podcasts did not appear to be used to replace lectures. Although podcast users were less likely to attend lectures every week than students who did not access the recordings, differences in self-reported lecture attendance between users and non-users were not significant and it is of note that the proportion of students who never attended lectures was low.

Despite debate about the value of lectures, they remain an integral part of learning and teaching in many disciplines. They can be useful, not just as a cost-effective means of delivering material, but for the role they play in helping lecturers quickly gauge understanding and for shaping communities of practice. Previous research has explored why students choose to attend lectures when podcasts were available. When asked this question students have emphasised a desire for “live” interaction and the value of being able to ask questions (Copley, 2007). Attending live lectures is also perceived by students to provide motivation and structure (Copley, 2007; McNeill, Woo, Gosper, Phillips, Preston, & Green, 2007). McNeill et al. (2007) concluded “We can surmise that lectures are important to many students’ learning and if useful visual aids are provided and a stimulating and motivating environment is created, students will choose to come to lectures if possible” (p.5). Results from the present study support this conclusion. More than 50% of students in the present study chose not to use the podcasts, relying solely on the face-to-face lectures and even for the majority of those who used the podcasts, lecture attendance remained the primary mode for accessing course content, with podcasts used to supplement material. The request by students for video of the lecturer suggests that non-verbal aspects of lectures are perceived to be useful.

A small proportion of students who used the podcasts did not attend lectures. Whether Lectopia encouraged students to miss lectures or whether these were students unlikely to attend lectures anyway is unclear. If the latter is the case then it could be argued that the podcasts serve an important function, providing information for students who otherwise would have missed out. What is clear from the present study is that students overestimate their lecture attendance; self-reports of lecture attendance, like self-assessment of the impact of lecture recordings on one’s learning, are likely to be flawed measures. Further research is required to better understand the causative relationship between podcast use and lecture attendance. The primary reasons for podcast use were not necessarily related to missed classes. Examination revision, revisiting complex material, and working at one’s own pace were all predominant reasons for accessing the podcasts, suggesting that students use podcasts to complement rather than supplement face-to-face lectures.

From this study a pattern emerged of podcast users as older, more confident students, who are typically engaged in their learning. Whether using lecture recordings increases academic self-efficacy or whether students with higher self-efficacy are more likely to make use of the recordings, is unclear from the data, although it seems likely that confident students make use of a range of resources available to them. For example, they also contact staff more than non-users.

To determine the direction of the relationship between academic self-efficacy and podcasting experimental studies could be developed. In the meantime some knowledge has been gained from this study. For example, for the most part the students who reported not using podcasts appeared to make the choice consciously, preferring the learning opportunities provided in face-to-face lectures to podcasts. Half of these students rated the learning available in face-to-face lectures sufficient for their purposes. Of particular note, however, are the small number of students who were unaware of the lecture recordings or unsure how to access them. Students with low academic self-efficacy were over-represented amongst this group. Given the attention paid to the podcasts by staff in all the courses chosen for the study these results were surprising. In part this finding may be a function of the newness of the technology within the university; as it becomes more commonplace these reasons for non-use will hopefully decrease. In the meantime the finding highlights the value of emphasizing innovations several times throughout a course and the importance of providing sufficient training for students, particularly those who may otherwise lack confidence in their ability to meet the demands of study.
Uptake and satisfaction varied across courses supporting the notion that mandatory podcasting may be inappropriate. The significant finding for year level and satisfaction may provide useful information for staff planning to introduce podcasts across programs. First year students, dealing with transition issues, may prefer in-person delivery of material. Year level differences offer an interesting and potentially profitable variable for future research.

**Limitations of the study**

In interpreting the results of the present study two points are important to bear in mind. First, evaluating an intervention in the first year it is introduced is undoubtedly useful, but complex. On the one hand, information collected from a trial phase can be instrumental in shaping subsequent deployment and save considerable time and resources in the future. On the other hand, early adopters of technology are frequently faced with teething problems. In the present case, the students articulated some of the problems. Some lectures did not record properly and not surprisingly students noted this unreliability. This is likely to have impacted on use as well as satisfaction ratings and may further influence both student and staff confidence in the technology in the future. Working with lecture recordings requires specific skills of lecturers to ensure that listeners can make good sense of the recording. Some of the issues with sound quality noted by students can be relatively easily fixed with the use of lapel microphones and with appropriate training for staff, e.g., remembering to repeat questions and comments from students.

Some of the findings of the present study may be an artifact of the university’s newness to podcasting and caution needs to be applied when comparing the present findings with studies from universities where the technology is well embedded. The tendency for Lectopia users to attend lectures less frequently than non-users is a case in point. As users become familiar with technologies they will undoubtedly gather feedback on the most effective ways to use them and adapt them in ways that are useful and meaningful for them. As students become familiar with lecture recordings we might therefore expect evolution in the ways they use them. Studies of early adoption therefore provide a snapshot, but are not necessarily predictive of future use.

Second, the response rate to the second survey, which was administered online after the completion of examinations, was low, limiting generalisability. Although this second questionnaire was hampered by a low response rate, it provided important information about actual, rather than anticipated use of podcasts for examination revision. Given that examination revision appears to be the primary reason students use the podcasts, collecting reliable data on this aspect is important. The relationship between podcasting use and grades could be further examined. Using incentives might be one way to encourage better responses to surveys conducted after semester has finished.

**Future directions**

Students in the present study suggested a range of useful changes to podcasting provision. Extending the use of podcasting to all courses underscored the positive evaluation of this technology. Videoing the lecturer, a facility currently available through some programs, also highlighted the value of the face-to-face lecture and students’ perception that non-verbal communication adds to the learning experience. Also suggested was the chapterising of recordings. At present podcasts are typically available as a single recording. Chapterising recordings would enable easy searching and permit students to find specific sections more efficiently. Given that one of the primary reasons for using podcasts appears to be to review specific, difficult material facilitating this process would be a worthwhile goal.

A number of suggestions for future research are indicated by the present study. The belief that lecture recordings will decrease attendance is often cited by academics as reason to avoid offering podcasts. Exploring the causal links between podcast use and lecture attendance is therefore an area of future research. In addition, it would be useful to tease out the possible interaction between year of study and discipline in student use of and satisfaction with lecture recordings.

**Conclusion**

In conclusion lecture recordings have proved to be a technology valued by students. As podcasts are increasingly embedded into courses and programs, uptake by staff and students is likely to increase and the ways in which they
are used is likely to evolve. As usage develops it will be important to continue to explore the characteristics of effective use.

References


The Effect of Incorporating Good Learners' Ratings in e-Learning Content-based Recommender System

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ABSTRACT
One of the anticipated challenges of today’s e-learning is to solve the problem of recommending from a large number of learning materials. In this study, we introduce a novel architecture for an e-learning recommender system. More specifically, this paper comprises the following phases i) to propose an e-learning recommender system based on content-based filtering and good learners’ ratings, and ii) to compare the proposed e-learning recommender system with exiting e-learning recommender systems that use both collaborative filtering and content-based filtering techniques in terms of system accuracy and student’s performance. The results obtained from the test data show that the proposed e-learning recommender system outperforms existing e-learning recommender systems that use collaborative filtering and content-based filtering techniques with respect to system accuracy of about 83.28% and 48.58%, respectively. The results further show that the learner’s performance is increased by at least 12.16% when the students use the e-learning with the proposed recommender system as compared to other recommendation techniques.

Keywords
E-learning, Recommendation system, Good learners’ ratings, Content-based filtering, Collaborative filtering

Introduction
Web-based learning environments are becoming very popular nowadays as a means of delivering lectures or simply as a place to share notes. This has led to the creation of huge amounts of digital learning materials that are either used as mandatory or supporting materials in the web-based learning environments (MERLOT, 2009). The arising problem with the existence of such huge amounts of learning materials is how to recommend quality items to learners when they have limited time to view and study all the learning materials (Nachmias & Segev, 2003). We are motivated to solve this problem by proposing a new e-learning recommender system that is able to recommend quality items to learners. This in turn can improve the student’s performance.

A recommender system is a tool that supports users in identifying interesting items especially among large numbers of items. Among the popular approaches used in recommender systems are using either a collaborative filtering or a content-based filtering technique. Collaborative filtering identifies the interesting items from other similar users’ opinions by calculating the nearest-neighbor from a rating matrix. New items that are of interest to the nearest-neighbor and that have not been rated by other users with similar interest will be recommended to them. In contrast, content-based filtering uses features of items to infer recommendations. Hence, items with similar content to the current viewing item will be recommended to the active user (Felfernig et al., 2007). As like in other domains, recommender systems in e-learning can differ in many ways depending on what kind of object is to be recommended (i.e., course to enroll, learning materials, and etc.) and whether the context of learning is considered important (Soonthornphisaj et al., 2006; Liang et al., 2006; Tang & McCalla, 2003). For example, when a learner is reading on C++ arrays, the learner is expecting to get recommended items that are able to support and enhance their understanding of the current learning context, namely the topic of arrays in the programming language of C++. The recommendations would be different if the learner is reading about a business topic of study where the context may depend on several other fields such as finance and accounting.

While recommender systems have become a popular method of suggesting items, peer learning has emerged as an effective way of learning (Topping, 2005). Topping (2005) defined peer learning as the acquisition of knowledge and skill through active helping and supporting among status equals or matched companions. It involves people from similar social groupings who are not professional teachers helping each other to learn while learning themselves by so doing. Helping and support between peers can happen in many ways such as teaching, demonstrating, or sharing materials. Topping (2005) uses the term “peer helper” for someone who is considered among the “best students” and acts as a surrogate teacher, in a linear model of the transmission of knowledge, from teacher to peer helpers to other learners. The idea of learning from the best students or good learners is also strongly supported by Social Learning...
Theory (Bandura, 1977). Social Learning Theory (Bandura, 1977) stated that people can learn by observing the behavior of others and the outcome of those behaviors. Furthermore, the theory also mentioned that other people will most likely exhibit the behavior if the outcome is positive. This theory strongly supports the idea of learning from good learners where by exhibiting good learners’ behavior (i.e., focus on highly rated items) can increase students’ performance.

The objective of this study is to propose a new e-learning recommender system based on the content-based filtering and good learners’ ratings techniques. Our proposed method ensures that the recommended items will remain in the current learning context. The good learners’ ratings are used in this study as rating recommendation that will help other learners to focus and choose the best learning materials. A good learner is a learner that scores more than 80% in the post-test. The terms learning materials, items, and documents are used interchangeably through the whole paper.

In summary, a new e-learning recommender system is proposed in this paper that uses the combination of content-based filtering and good learners’ ratings. We evaluate the proposed e-learning recommender system by comparing the recommender system accuracy and the decision-support accuracy with several techniques of recommendation in e-learning. In addition, we compare the student performance of several groups that make use of (i) an e-learning system without a recommender system, (ii) an e-learning system with the proposed recommender system, (iii) an e-learning recommender system with content-based filtering, and (iv) an e-learning recommender system with collaborative filtering.

The remaining part of this paper is organized as follows. ‘Related Work’ section will discuss the current work of e-learning recommender systems. ‘Learning Materials Recommendation Framework’ section will discuss the process involved in the modeling and recommendation phase. In each phase, the mathematical models that are used for calculations are presented. ‘Experimentation and Results’ section will discuss the data set, experiment setup, metrics used for measurement, and the result of the experiment. Note that some of the works described in ‘Learning Materials Recommendation Framework’ section and ‘Experimentation and Results’ section have been reported in Gauth & Abdullah (2009), Gauth & Abdullah (2010a), and Gauth & Abdullah (2010b). The main differences is that this paper focuses on both student’s performance and recommender system accuracy as well as comparing the proposed recommender system results (i.e., student’s performance and recommender system accuracy) with various types of recommender system techniques. Finally, ‘Conclusion and Future Works’ section provides the concluding remarks along with suggestions for future work.

Related Work

Recent trends in e-learning recommender systems show that most of the researchers use the data mining approach and the information retrieval technique as the recommendation strategies (Zaiane, 2002; Liang et al., 2006; Kerkiri et al., 2007). Zaiane (2002) proposed the use of web mining techniques to build agents that could recommend online learning activities or shortcuts in a course website based on learners’ access histories to improve course navigation as well as assist with the online learning process. Khribi et al. (2008) compute online automatic recommendations based on learners’ recent navigation histories as well as exploiting similarities and dissimilarities among user preferences and among the contents of the learning resources. They used web usage mining techniques together with content-based and collaborative filtering to compute relevant links to recommend to active users. Soonthornphisaj et al. (2006) apply the collaborative filtering approach to predict the most suitable documents for the learner. New learning materials are able to be recommended to learners with a high degree of similarity. They were also proposing a new e-learning framework using web services that has the ability to aggregate recommended materials from other e-learning web sites and predicts more suitable materials for learners. Liu et al. (2007) designed a material recommendation system based on association rule mining and collaborative filtering. The system is implemented by integrating the techniques of LDAP and JAXB to reduce the load of development of search engine and the complexity of the content parsing for improving the learning performance of learners. Liang et al. (2006) applies the knowledge discovery techniques, and a combination of content-based filtering and collaborative filtering to make personalized recommendations for a courseware selection module. Their experiment shows that the algorithm used is able to reflect users’ interests with high efficiency. Tang et al. (2003) proposed an evolving web-based learning system that is able to find relevant content on the web, personalize and adapt the content based on the system observation of its learners and the accumulated ratings given by the learners without the learners having to directly
interact with the open Web. They use a clustering technique to cluster the learners before using collaborative filtering to calculate learners’ similarities for content recommendation. Kerkiri et al. (2007) proposed a framework that exploits both description and reputation metadata to recommend personalized learning resources. Their experiment proved that the use of reputation metadata augmented the learner’s satisfaction by retrieving those learning materials that were evaluated positively. Chen et al. (2005) proposed a personalized e-learning system based on Item Repository Theory which estimates the abilities of online learners and recommends appropriate course materials to learners. The experiment shows that the system can precisely provide personalized course material recommendations based on learners’ abilities and accelerate learners’ learning efficiency and effectiveness. Otair et al. (2005) proposed a framework for an expert personalized e-learning recommender system by using a rule-based expert system that can help learners in finding learning materials that best suits their needs. Tai et al. (2008) proposed e-learning course recommendation based on artificial neural network (ANN) and data mining techniques. ANN is used to classify the learners based on groups of similar interests and learners can obtain course recommendations from the group’s opinion. They used a data mining technique to elicit the rules of the best learning path.

From the previous related works, none of the recommender systems have attempted to use content-based filtering together with good learners’ ratings as learning materials recommendation method. The benefits of having both content-based filtering and good learners’ ratings as recommendation methods is that it will ensure the recommended items remain in the current learning context and quality materials are able to be recommended. We have chosen the method proposed by (Soonthornphisaj et al., 2006) to be compared with our proposed e-learning recommender system in terms of system accuracy and student’s performance since they used an information retrieval technique for recommendation that is similar to the one in our proposed work.

Learning Materials Recommendation Frameworks

Figure 1 shows the good learners’ recommendations strategy framework. Before the recommendation process begins, the instructors have to upload the learning materials and provide keywords for the learning materials. The learning materials can be either mandatory learning materials or additional learning materials. All the learning materials will be converted into image to preserve the fidelity of the original presentation of the learning materials. Our system provides an easy tool for instructors to upload the image and provide keywords. The keyword is used to describe the learning materials and it consists of information about the author, title, and keywords. Once the learning materials are stored in the server, the recommender system will query for the keywords of the learning materials. The keywords are then used to calculate the items’ similarity. Good learners’ ratings are used as rating recommendations on every learning material. If the good learners’ ratings are available for a particular item, the average rating of the good learners will be used as rating recommendation. Otherwise, the recommender system will predict the good learners’ ratings for the item. Finally the learner is able to view the learning materials. For each viewing learning material, it will be recommended with similar learning materials and good learners’ ratings. ‘Modeling Phase’ will describe the process which involves creating a content profile builder and a rating profile builder. Meanwhile, ‘Recommendation Phase’ will describe the process which involves selecting top-N similar items and calculating the good learners’ ratings for a particular item.

![Figure 1: The good learners’ recommendation strategies framework](image)
Modeling Phase

The modeling phase involves creating the content profile builder and the rating profile builder. The content profile builder is responsible to query the document repository for the item’s keywords that is to be used for calculating the document weight. The document weight is then used to calculate the document similarity. The document weight $w_{i,j}$ is calculated using the term frequency/inverse document frequency (TD-IDF) with normalized frequency as shown in equation (1). In TD-IDF, all the terms are treated as independent terms. The equation is defined as follows.

$$w_{i,j} = \frac{f_{i,j}}{\max_z f_{z,j}} \cdot \log \left( \frac{D}{d_i} \right)$$

(1)

where $f_{i,j}$ denotes the frequency a term $i$ occurs in document $j$. The $\max_z f_{z,j}$ is the maximum frequency among all the $z$ keywords that appear in document $j$. The $D$ is the total number of documents that can be recommended to the learners. The $d_i$ is the number of documents that contain term $i$. The normalized frequency ensures that the long documents with high occurrence terms will not have high impact on the weight thus it helps to reduce the possibility of keyword spamming (Castells et al., 2007). The weight computed using equation (1) is used to calculate the similarity value between the two items. The cosine similarity value is defined as follows.

$$\cos(w_c, w_s) = \frac{w_c \cdot w_s}{||w_c|| ||w_s||}$$

(2)

where $w_c$ and $w_s$ are treated as a vector of content based profile of user $c$ and the content of document $s$. Both $||w_c||$ and $||w_s||$ are the magnitude of the vector $w_c$ and $w_s$. Similarities between the documents are measured by measuring the angle between the two vectors where a smaller angle indicates a higher similarity.

Meanwhile, the rating profile builder is responsible to query the good learners’ ratings from the rating repository. The ratings will be used in recommendation phase (refer to ‘Recommendation Phase’ section) to calculate the good learners’ ratings for a particular item.

Recommendation Phase

The recommendation phase involves selecting the top-N similar items calculated earlier [as calculated using equation (2)] in the modeling phase and recommending each item along with its good learners’ ratings. The good learners’ average rating is obtained by calculating the average rating of good learners’ ratings on a particular item. The mathematical equation is defined as follows.

$$R_{i,j} = \sum_{i=1}^{N_j} \frac{r_{i,j}}{N_j}$$

(3)

where $r_{i,j}$ is the rating of good learner $i$ on item $j$. The $N_j$ is the total number of good learners that rated item $j$. Note that the calculation for good learners’ average rating on a particular item is solely based on good learners’ ratings.

In the case where the item has not received any rating from the good learners, then the item will be recommended with good learners’ prediction rating that is calculated as follows.

$$p_j = \sum_{i=1}^{N} \frac{\text{sim}(d_i, d_j) \cdot R_i}{\text{sim}(d_i, d_n)} \cdot R_n$$

(4)

where $\text{sim}(d_i, d_n)$ is the similarity between item $i$ and item $n$ [as calculated using equations (1) and (2)] and $R_n$ is the good learners’ average rating on item $n$ [as calculated using equation (3)].

Experimentation and Results

Although the data sets to test the recommender system are available at MovieLens (2009), the data included in (MovieLens, 2009) is less suitable for testing on the e-learning recommender systems, since the data sets are based on movie ratings. Therefore, for this experiment, we use three main sets of PowerPoint slides on different topics of XML and also two additional sets of PowerPoint slides as additional references that comprise 131 separate items. All the slides are converted into images and each of the slides is described by author-defined keywords. The images are embedded into an HTML page and can be accessed by an authorized learner.

The experiments were conducted on 95 university students (second year students of Software Engineering) from four different classes who were undertaking the Web Services course. Group 1 (G1) consists of 21 students from the first class that use the e-learning without a recommender system, group 2 (G2) consists of 21 students from the second class that use the e-learning with a content-based recommender system (G2), group 3 (G3) consists of 24 students from the third class that use the e-learning with the proposed recommender system, and finally, group 4 (G4) consists of 29 students from the fourth class that use the e-learning with a collaborative filtering recommender system (G4) as proposed by (Soonthornphisaj et al., 2006). The experiments on G1 and G2 were conducted in week 1 (a week before experiment on G3), since we need to get the good learners’ ratings from G1 and G2 to be used in the proposed recommender system. The experiment on G3 was conducted on week 2. On the other hand, the experiment on G4 was conducted on week 3 (a week after the experiment on G3), as the experiment on G4 needs the ratings from a large number of users (i.e., users from G1 until G3) to calculate the users’ similarity and to minimize the cold-start problem. Cold-start problem is a problem where the items cannot be recommended due to insufficient ratings received (Herlocker et al., 2004). Initially, no items will be recommended to the users in G4 until the users have rated a few items and the similarity values between users have been updated. The system will periodically calculate the users’ similarities as the similarity value will change each time the user provides a rating or re-rates a learning material. Before the students can use the assigned systems, they will have to sit for the same pre-test. It is used to assess the pre-knowledge of the students before they start the formal learning using the assigned systems. The students are then given one week to study and rate the learning materials based on the usefulness of the materials. The learning process is then followed by a post-test. The questions for the pre-test and the post-test are arranged in different orders and the save function is set to disabled for the pre-test and the post-test web pages as it helps to avoid the possibility of cheating. All the assessments (pre-test and post-test) are conducted during a formal class in a monitored environment. Furthermore, the experiments are conducted on four different classes, instead of one class, to minimize the possibility of collaborating between the students from different groups. The experiments are unknown to the students until they are given the URL address of the assigned e-learning system. All of these precautions are taken into account since the experiment on G3 is conducted after the tests on G1 and G2 are over, and the experiment on G4 is conducted after the experiments on G1, G2, and G3 are over. The results obtained from the pre-test and the post-test are used to measure student’s performance.

We use Mean Absolute Error (MAE) to measure the accuracy of the recommender systems. MAE can be defined as the rating deviation between the predicted rating and the user-given rating (Hernandez del Olmo & Gaudioso, 2008). The smaller the MAE value indicates that the rating prediction is closer to the user-given ratings and the recommender system has a high accuracy. The formula is given as follows:

\[
MAE = \frac{\sum_{i=1}^{N} |p_i - r_i|}{N}
\]

Where \(p_i\) is the predicted rating for item i, \(r_i\) is the user-given rating for item i, and \(N\) is the total number of the pair ratings \(p_i\) and \(r_i\).

Figure 2 shows the MAE value of the three types of recommender systems. We receive a total of 9803 ratings for all the items. It is clear that the proposed system has the smallest MAE value that is less than 0.5. In contrast, the collaborative filtering technique has the highest MAE value which is more than 2.5. The content-based filtering technique yields a better MAE value than the collaborative filtering technique where the MAE value is about 0.8. Based on the obtained results, we can say that the proposed method has a better accuracy in terms of rating deviation compared to the content-based filtering and the collaborative filtering techniques.
Note. CF (collaborative filtering); CBF (content-based filtering); CBF-GL (content-based filtering with good learners rating strategies)

Figure 2: The Mean Absolute Error for all recommendation techniques

Besides measuring the rating deviation between predicted ratings and user-given ratings, we also calculate the Precision, Recall, and F-measure of the recommender systems to measure the decision-support accuracy that indicates how effectively predictions help a user select high-quality items from the item set (Kunaver et al 2007). The mathematical formula for Precision, Recall, and F-measure are given as follows.

\[
\text{Precision} = \frac{tp}{tp + fp} \\
\text{Recall} = \frac{tp}{tp + fn} \\
F\text{-measure} = \frac{2 \times \text{Precision} \times \text{Recall}}{\text{Precision} + \text{Recall}}
\]

(6)

where \(tp\) stands for true positive, \(fp\) stands for false positive, and \(fn\) stands for false negative. We set the threshold for determining true positive to 0.7 meaning that if an item is rated 0.7 or higher, it is considered to be accepted by the user. The value for Precision, Recall, and F-measure ranges from 0 to 1, where 0 indicates the worst value and 1 indicates the best value.

Figure 3: The Precision for all recommendation techniques

Figures 3, 4, and 5 show the obtained Precision, Recall, and F-measure of the recommender systems. It is obvious that the proposed e-learning recommender system has the highest precision with the expense of recall. In contrast, the recommender system that uses collaborative filtering technique has the highest recall with the expense of
The F-measure reveals that the proposed e-learning recommender system has slightly a higher F-measure value compared to the recommender system that uses the content-based filtering technique. Meanwhile, the recommender system that uses the collaborative filtering technique has the worst F-measure value. From the obtained results, we can say that the recommender system that uses the collaborative filtering technique has the worst decision-support accuracy and the proposed e-learning recommender system has the best decision-support accuracy.

**Figure 4**: The Recall for all recommendation techniques

**Figure 5**: The F-measure for all recommendation techniques

**Figure 6**: The pre-test and post-test average mark
The student’s performance is measured by calculating the average mark of each group and the t-score for the average mark among each pair of groups to determine the significance. We use a two-tailed test for the pre-test and a one-tailed test for the post-test. We assume in our hypothesis that in a pre-test, there is no significant difference in the average mark among the groups. For the post-test hypothesis, we assume that learners who use the proposed system will have a higher average mark compared to other groups. To further justify the student’s performance, we calculate the average percentage of mark increments from the pre-test to the post-test for each group.

![Standard Deviation](image1)

**Figure 7:** The pre-test and post-test standard deviation

<table>
<thead>
<tr>
<th>Group</th>
<th>Pre-test</th>
<th>Post-test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Standard Deviation</td>
</tr>
<tr>
<td>G1</td>
<td>40.48</td>
<td>12.44</td>
</tr>
<tr>
<td>G2</td>
<td>35.71</td>
<td>15.02</td>
</tr>
<tr>
<td>G3</td>
<td>36.67</td>
<td>15.79</td>
</tr>
<tr>
<td>G4</td>
<td>34.48</td>
<td>13.78</td>
</tr>
</tbody>
</table>

![Percentage of Mark Increment from Pre-test to Post-test](image2)

**Figure 8:** The percentage of mark increment from pre-test to post-test

<table>
<thead>
<tr>
<th>Group</th>
<th>Pre-test (two-tailed test)</th>
<th>Post-test (one-tailed test)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>t</td>
<td>Df</td>
</tr>
<tr>
<td>G1-G2</td>
<td>1.12</td>
<td>40</td>
</tr>
<tr>
<td>G1-G3</td>
<td>0.90</td>
<td>43</td>
</tr>
<tr>
<td>G1-G4</td>
<td>1.61</td>
<td>48</td>
</tr>
<tr>
<td>G2-G3</td>
<td>0.21</td>
<td>43</td>
</tr>
<tr>
<td>G2-G4</td>
<td>0.30</td>
<td>48</td>
</tr>
<tr>
<td>G3-G4</td>
<td>0.53</td>
<td>51</td>
</tr>
</tbody>
</table>

**Note:** * indicates statistically significance
The average mark and standard deviation for all groups are summarized in figure 6, figure 7, and Table 1 respectively. Table 2 summarizes the t-score (t) and the degree of freedom (df) between each group pairs for the pre-test and the post-test average marks. The results show that there is no significant difference at p < 0.05 between each group for the pre-test average mark. On the other hand, the post-test average mark obtained by G3 has a significant difference when compared with G1, G2, and G4 with a t-score value of 1.78 (significant at p < 0.05), 2.03 (significant at p < 0.025), and 4.04 (significant at p < 0.0005) respectively. Furthermore, G3 has the highest percentage of mark increment from the pre-test to the post-test which is about 45% as shown in figure 8. In contrast, G4 obtained the lowest percentage of mark increment from the pre-test to the post-test which is slightly above 30%.

Conclusion and Future Work

In this paper, we have discussed various techniques of e-learning recommender systems and we have proposed a new e-learning recommender system framework based on the content-based filtering and good learners’ ratings that offers better system accuracy and increases student’s performance. The implementation of content-based filtering ensures that the related items are in the learning context and the good learners’ rating serves as a guideline for other learners to choose from and focus on the learning materials. A comparative study among other e-learning recommender systems has been conducted for performance benchmarking. The experimental results show that the system’s accuracy of the proposed system is increased by 83.28% compared to collaborative filtering technique and 48.58% when compared to content-based filtering technique. The student’s performance has also increased by at least 12.16%. These have showed that the introduction of good learners’ rating into recommender systems has improved both the system accuracy and increased the learner’s performance.

Even though the results have shown that the proposed system has produced a better accuracy and increase learner’s learning performance, there are several works that can be done in the future to further justify and enhance our work. First of all, the experiments were conducted on Software Engineering students whose computer literacy is expected to be high. Furthermore, the experiments were using a predefined set of learning materials prepared by one instructor. It will be interesting to see the performance of other group of learners with different level of education using the proposed system to study various subjects. This will help to justify whether the proposed system is suitable to be used by students from different level of knowledge and from various topics domain. In order to improve the accuracy of the proposed system, we plan to incorporate the good learners’ ratings with other types of content-based filtering algorithms. The content-based filtering algorithm has a direct impact on the calculation of good learners’ rating prediction and the better prediction accuracy may improve the recommendation. Since the number of learning materials used in the experiments is considered small, the task of assigning keyword was done by the instructor. The use of automatic keyword extraction should be considered if the number of learning materials is large. The accuracy of the system may be affected since the keywords assigned by the instructor may differ from the extracted keywords. As our proposed system disregard the user’s knowledge in recommending the items, we plan to incorporate the knowledge based method (Knutov, De Bra and Pechenizkiy, 2009) within the recommendation framework. This is to ensure that the learners are recommended with highly rated items by good learners and the items recommended are suit to the learner’s knowledge level. Lastly, we plan to make the proposed e-learning recommender system as a light program module that can be integrated into any web-based learning management system.

References


Student Engagement with, and Participation in, an e-Forum

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ABSTRACT

This paper examines engagement with an online discussion forum, aiming to identify the different levels of participation and to investigate factors that encourage or discourage student participation. The case involved the posing of a short real-life problem via a forum on the university’s virtual learning environment. An in-class survey was conducted to identify students’ participation and attitudes toward the forum. Students understood the benefits of the task, but did not participate due to time pressures and lack of motivation. The reasons for this were found to be inadequate explanation and encouragement to do the task, and insufficient moderator participation. Recommendations for improving forum participation are provided.

Keywords

E-learning, Discussion forum, Student engagement, VLE, Student participation

Introduction

The development of computer technology and the Internet has provided new methods for learning and teaching, with many educational institutions adopting e-learning techniques (Herrington, Reeves, Oliver, and Woo, 2004; Moore and Marra, 2005; Su, Bonk, Magjuka, Liu, and Lee, 2005). A popular e-learning technique is the online discussion forum, which is one of the technology-based techniques through which the transfer of tacit knowledge is facilitated by interacting with colleagues and experts (Valiathan, 2002). Forums are text-based communication methods that can increase the quality of the learning experience, enabling higher level learning to take place (Kanuka, 2005). Kanuka, 2005 maintains that discussion forums increase student participation and improve critical thinking. This claim is supported by Perkins and Murphy (2006) who developed a model for measuring engagement in critical thinking in online discussions.

Forums are clearly powerful learning tools, but only if students engage with them. However, student participation in forums is rarely as complete as one would hope, considering the formative benefits that could be gained (Kovacic, 2004; Yang, Li, Tan, and Teo, 2007). Thomas (2002, p. 356) found “limited activity in the first weeks”, but increased activity in the final weeks. This, he believed, was due to the participants exploring and becoming familiar with the forum. Schier and Curtin (2009) also found a low initial engagement rate, namely two out of 140. Su et al. (2005) refer to different levels of interaction in learning. Of particular interest in this study is their ‘learner-content’ interaction, where students engage with the problem content, rather than with the tutor or other students. Su et al. (2005) indicate a lack of research into learner-content interaction, and, therefore, a need for more research into engagement within forums, especially in terms of engagement with content of the forum problem. This is supported by Guzdial and Turns (2000, p. 437) who identify “effective discussions as those that are sustained and are focused on topics related to class learning goals.”

This paper examines the problem of engagement with a forum, and aims to identify the different levels of participation in a forum. The paper also investigates some possible factors that could encourage or discourage student participation.

The current study involved the posing of a short real-life problem via a forum on the university’s virtual learning environment (VLE), which is known as Wolf, providing an authentic, problem-based learning approach. Problem-based learning leads to learning through development of new knowledge as well as building on existing skills, with students taking responsibility for their own learning (Miliszewska and Horwood, 2006). Miliszewska and Horwood (2006) adopted a constructivist approach that Herrington et al. (2004) claim should encourage student engagement. This paper presents the forum, explains how it was implemented, and describes what its outcome was. A critical reflection on the forum is then presented to identify anticipated and actual results relative to the extant literature. Based on this reflection and on the literature, an empirical, questionnaire-based survey was constructed in order to identify the participants’ opinions about the forum, especially with regard to their reasons for engagement or non-engagement.
The rationale for this research was the identification of issues that academics should address to encourage greater participation in forums. Such participation, especially in a formative assignment, should encourage deeper learning in the participating students. Research has shown that engaged learners perform better and are more satisfied, but much of the research is outdated (Shana, 2009, p. 217). A decade ago, Guzdial and Turns (2000) called for research on tools to integrate discussions effectively into a learning programme, and ten years later Yukselturk (2010) is still calling for more research in this field.

The forum as a technology supported learning (TSL) solution

A forum task (see Figure 1) was set up primarily to introduce students to the use of the forum tool in the VLE, as well as getting them to consider a real life customer relationship situation. The task introduced the Customer Relationship module and was used in the first two weeks of this second level module with 56 students, all of whom have completed an introductory module in marketing, so have the underlying knowledge to reflect on the situation. They all had had 18 months of experience using the Wolf VLE system, and although they had not used the Wolf forum tool before, they were familiar with the concept of ‘blogging’ and should have been comfortable using the forum tool. In order to initiate participation, the lecturer explained and demonstrated the process of getting to, and posting onto, the forum during class. The lecturer also explained the reason for the forum task and the benefits it would provide them.

According to Herrington et al. (2004, p. 22), an authentic task “enhance(d) the transfer of deep and lifelong learning” and encouraged “students…to spend much more time on the tasks.” The forum task was designed as an authentic task to encourage students to engage with the problem, and through participation, achieve deep learning, as the ‘presage’ factors (prior knowledge, motivation, teaching objective, friendly climate, etc.) of the Three P model (see Figure 2) are present (Biggs, 2003, p. 19). The Presage component of the model in Figure 3 shows that both the Student Factors and Teaching Content have been designed so as to maximise the deep learning, as were the Learning focussed activities discussed in the Process component of the model. This concept is supported by Thomas (2002) who found engagement was related to students’ knowledge – suggesting that knowledge is low at the beginning of a semester, and as a result engagement is also low. The presage and process factors adopted were consistent with Guzdial and Turns’ (2000) ‘anchor’, a topic that would be of interest to participants, namely something that would help their learning.

The task also involved active teaching, requiring “students to question, to speculate, to generate solutions” (Biggs, 2003, p. 4) and to “carry out a task … thinking about, discussing, and applying concepts” (Littlejohn and Higgison, 2003, p. 12). Schier and Curtin (2009) also stressed the importance of awarding assessment marks in encouraging engagement. Schier and Curtin (2009) claim that respondents also found activities that focussed on the learning material to be particularly helpful. Furthermore, the principles of the expectancy-value theory of motivation (Biggs, 2003, p. 58) were present – the value/worth of the task was explained - and the task was relevant, practical, topical, and an everyday problem. The lack of relevance that can lead to surface learning was not present (Fransson,
Ramsden, 1992, p. 66). Thus the ‘process’ factors that should have contributed to high levels of engagement were present, although the “external pressures of increased study load” (Thomas, 2002, p. 357) could have negatively influenced this. The asynchronous nature of the forum should also have encouraged engagement (Bostock, 2007, p. 43).

**PRESAGE** | **PROCESS** | **PRODUCT** | **FOLLOW UP**
---|---|---|---
Student Factors | Learning focused activities | Learning outcomes | Follow-up activity/Reflection
Knowledgeable re Marketing | Deep approach encouraged due to knowledge, topic relevance/interest and no right answer – must give own thoughts/interpretations and relate to theory of marketing | * Most engaged at surface level - simple critique from personal point of view. | * Asked reasons for engagement (no guilt) – couldn’t access, a few lurking
Topic of relevance | | * A few went deep, considering other reasons, i.e., marketing strategies, including relevant literature | * Questionnaire on attitudes, engagement, enjoyment, worth doing
Level 2, so mature | | Only 20% engaged | |
Curiosity re Wolf 2 | | | |
Blog type, so topical to younger people | | | |

Source: Biggs, 2003: 19

*Figure 2: Three P model as applied to this e-forum*

Individual postings were reflected in the forum as shown in the abbreviated and anonymised extract in Figure 3. From this, individual students’ participation could be identified.

---

by Student X on 06 February 2008 16:14:05

_**RE: First Direct Relationship Marketing**_

Reply | Edit | Delete | Quote

![Question Mark]

- Doing this could limit their chances of gaining new customers, but more importantly could have a negative effect on their relationships with current customers.

The current customers ……………………

---

by Student Y on 07 February 2008 09:39:54

_**RE: First Direct Relationship Marketing**_

Reply | Edit | Delete | Quote

![Question Mark]

- By adopting this strategy First Direct are not putting the needs of their customers first. As a result certain customers will not be satisfied and as ……………………..

*Figure 3: Example of forum postings*

Despite all these activities to encourage engagement, only ten students out of the 56 in the class (17.9%) engaged with the discussion, with each of these ten students only posting once each. This result was better than that of Schier and Curtin (2009) who showed a response of 1.4% after two weeks, but worse than that of Yukselturk (2010) who showed an overall participation of 66%. 

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Reflective critique of TSL solution (forum)

Salmon’s (2003) five stage model is useful as a reflective framework with which to consider and review the forum task. Figure 4 shows that Stage 1 is important in motivating students to participate, requiring quick and easy access to the technology. Stage 2 stresses the importance of strong scaffolding to encourage socialisation in the forum, and Stage 3 introduces interaction between students and learning content and other participants. Stage 4 expects participants to construct knowledge by drawing on real, personal situations and experiences through critical and practical thinking. This leads to Stage 5 where continuing independent learning happens, building on the constructed ideas and reflecting on what has been learned.

The result, after two weeks of running the forum, was that only ten out of the 56 students in the class (17.9% of the class) posted to the forum and an unknown number ‘lurked’, thereby at least gaining some benefit from the task. This response was unexpected and disappointing, as a higher engagement was expected due to the reasons set out previously.

A possible reason for the lack of engagement with the task was that mainly stages 1 and 4 of Salmon’s (2002a) model were addressed – effort was put into explaining the benefits the students would obtain and motivating them to participate. Reflecting on the problem and constructing an answer to post required the students to jump straight to Stage 4, constructing knowledge to resolve the problem. Stages 2 and 3, which help facilitate engagement, were missed (Salmon, 2003). No significant effort was made to create a scaffold via Stages 2 and 3 to gradually build on students’ knowledge (Salmon, 2002b). Since this was a blended learning approach, including face-to-face lectures and tutorials, it could be argued that online socialisation of the participants was less important. However, the lecturer could have initiated the forum with a request for all students to complete their profile on the forum which would have helped with socialisation as well as helping with technology familiarisation and engagement with the forum. This is especially important since Guzdial and Turns (2000) found that unfamiliarity with a discussion may discourage engagement. Stage 3 requires considerable moderator participation to encourage interaction and avoid lurking (Salmon, 2002a and b). This is supported by Guzdial and Turns (2000) and Balaji and Chakrabarti (2010) who both maintain that forum effectiveness and student interactions are increased by greater instructor activity.
especially in the form of discussion management, sustained facilitation, and focusing on learning topics. Balaji and Chakrabarti (2010) also found that more instructor communication led to greater student participation. As moderator, the lecturer only posted once between opening and closing posts, which was insufficient to encourage participants, especially those lurking, to interact with the content. As Andresen (2009) stresses, increased postings by the moderator lead to learners perceiving the moderator as more enthusiastic and having more expertise. This can lead to increased student interest and motivation (Balaji and Chakrabarti, 2010). However, Guzdial and Turns (2000) highlight the increased time this requires and explain that this may be an impediment to effective forums.

Another possible reason for low engagement may be explained by Biggs’ (2003) SOLO taxonomy, which Brown, Smyth, and Mainka (2006) maintain is an appropriate tool for analysing constructively aligned discussions. Most of the students’ postings were at the Unistructural level, i.e., focussing on one issue, e.g., unfairness to consumer, and ignoring the complexity of the case, e.g., marketing theory, company viewpoint, etc. A few of the students may have gone to the Multistructural level by giving more detail about, or consideration to, the “poor consumer” approach. Only two participants went to the Relational level, considering the problem in the context of the company and in the context of the marketing theory that they had previously learned, and thus linking the case to academic marketing theory.

Most students clearly approached the problem from the consumer viewpoint, and not as marketers. In other words they used ‘common sense’ ideas about the case. This can be expected as most students only have experience of such problems as ‘consumers’, and therefore are unable to perceive the issue as faced by marketers. According to Reinhart, Slowinski and Anderson (2001) this is an acculturation problem (unfamiliar problem and tools), and acculturation takes time to happen. Continuation of the forum for longer may well have led to increased participation (Andresen, 2009). Furthermore, as second level students, they have not had sufficient time to learn to think like marketers – many think they can rely on innate knowledge without engaging with the new knowledge, theories, and literature necessary to change their cognitive viewpoints. This implies that the problem is with their ‘prior knowledge’, as per the three P model (see Figure 2). The challenge is, in addition to more time, to get students to change their cognitive approach and to think as marketers rather than as consumers, thereby applying newly learnt knowledge to the problem, rather than their ‘prior knowledge’.

Another reason for the low participation may have been inadequate instructions. Balaji and Chakrabarti (2010) found that full instructions encouraged students to complete discussions. A more interesting and attention-catching question may have encouraged greater engagement. Yang et al. (2007) found that the expectation of a positive outcome increases participants’ intention to participate in a forum. Furthermore, Groves and O’Donoghue (2009) emphasised that intrinsically motivated learners engage more with a task, while extrinsically motivated learners adopt a surface learning approach. Maybe this forum task did not provide sufficient intrinsic motivation.

Finally, an issue not considered in the development of the forum and not researched in this study, was the effect of demographics on participation. Kovacic (2004) found, in New Zealand, that European learners participated more actively than Asian or Maori learners. This could be due to the fact that a forum is a verbal technique, while Asians, especially, are predominantly visual learners. He also found that age and gender were correlated with participation – higher participation was associated with older learners and female learners (descriptive of the two students who went to the relational level in this forum). No correlations were found for education levels or occupation.

Method of empirical survey

Research design

To gain a better understanding of the low level of task engagement by these students, a survey was developed to investigate the students’ reasons for their lack of participation, and to explore their attitudes to the task. The research design was thus cross-sectional, descriptive and mainly quantitative. To meet these objectives, a questionnaire approach was selected as the literature had provided possible reasons for the poor engagement, which could then be tested. Also the volume of students made a more qualitative approach less feasible.
Data collection instrument

The questionnaire was developed to identify the level of student participation and then to measure their attitudes toward factors such as relevance, confidence, knowledge, lack of assessment, guilt, etc. These issues, and the resulting questionnaire, were identified and developed from the literature. Mainly fixed alternative responses (multiple choice and Likert scales) were used to measure respondents’ participation and attitudes. An open-ended question was included to better interpret and understand their answers. Yukselturk’s (2010) research showing that achievement, gender, and weekly hours of Internet use are related to participation in a forum was published after completion of this survey. With hindsight, these might have been worth investigating, but the data could not be collected after the fact.

Data collection

To maximise response, the questionnaire was applied during class. A convenience sample was used – in other words, those who were in the classroom on the appointed day made up the sample. The lecturer was class tutor, and therefore the students could have felt obliged to respond and/or felt pressured to provide ‘positive’ answers. For ethical reasons, therefore, it was explained that questionnaire completion was voluntary, and they could choose not to participate – the lecturer had no way of knowing if a particular student participated or not. They were told that no individual names or other form of identification were required. A student collected the completed questionnaires, and visibly shuffled them before handing them to the lecturer, which further ensured anonymity. The lecturer also verbally promised confidentiality and anonymity before handing the questionnaires out, explaining that knowing the identity of individuals was irrelevant to the research. No issues of diversity or equality were felt to be relevant and there were no students in class with any apparent vulnerability issues. The result of the data collection was that 26 students participated, giving a response rate of 46.4% of students registered for the module. Although rather low, it is acceptable according to Bryman (2008), who also mentions that response rate is less relevant in convenience samples. The number of students in class was not recorded, so the percentage refusing to complete the questionnaire, if any, is unknown.

Analysis method

Analysis was conducted using the Statistical Package for the Social Sciences, Version 16, to identify the participation and attitudes of the responding students. The open-ended questions were analysed manually to provide a qualitative view of the respondents’ attitudes to the task.

<table>
<thead>
<tr>
<th>Participation</th>
<th>n</th>
<th>%</th>
<th>Reasons for not completing task</th>
<th>f</th>
<th>% of total n*</th>
<th>% of row n in col 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Completed task</td>
<td>7</td>
<td>26.9</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attempted task unsuccessfully</td>
<td>3</td>
<td>11.5</td>
<td>Technical problem</td>
<td>1</td>
<td>3.8</td>
<td>33.3</td>
</tr>
<tr>
<td>Read/looked at task (lurked?)</td>
<td>11</td>
<td>42.3</td>
<td>Forgot about it</td>
<td>4</td>
<td>15.4</td>
<td>25.0</td>
</tr>
<tr>
<td>Did not do task</td>
<td>5</td>
<td>19.2</td>
<td>No time – too busy</td>
<td>3</td>
<td>11.5</td>
<td>18.8</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td></td>
<td>Didn’t see any benefit</td>
<td>5</td>
<td>19.2</td>
<td>31.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Other reasons</td>
<td>6</td>
<td>23.0</td>
<td>37.5</td>
</tr>
<tr>
<td>Total</td>
<td>26</td>
<td>100.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Can sum to more than column 3 figures, as some respondents gave more than one reason

Results

Levels of engagement

Table 1 reflects the different levels of engagement with the task (column 1) and some possible reasons for the limited participation (fourth column). The most common reasons given were “didn’t see any benefit” in the task, which is consistent with the literature regarding motivation (Salmon, 2002a; Biggs, 2003; Yang et al., 2007), and “forgot
about it”, which is difficult to justify since the task was discussed in lectures each week. This latter reason is probably indicative of the lack of interest in, or commitment to, the task due to other problems, such as being too busy or external pressures (Thomas, 2002; Brown et al., 2006).

Attitudes toward the forum task

To assess attitudes toward the task, means were calculated for the Likert scaled questions, with ‘Strongly agree’ equal to 5 to ‘Strongly disagree’ equal to 1, with 3 thus being the neutral point. A one-sample t-test was used to identify the relative importance of these attitudes and whether they were statistically significant or not. A test value of $p \leq 0.05$ for the desired level of significance was used. Table 2 displays both the attitude scores and the t-test results.

<table>
<thead>
<tr>
<th>Questions</th>
<th>One sample statistics</th>
<th>One-Sample T-Test (Test Value = 3)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Mean</td>
</tr>
<tr>
<td>Did my best to give meaningful answer</td>
<td>11</td>
<td>3.545</td>
</tr>
<tr>
<td>No right answer so happy to give opinion</td>
<td>11</td>
<td>3.182</td>
</tr>
<tr>
<td>Task helped to expand my RM knowledge</td>
<td>11</td>
<td>3.818</td>
</tr>
<tr>
<td>Task helped me to learn Wolf forum</td>
<td>11</td>
<td>3.545</td>
</tr>
<tr>
<td>My marketing knowledge enough for task</td>
<td>18</td>
<td>3.389</td>
</tr>
<tr>
<td>Task was of relevance to the module</td>
<td>15</td>
<td>4.067</td>
</tr>
<tr>
<td>My banking/finance knowledge adequate</td>
<td>16</td>
<td>3.438</td>
</tr>
<tr>
<td>Comfortable with blogs, and with forum</td>
<td>15</td>
<td>3.533</td>
</tr>
<tr>
<td>Task not assessed, so no risk doing it (e.g., getting it wrong, feeling stupid)</td>
<td>18</td>
<td>2.889</td>
</tr>
<tr>
<td>Task voluntary so no guilt if not done</td>
<td>17</td>
<td>3.059</td>
</tr>
</tbody>
</table>

* Bold statistics indicate statistical significance at $p \leq 0.05$

Based on the figures presented in Table 2, the respondents can be seen to have generally agreed (as indicated by a mean greater than 3.5) that:
- they had tried their best when attempting the task (3.545),
- the task helped develop their relationship marketing (RM) knowledge (3.818),
- the task helped them to become familiar with the VLE (3.545),
- the topic was seen to be relevant (4.067), and
- they were comfortable with blogging (3.533).

Reasons for engagement or non-engagement

Possible problems identified from Table 2 (as shown by a mean close to, or below, the mid point of 3) were that:
- they may have worried about their posts being seen as ‘wrong’ or ‘stupid’ (2.889),
- although a voluntary task, there still was some guilt about not participating (3.059),
- nearly half the respondents may have felt there was a ‘correct’ answer, which may have affected their confidence to participate (3.182).

Although these findings are interesting, it is important to assess the statistical significance of the findings in order to draw inferences about the attitudes of the whole class. Findings that were statistically significant were that:
• ‘the task helped to expand my RM knowledge’ \((t = 3.105, df = 10, p = .011)\),
• ‘the task helped me to be familiar with the forum’ \((2.631, df = 10, p = .025)\),
• ‘the task was of relevance to the module’ \((t = 5.172, df = 14, p = .000)\), and
• ‘my banking/finance knowledge was adequate’ \((t = 2.150, df = 15, p = .048)\)

These statistically significant findings showed that the students felt the task was worthwhile and helpful, especially considering the fact that ‘relevance to module’ and ‘helped to expand RM knowledge’ showed the greatest level of agreement. Therefore, other possible reasons, in addition to the perceived lack of benefits as show in Table 1, must exist for the lack of the class’s engagement with the task. These reasons may be those problems highlighted previously, namely fear of giving wrong answers or being seen as stupid by colleagues.

**Qualitative opinions of the forum task**

To further understand the attitudes of the respondents to the task, an open-ended question was included to encourage the respondents to give any other ideas or thoughts about the task. This question asked about “the general idea of tasks being placed on Wolf, the idea of formative assessments or anything else relating to such tasks that you have ideas or feelings about. Any thoughts you have in this regard will be valued.”

The responses were summarised, similar responses were amalgamated into a limited number of general comment categories, and then grouped into positive and negative comments. The result of this analysis is provided in Table 3.

<table>
<thead>
<tr>
<th>Positive comments</th>
<th>f</th>
</tr>
</thead>
<tbody>
<tr>
<td>Idea of a task on the discussion forum is good</td>
<td>10</td>
</tr>
<tr>
<td>It helps to see other peoples ideas, interesting and informative</td>
<td>5</td>
</tr>
<tr>
<td>Provides feedback and enhances one’s knowledge, helps with assignments</td>
<td>3</td>
</tr>
<tr>
<td>Online tasks are helpful, helps reading, apply theory in real life situations</td>
<td>3</td>
</tr>
<tr>
<td>Negative comments</td>
<td>f</td>
</tr>
<tr>
<td>Task must be compulsory (do if have to, not assessed so don’t do it, nothing makes people complete it)</td>
<td>3</td>
</tr>
<tr>
<td>Would have preferred a non–online task, i.e., workshop/group based, or lectures with discussion &amp; help</td>
<td>2</td>
</tr>
<tr>
<td>Not a good use of time (waste of time, uses up assignment time)</td>
<td>2</td>
</tr>
<tr>
<td>Other (access difficulties, more feedback in class, relate to topic (?), never knew about it, not enough emphasis put on such activities, doesn’t suit everyone)</td>
<td>6</td>
</tr>
</tbody>
</table>

Of those who gave qualitative comments, 84.2% of respondents were positive and only 15.8% were more negative. Thus, the students were generally positive about the forum and the task.

Of the positive comments, half were general comments about the task being good. The other half all indicated an understanding of the benefits that the forum task could provide. This seems to cast doubt on the reason for non-engagement given in Table 1, namely that benefits were not seen. Clearly, a large proportion of the respondents do understand the benefits of participating in the task.

Examining the negative comments shows that there were a wide variety of negative attitudes. The one similarity that appears to run through most of the negative comments is to do with the implementation of the task in the lecture theatre. The negative comments seem to indicate:

• a lack of talking about the task in class,
• a lack of integrating it with other classroom activities,
• insufficient face-to-face feedback about postings,
• insufficient help with facilitating access to the site,

It can be concluded, therefore, that the respondents understand and appreciate the value of the task, but their engagement with the task is influenced partly by infrastructural issues (ease of access), but mostly by implementation issues in the lecture theatre.
Conclusions and recommendations

Conclusions

The findings of this survey were generally consistent with previous findings in the literature. The Stage 1 requirements of Salmon’s (2002a) model were mostly met, with only a few access problems. The lack of attention to Stage 2 (online socialisation) is reflected in the respondents’ comments regarding preference for lectures, in-class feedback and workshops. Stage 4 is about information exchange, requiring considerable moderation. The lack of inter-student interaction and the facilitator’s limited postings are indicative of a weakness in Stage 3. All the positive comments were primarily related to Stage 4 type activities, namely construction of knowledge. Thus, for certain students, the task was a success, but for the majority, the lack of scaffolding deterred them from reaching Stage 4. The two-week length of the task was too short to expect anyone to reach Stage 5 (Brown et al., 2006), but, had the task continued, only two of the students may have achieved the “continuing learning through reflection” required of Stage 5.

From the statistical analysis it can be seen that the task itself was adequate, and most students perceived the benefits of the task and felt competent to do it. The issues of the task being voluntary, not having a correct answer and not being assessed were, surprisingly, not important. This implies that the poor level of participation was probably caused by inadequate explanation, motivation, and moderation.

A comparison of the literature and empirical findings suggest a number of steps that should be taken to improve the task to increase participation and engagement with the forum:

- Introduce the task in a computer lab session to ensure all students are accurately introduced to, and know how to access, the task, thus overcoming any infrastructural problems (Salmon’s stage 1),
- Provide more detailed and specific instructions, especially showing the task’s relationship to the rest of the module,
- Provide a more motivational explanation of the forum, emphasising all the benefits. Repeat this regularly in the face-to-face lectures,
- Get students to add a short discussion and photograph to their ‘profiles’ to engage them right from the start (Salmon’s stage 2),
- Provide some more links to real-life First Direct websites and blogs to link the task more closely to real-life, and
- Increase the quantity of moderation – respond after each posting, for the first few posts, encouraging students to comment on each other’s posts (Salmon’s stage 3). In these moderator’s posts, ask questions that encourage participants to respond at a multistructural, or relational, level (Biggs, 2003).

Contribution to knowledge

Although this research has tended to validate the findings of earlier studies and has suggested some actions for educators to take to increase engagement and make online discussion forums more effective, it has also made some contributions to the knowledge about online discussion forums. These contributions include:

- It has sought to find out from students themselves why they participate or do not participate. Most other studies have investigated reasons for engagement less directly.
- This study has added to the knowledge about engagement with problem content, rather than engagement with the tutor or other students, as called for by Su et al. (2005).
- Most other studies have concentrated on the forum content or the learning that has, or has not, resulted. This study is different in that it focuses on the engagement by the students with the forum problem.
- Salmon’s (2003) 5-stage model is helpful in analysing engagement, and yet it has not been widely used in researching online discussions. Its use in this study therefore is a methodological contribution to the online discussion literature.

Future research

Since there is a shortage of research on learner-content interaction (Su et al., 2005), further research into how participants’ prepare and complete a post is needed, specifically their opinions on content, how much ‘time-on-task’
they spend, the amount of background research they do and whether they interact and discuss with colleagues as part of the preparation. Although this study has highlighted some reasons for lack of engagement, a deeper understanding of these reasons is needed. Therefore, qualitative research, probably involving focus groups, is suggested to fully understand why students do not participate in discussion forums, even though they perceive task benefits and feel it is a good idea.

References


Efficacy of Simulation-Based Learning of Electronics Using Visualization and Manipulation

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ABSTRACT

Software for simulation-based learning of electronics was implemented to help learners understand complex and abstract concepts through observing external representations and exploring concept models. The software comprises modules for visualization and simulative manipulation. Differences in learning performance of using the learning software either with or without the simulative manipulation module were investigated in 49 college sophomores. The learning performance was higher for learning software utilizing simulative manipulation and visualization yields than for that lacking simulative manipulation, which suggests that learning performance can be enhanced if visualized learning can appropriately integrate simulative manipulation activities. An analysis of the learning process revealed that the use of simulative manipulation activities to verify and clarify the existing knowledge is crucial to improving the learning performance.

Keywords

Simulations, Interactive learning environments, Applications in electronics

Introduction

Visualized simulation provides external representations of complex and abstract concepts, and helps learners to understand their nature. Gordin and Pea (1995) and Ainsworth (2006) found that visualized simulation helps learners to achieve a higher level of cognition by facilitating their interactions with multiple external representations and reflection on phenomena, as observed when learning a given abstract concept. Moreover, visualized learning also motivates learners and helps them to transfer concepts into long-term memory (Colaso et al., 2002; Naps et al., 2003).

The many studies on computer-based visualized simulation learning have covered almost all subjects of science education (Jensen et al., 2002; Khoo & Koh, 1998; Luo et al., 2005). However, studies on how computer visualization improves learning performance have produced diverse results, with some of them revealing positive influences of computer visualization on learning (Catalano & Tonso, 1996; Colaso et al., 2002; Jensen et al., 2002; Luo et al., 2005; Meyer & Krzyzkowski, 1994; Naps et al., 2003; Wallace & Mutooni, 1997), with others finding that visualization does not enhance learning performance (Reamon & Sheppard, 1997; Regan & Sheppard, 1996). Many researches have attempted to understand why visualization would not have a positive impact on learning, and our review of these research findings revealed that learning performance can be enhanced if a visualized learning environment promotes learner interactions and gives them opportunities for manipulation (Colaso et al., 2002; Jensen et al., 2002; Korhonen & Malmi, 2000; Naps et al., 2003; Tversky et al., 2002). The results of this review agree with the overall learning theory stating that interactive learning activities that gains in motivation, and enhanced motivation and learning outcomes (Prenskey, 2002). The use of computer simulation by learners allows them to readily manipulate parameters and observe the resulting changes in a given phenomenon, which helps the process of higher-level reasoning (Gallagher, 1987).

A common problem faced by learners of electronics is being unable to fully understand the abstract concepts that underlie the system responses predicted by theoretical models. This often results in learners being unable to see the link between models and actual circuits (Ronen & Eliahu, 2000). Learners frequently cannot understand the abstract concepts underlying the microscopic world of electrical circuits since they cannot see the flow of electric currents authentically, and some teachers are also unable to clearly explain the details of these complex concepts. Moreover, learners may feel frustrated and discouraged if there is no real-time feedback about a learning problem when they are attempting to understand complicated abstract concepts (Oakley, 1996). Ronen and Eliahu (2000) believed that simulation has great potential as a supplementary tool, with simulation as a medium helping learners to repair missing links between theories and actual electronics processes.
Interactive simulation learning as an area worthy of study, thus, previous studies often fail to provide the information necessary to determine if interactive simulation is indeed helpful (Vogel et al., 2006). For this study we implemented electronics simulation learning software aimed at helping learners to understand the nature of the abstract electronics concepts. The software contains two modules: (1) the concept visualization module, which provides a visualized representation with corresponding narrations and descriptions of texts and symbols to help learners understand the complicated abstract concepts, and (2) the simulative manipulation module, which guides learners to observe changes resulting from manipulations of relevant parameters, thereby facilitating cognitive reflection and integration of the relevant abstract concepts. This study investigated the effectiveness of the learning activities of visualization and manipulation, and also whether the learning results of using the learning software differed depending on whether or not it contained the simulative manipulation module.

Simulation-based Learning Activities

The simulation-based learning model constructed in this study contains three phases: concept learning, simulative manipulation, and concept clarification (see Figure 1). In the concept-learning phase, the learner conducts the activities through the visualized representation with corresponding narrations and relevant texts and symbols that help learners understand complicated abstract concepts and facilitate reflection through learning-reflection learning path. After the basic concepts are understood, a learner then manipulates parameters and observes the corresponding simulated output changes in order to iteratively reflect on the concepts and understand them in more detail through manipulation-reflection learning path. If a learner finds that learned concepts conflict with each other during manipulation, he/she can reuse the concept visualization module to further clarify them through learning-manipulation-reflection learning path.

Software for simulation-based learning of electronics was implemented to help learners understand complex and abstract concepts through the simulation-based learning model. The software comprises modules for visualization and simulative manipulation in the “half-wave rectifier”, “half-wave rectifier with filter”, “full-wave rectifier”, and “Zener diode” units. A “half-wave rectifier” is the diode circuit used to convert AC to pulsating DC is to simply allow half of the AC cycle to pass, in contrast with “half-wave rectifier”, the “full-wave rectifier” is the diode circuit used to convert AC to pulsating DC is to allow full of the AC cycle to pass. A “Zener diode” is a type of diode that permits current not only in the forward direction, but also in the reverse direction if the voltage is larger than the breakdown voltage.

Concept learning

When conducting concept-learning activities, a learner clicks on the concept visualization module that divides the learning unit into several topics, such as “half-wave rectifier circuit”, “theories of the half-wave rectifier circuit”, “the positive cycle when power is on”, “after reaching the peak value of the positive cycle, the input voltage is less than the output voltage”, and “when the voltage input is again greater than the output voltage”. For example, the learning screen shown in Figure 2 is displayed when a learner clicks on the topic of “theories of the half-wave rectifier circuit”. In the concept-learning activity, the upper-left corner and the lower-left corner of screen show the waveform of the input voltage and the output voltage, respectively. At the same time, the right side of screen allows the learner to observe how it is affected by the input voltage and the changes in electric current, thus imparting a
gradual understanding of the principles of operation of the half-wave rectifier circuit. This process is facilitated by narrations that accompany the visual demonstration. During the process, the learner can choose to pause or repeat the material, relearn it, or go to the next topic at his/her own speed.

Figure 2: Concept learning: show the waveform of input and output voltage on the screen, respectively

**Simulative manipulation**

Based on the learned concepts, a learner observes the changes of the outputs resulting from manipulating parameters in a simulative context in order to verify whether he/she has correctly understood the concepts. The simulative manipulation module asks a series of questions that guide the learner to manipulate the parameters and observe the results. The question shown at the top of the example shown in Figure 3 is as follows: “For a sine wave voltage amplitude of $V_p=30$ V, a frequency of $f=60$ Hz (Hz is the unit of frequency), and a load resistance of $R=10$ kΩ (Ω is the unit of resistance, $1kΩ=1000Ω$), please adjust the capacitance to 20 μF (F is the unit of capacitance, $1μF=10^{-6}F$) and observe the amplitude of the ripple voltage on the oscilloscope”. The question prompts the learner to adjust the value of capacitance, set the values for the circuit components, and connect the oscilloscope to the two ends of resistance R to observe whether the value of the ripple voltage is as expected. The result shows that when the capacitance was 20 μF, the ripple voltage was about 2.5 V.

Figure 3: Simulative manipulation: question prompts the learner to adjust the value of circuit components, and observe whether the value of the ripple voltage is as expected
The simulative manipulation module guides learners to conduct manipulations, and each set of questions guide learners to understand complicated abstract concepts. Each set typically comprises two to four questions. For example, for the “half-wave rectifier circuit” unit, the topic addressed by the question set comprising four questions was the inverted relationship between capacitance and ripple voltage. As shown in Figure 3, a learner conducts manipulations under the guidance given in question 1, and when the capacitance was 20 µF, the ripple voltage was 2.5 V. Question 2 prompts the learner to observe the value of the ripple voltage when all conditions remain the same except for the capacitance decreasing to 10 µF. After the manipulation, the enlarged display of the oscilloscope showed that the ripple voltage was increased to about 5 V. Question 3, which is “what is the value of capacitance that will produce the minimum ripple voltage amplitude?”, and then guides the learner to reflect on the results from questions 1 and 2. For example, based on the experimental results from questions 1 and 2, a learner may continuously adjust capacitance and observe the ripple voltage, and having a result that the ripple voltage value changes to 3.2 V when the capacitance is changed to 17 µF and, but increases to 4.2 V when the capacitance drops to 13 µF. Through the continuous manipulation of capacitance parameters and observation of voltage waveforms, the learner gradually discovers how changes in the capacitance affect the ripple voltage, as indicated by question 4: “please adjust the capacitance, observe the changes in waveforms, and decide which of the following descriptions regarding the relationship between the capacitance and ripple voltage is correct”.

**Concept clarification**

Based on the guidance provided by the questions, a learner manipulates parameters in order to understand the relationships between parameters and outputs, and cross-examines them with the concepts learned during concept learning. If the manipulation outputs match the learned concepts, the learner can draw his/her own conclusions based on the simulative results. However, if the outputs conflict with the learned concepts, the learner will return to the concept learning phase and review the relevant topics in order to resolve the conflict. For example, if the learner originally assumes that capacitance is directly proportional to the ripple voltage, but the simulative results suggest otherwise, he/she can return to the concept visualization module and review the descriptions of the function of capacitance in a rectifier circuit (Figure 4). When a learner clicks on the finger icon next to the capacitance in Figure 4 the system will explain the functions of capacitance in order to help him/her reflect on how the value of the capacitance will influence the ripple voltage.

![Figure 4: Concept clarification: review the descriptions of the function of capacitance in a rectifier circuit](image-url)
Experiments

In this study, we investigated differences in the learning performance when using electronics simulation learning software that contain either only a concept visualization module (provide learning-reflection learning path only) or both concept visualization and simulative manipulation modules (provide learning-reflection, manipulation-reflection, and learning-manipulation-reflection learning paths), in order to determine the efficacy of including a manipulation mechanism in the learning software. The learners in the experimental group used software that contained both modules in order to perform the following three activities: concept learning, simulative manipulation, and concept clarification; whereas those in the control group only performed concept learning activities through the concept visualization module.

Subjects

The research subjects were 49 sophomore students in Taipei (37 males and 12 females), all of them had learned about diodes in an electronics course provided before this study. They were randomly divided into the control group (16 males and 7 females) and the experimental group (21 males and 5 females).

Experimental design

We adopted a quasi-experimental design for the study, in which the independent variables were the groups (experimental and control groups) and the test phases (pre- and posttests). The dependent variables were the posttest results of the four units on electronics topics related to diode circuits: half-wave rectifier, half-wave rectifier with filter, full-wave rectifier, and Zener diode. In order to avoid experimental errors due to the use of different instructional methods and learning materials, the same instructor and materials were used for both the experimental and control groups. The mid-term electronics examination scores of the participants were used as covariance to eliminate the influence of prior knowledge of electronics on the learning results. The mid-term examination covered the four units related to diode circuits. Pearson's correlation coefficient between the scores of mid-term examination and pretest in the experimental and control groups was 0.63 (p=.006<.01) and 0.61 (p=.008<.01). There was a strong positive correlation between the mid-term examination and pretest scores in both groups.

Tools

The tools used in the experiments were (1) electronics simulation learning software as described above and (2) pre- and posttests constructed based on the electronics material that the participants studied. The test contents were based on college-level electronics courses, and the tests were examined and amended by two experienced instructors in this subject area. Seventy-two college students participated in the pilot study, in which 36 copies of pre- and posttests were randomly given out. The Kuder-Richardson reliabilities of the pre- and posttest were .78 and .69, respectively.

Procedures

All learners underwent a 30-minute-long pretest prior to the commencement of the experiment, with the experimental treatment beginning in the following week. The simulation learning activities lasted 3 weeks. The “half-wave rectifier” and “half-wave rectifier with filter” units were given in the first week, in which both groups underwent a 20-minute system introduction before undergoing 60-minute-long learning activities. The “full-wave rectifier” unit was given in the second week, in which both groups underwent a 30-minute-long learning activity. The “Zener diode” unit was given in the third week, and both groups again underwent a 30-minute-long learning activity. After the learning activities ended, both groups received a 30-minute-long posttest and a 15-minute-long questionnaire survey.
Results

We used a two-way mixed ANCOVA to evaluate the learning performance in both groups and compare the differences between them. After eliminating the influence of prior knowledge on the learning performance of learners, we analyzed whether there were significant differences between (1) the posttest scores in the experimental and control groups and (2) the pre- and posttest scores in each of the experimental and control groups. Table 1 summarizes the pre- and posttest scores in the two groups.

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Pretest Mean</th>
<th>Pretest SD</th>
<th>Posttest Mean</th>
<th>Posttest SD</th>
</tr>
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<tbody>
<tr>
<td>Experimental</td>
<td>26</td>
<td>74.90</td>
<td>18.55</td>
<td>84.82</td>
<td>10.87</td>
</tr>
<tr>
<td>Control</td>
<td>23</td>
<td>71.17</td>
<td>17.37</td>
<td>71.17</td>
<td>19.94</td>
</tr>
</tbody>
</table>

Tests of the homogeneity of the regression coefficient revealed that interaction $F(2,45)$ between the independent variables and covariance was .68, and not significant ($p > .05$). This confirms the hypothesis of homogeneity of the regression coefficient.

The mid-term examination scores were used as the covariance to check the significance of differences in changes in the pre- and posttest scores in the experimental and control groups. Table 2 indicates that there were interactions between the pre-/posttests and groups ($F(1,46) = 4.90, p < .05$), and a test on simple main effects was conducted.

Table 3 lists the results of a simple main effect test on the factors of group and pre-/posttest. There was no significantly difference between the experimental and control groups at the pretest ($F(1,94)=.593, p > .05$), where the posttest scores were significantly higher in the experimental group than in the control group ($F(1,94) = 7.933, p < .05$). This indicates that the learning performance was significantly better in the experimental group than in the control group. Moreover, there were no significant differences between the pre- and posttest scores in the control group ($F(1,47)=.000, p > .05$), whereas posttest scores were significantly higher than pretest scores in the experimental group ($F(1,47) = 10.620, p < .05$). This indicates that the experimental group improved significantly whereas the control group did not.

<table>
<thead>
<tr>
<th>Source of variation</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>p</th>
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<tr>
<td>Between subjects</td>
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<tr>
<td>Group</td>
<td>1920.70</td>
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<td>1920.70</td>
<td>5.616*</td>
<td>.022</td>
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<tr>
<td>Error</td>
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<td>46</td>
<td>342.03</td>
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<tr>
<td>Within subjects</td>
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</tr>
<tr>
<td>Pre-/posttest</td>
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<td>678.67</td>
<td>5.57*</td>
<td>.023</td>
</tr>
<tr>
<td>Interaction</td>
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<td>595.99</td>
<td>4.90*</td>
<td>.032</td>
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<tr>
<td>(pre-/posttest × group)</td>
<td>5606.259</td>
<td>46</td>
<td>121.88</td>
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* $p < .05$

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<th>MS</th>
<th>F</th>
<th>p</th>
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<tr>
<td>Experimental group</td>
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<th>MS</th>
<th>F</th>
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<td>Group</td>
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<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Pretest</td>
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<td>1</td>
<td>169.952</td>
<td>.593</td>
<td>.443</td>
</tr>
<tr>
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<td>1</td>
<td>274.150</td>
<td>7.933*</td>
<td>.005</td>
</tr>
<tr>
<td>Error</td>
<td>26945.913</td>
<td>94</td>
<td>286.659</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* $p < .05$
Discussion

It is commonly believed that visualization technologies have positive impacts on learning. However, the educational benefits of such technologies would be impaired if they do not help learners become active in the learning process (Naps et al., 2003), and many studies suggested that increasing interactions and opportunities for manipulation improves learning (Calaso et al., 2002; Jensen et al., 2002; Korhonen & Malmi, 2000; Naps et al., 2003; Tversky et al., 2002). Therefore, we incorporated interactive operations in computer-based visualized simulations and constructed simulation-based learning models aimed at helping learners to conduct concept explorations and verifications through concept learning, simulative manipulation, and concept clarification activities. Simulation-based learning activities help learners to acquire knowledge through the process of observation, exploration, experiencing, and reflection.

The posttest scores in our empirical study were significantly higher in the experimental group than in the control group. Moreover, the posttest scores were significantly higher than the pretest scores in the experimental group, but they did not differ in the control group. These results indicated that the learning performance was higher when integrating visualization and manipulation than when using visualization only, and was not improved when visualization was not included in the interactive manipulation mechanism.

A detailed analysis of the study revealed that learners whose grades improved in the experimental group often returned to previous topics to review concepts after completing the explorations in manipulation activities in order to clarify relevant concepts and revise previous concept models, and that this behavior was absent in those who showed no improvements. In contrast, there was no such difference between those who improved and those who did not improve in the control group. Although the learners in the control group also reviewed relevant concepts, they lacked a concept clarification process and did not gain a better understanding of the concepts or construct a comprehensive knowledge structure. This resulted in most of them not improving, and also performing worse than the subjects in the experimental group. The limitation of study is that it had focused on the qualitative exploration of learning activities; detail research is needed to analyze the learning behavioral patterns in such learning environment from a quantitative perspective.

Doulai (2001) stated that the use of computer simulation software improves the motivation of learners, with the resulting exploration activities improving their learning performance. Matching this idea with the questionnaire findings, we found that 66% of the learners in the experimental group stated that the manipulations helped to increase their interest in electronics, with 77% of them stating that manipulation benefited their learning. In contrast, only 30% in the control group stated that concept visualization motivate them, with only 48% of them stating that it benefited their learning.

Conclusions

Based on the electronics topic of diode circuits, learning models that included concept learning, simulative manipulation, and concept clarification phases were formulated in this study in order to realize learning software that contained concept visualization and simulative manipulation modules. Applying this learning software to 49 college sophomores showed that the learning performance was higher for those who utilized manipulative tools, which indicates that integrating visualization with an appropriate manipulation context benefits the learning achievements of learners. Our analysis of the learning process revealed that the important factors for an enhanced learning performance are whether learners can follow the simulation-based learning model, construct knowledge through concept learning, simulative manipulation, and concept clarification activities, make use of simulative practice to identify the nature of concepts, and integrate this with their existing knowledge.

Even though some previous studies reporting negative results about educational technology enhance learning, but other studies revealed that learning performance can be enhanced when pedagogy is sound (Kadiyala & Crynes, 2000). The meaningful learning will take place when these technologies allow learner to be engaged in the knowledge construction, conversation, articulation, collaboration, authenticity, and reflection activities (Jonassen et al., 2000). An important aspect of the pedagogical model presented in this paper is the idea that authentic manipulation in simulation-based learning environment will stimulate deeper reflection about the electronics concept while learners construct knowledge through the learning-manipulation-reflection learning path base on the
simulation-based learning model. In the learning model, another finding is that problem solving strategy used in the manipulative environment will facilitate critical reflection through the manipulation-reflection learning path. Interactive simulation helps learners engaged in the authenticity, reflection and knowledge construction activities to achieve a higher level of cognition. Moreover, interactive learning also motivates learners and useful to improve learning in complex domains (Spector, 2000).

To increase and refine our knowledge of this subject, it would be interesting to extend the study to other learning domains, and to conduct quantitative studies involving large numbers of students using these environments in real learning context. It would also be worth investigating the learning behavioral patterns, either in qualitative or quantitative studies, in the simulation-based learning environment. On the other hand, Learners exhibit diverse types of misconceptions when learning about electronics (Ronen & Eliahu, 2000). We have demonstrated the efficacy of applying simulative manipulation to learning performance, and future studies should attempt to elucidate whether simulative manipulation can clarify learner misconceptions.

References


Designing Online Learning Modules in Kinesiology

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ABSTRACT

Online-learning environment can substantially improve student learning and retention of key health concepts. In this case report, we describe our approach for the design of online learning modules to teach concepts in an undergraduate health science/kinesiology curriculum. This report describes our use of these concepts in two lower division and one upper division college courses at a major university in Texas. While our approach is based on our experience in health science/kinesiology courses, we anticipate that this report will inspire educators to explore the use of online learning principles in a variety of college courses.

Keywords

LMS, Hybrid instruction, Health science, Kinesiology, Exercise Science

Introduction

Advances in computer technology and software have opened a new age of classroom instruction. Student learners now have the opportunity to take courses that are either fully online or have a blended traditional/online, hybrid learning experience. These learning environments carry over well to corporations and professional employees. The findings of research studies have supported the notion that the key to successful online learning is the formation of an effective learning community as the vehicle through which knowledge is transmitted (Palloff & Pratt, 2007). The traditional focal points of an online learning community are: selecting the learning environment best suited for the purpose of subject material, the role of the instructor, and the role of the student. The current focus of health education research is to examine how the utilization of instructional technology can be used to effectively and efficiently achieve the demonstration of key learning objectives (Palloff & Pratt, 2007).

When online learning experiences are properly structured, they can significantly enhance a student’s ability to learn and retain information related to complex topics found in the health sciences (Gallagher et al., 2005; Herse & Lee, 2005; McFarlin, 2008; McFarlin & Jackson, 2008). Learning games play a key role in the design of effective online learning solutions (Gallagher et al., 2005). Such games or interactive learning activities allow the learner to self-test their knowledge base. The key to successful use of online learning is to follow a set of established best practices. Best practice approaches can be simple or complex depending on the educational objectives the instructor or course designer is trying to achieve. We have previously published reports regarding the effectiveness of our approach (McFarlin, 2008). In this model (McFarlin, 2008), students who took a hybrid course earned higher letter grades than students in a traditional lecture based course.

One major advantage of online learning is that it has redefined the role of the health educator such that they are a facilitator at the center of an active learning environment rather than the instructor of the content (Junco, 2007). Some authors have suggested that this new focus provides evidence that the traditional authoritative relationship between the educator and student needs to be reexamined (Palloff & Pratt, 2007). In fact many health educators have embraced the strengths of student directed active learning environment and blended these with traditional health education models (Goldberg et al., 2006).

The key purpose of this manuscript is to describe the approach we developed for the design and implementation of online learning modules in undergraduate kinesiology courses. We have previously demonstrated that our learning module design approach is associated with an improvement in student grades (McFarlin, 2008) and can serve as the foundation of an anti-obesity program targeting college students (McFarlin & Jackson, 2008).
Program Approach

Student Population

Today’s students are part of the net generation, born after the invention of the first computer. The key characteristics of net generation students are: that they are driven by commitment, social and team-oriented, experiential, and multitask learners (Junco & Mastrodicasa, 2007). Net generation students want to reach and draw their own conclusions through exploration. In addition, these students have developed a cognitive processing style due to their learning process through the use of familiar technology (Junco & Mastrodicasa, 2007). As such, traditional lecture courses do not always engage these students at the highest level. Redefining this role of the teacher does not imply a reduction in student-faculty contact hours. Instead, a use of technology through an online learning environment relieves the instructor from being primarily responsible for delivering core content and enables them to use the physical classroom for engaging students in higher level seminar-style discussions. Well-designed online/hybrid instruction represents one means by which the needs of today’s students can be addressed (McFarlin, 2008).

Targeted Courses

The current report utilized information collected during the design of three courses in the Health and Human Performance department at the University of Houston. The courses were KIN1252 (Foundations of Kinesiology, Full Online Delivery), KIN1304 (Public Health Issues in Physical Activity and Obesity, Full Online Delivery), and KIN3306 (Physiology of Human Performance, Hybrid Delivery). KIN1252 and KIN1304 utilize online learning modules (LM) as a primary content delivery tool targeting freshmen and sophomores, while KIN3306 uses LMs to provide introductory information for traditional in-class lectures targeting juniors and seniors. While the fully online and hybrid courses differ in their content and approach we have found that learning and content retention is similar (McFarlin, 2008).

![Figure 1: Learning Module Components](image-url)
Course Design and Administration

Proven successful online learning environment platforms can be used to standardize the teaching of a large number of students in introductory kinesiology courses (McFarlin, 2008; McFarlin & Jackson, 2008). For this manuscript, we selected to examine our approach to designing online learning modules for three unique courses. Two of these courses were fully online (KIN1252 and KIN1304), while the third course was hybrid (KIN3306). Our approach to these three courses has been designed to address the unique learning needs and expectations of today’s students. Most of these students have grown up with the Internet and expect to instantly have access to all learning materials necessary (Goldberg & McKhann, 2000; Knight & Wood, 2005; Goldberg et al., 2006).

Our courses were administered using the Blackboard Vista learning management system (LMS), which is commonly used at colleges and universities in the United States. Each course included a series of 8-9 learning modules (LM) that have been designed by our course development team headed by Dr. McFarlin. Each LM covers a different topic, but the fundamental structure of each LM is the same. Each LM includes (Figure 1) an enhanced, narrated online lecture presentation; downloadable lecture notes; downloadable lecture audio; online learning games; learning games that can be transferred to an Apple iPod; and a learning assessment quiz. We have previously demonstrated that this approach is effective at increasing learning of key concepts (McFarlin, 2008; McFarlin & Jackson, 2008). In our approach, students learn concepts by initial exposure (in the lecture) complemented with reinforcement (through learning games). The objective of this case report is to provide a guide for the development of online/hybrid LMs using our approach.

Structure of Online Lectures

Our approach relies on the development of custom online lectures. Our development process for these lectures included a multi stage approach. Initially, we developed storyboards to outline how the lecture would achieve specific learning objectives. The storyboards typically go through 2-3 revisions prior to the development of the final PowerPoint based storyboard. At this time we develop a written script to accompany each slide. The slides we develop are designed to be media-rich with minimal written text. In our experience this allows the learner to focus on the content rather than trying to memorize all of the written text (McFarlin, 2008; McFarlin & Jackson, 2008). Once the PowerPoint slide deck is complete, we utilize Articulate Presenter from the Articulate Studio (New York, NY) to record our narrations and animations. Articulate Presenter is the ideal tool for individuals who are new to courseware design, as well as advanced designers, because of its ease of use and integration directly into PowerPoint 2007 (Figure 2).
In addition to slide narration/animation, Articulate Studio is able to embed graded or ungraded learning games directly into the enhanced lecture. If the final product is used with an LMS, then the enhanced lecture can directly report student responses to questions. The use of learning games also allows the instructor to control the student’s flow through the lecture in a non-linear fashion (Figure 3). For instance, we typically integrate ungraded learning games every 5-7 slides. The learner must score 70% correct in order to “unlock” the next section of the lecture, if they score <70% then they will be directed to a series of remediation slides. This approach is significant because it allows the lecture to be customized to meet the unique learning needs of each student that watches it. Traditional classroom lectures have long been bound by restrictions that force presentation of material in a linear fashion. One major advantage of online instruction is that this restriction can be removed allowing for learning experiences to be custom tailored to the unique needs of each learner.

The final output of Articulate Presenter is a flash-based SCORM compliant lecture that can be loaded in our LMS (Figure 4). In addition to the interactive lecture, Articulate also allowed for us to produce a “notes” format (in PDF format) and an audio version that can be made available for the students to download for offline review. After the audio is produced, we load this into GarageBand (Apple audio editing software) and use jpg images of the lecture slides to develop enhanced Podcasts. The enhanced Podcasts are made available for download within each LM folder. Combination of online enhanced lectures, downloadable notes, and downloadable enhanced Podcasts provides the learners with three distinct mediums for exposure to material associated with the LM’s learning objectives.
Learning Games

Interactive gaming technology is a useful tool to enhance student exposure to key course concepts. These tools have become popular in the education realm in the past 10 years (Annetta & Holmes, 2006). When used to complement other learning activities, research has demonstrated that learning games are an effective way to reinforce key learning objectives (Sanchez et al., 2009). In our present design, we utilize two types of learning games. First, we produced basic learning games to work online via Blackboard using a question bank imported into Respondus Studymate (New York, NY) software. Activities include interactive flash cards, crossword puzzles, word finds, fill-in-the blank, matching, and challenge questions (Figure 5). The second type of learning game used was a portable quiz show format (iQuiz) that works with specific models of the Apple iPod. We are presently working to develop this interaction to work with other brands of portable media players and mobile phones. The combination of these basic learning games allows the learners to interact with and engage in the content associated with a specific LM’s learning objectives.

![Interactive Learning Game](image)

Figure 5: Interactive Learning Game

Formal Assessment of Learning Objectives

Once the student has completed the learning activities for a given LM, they are provided the opportunity to complete a graded assessment using the Blackboard assessment function. In this assessment, students are randomly presented with a set of 10 questions from a question bank with a minimum of 60 questions. The learners are allowed unlimited attempts to take an assessment and the final grade is recorded as the highest of their attempts. After each attempt, students are notified of which questions they have missed, but not the correct answer to those questions. The vast majority of students in our courses review the LM material again to locate the correct answer, which is yet another strategy that we use to reinforce learning. The formal LM assessments (i.e. count toward their grade) only account for a small portion of their final grade. The major determinant of the learner’s final grade in one of our courses is traditional examinations that are given either in the classroom (KIN3306) or online (KIN1252 and 1304).

Course Evaluations

The approach to the design of online learning modules, presented in this report as developed over a number of years use student feedback from formal and informal course evaluations. Effective course and LM design requires feedback from the learner. The efforts of the course design team will only be effective if the students feel that the learning matches their unique needs. As such, our design team has been proactive at soliciting feedback from our learners. We are interested in encouraging our students to provide constructive and honest feedback regarding the course. We collect this information through a series of anonymous surveys that are given throughout the semester.
Student input is extremely important to the success of designed courses and it is important that the course design team continues to make this a major component of the evaluation of any course.

Another means by which to evaluate course effectiveness is to examine student grades (McFarlin, 2008), although higher grades do not necessarily mean that the student has learned more in a given course. To partially combat this problem, we have attempted to develop formal evaluations (i.e. graded quizzes and exams) that test the students’ ability to apply the information that they have learned rather than merely demonstrating that they have memorized it. Another approach to testing that we have recently begun to use is to provide a similar pre- and post- test that includes a short assessment of the key concepts in the course. If properly designed, such assessments can provide practical information regarding student learning (Dancy & Beichner, 2002). We have designed our pre- and post- test surveys in such a way that we could also administer these at 6- and 12-months after the course is complete in order to assess long-term retention of key concepts. A combination of information collected from assessments is important to the design of effective courses.

Conclusions

In summary, online learning modules can be designed, which are effective at teaching complex material to large undergraduate courses. We have validated our approach in course delivery mechanisms with different levels of students. Specifically, we targeted freshman and sophomores (KIN1252 and KIN1304), as well as juniors and seniors (KIN3306). Lower division courses typically require a different level of content delivery than upper division courses and a major strength of our approach is that we have validated our approach across this range. In general, the examinations in KIN1252 and KIN1304 focused on teaching students basic foundation material, while KIN3306 focused on upper level, advanced applications. This report demonstrates that our approach to the development of online learning modules is well suited for a variety of applications on content levels. It is our expectation that this case report will encourage current health educators to explore the use of online/hybrid learning techniques.

Future work in this area should use factor analysis to determine which aspects of online learning modules provide the most effective boost in academic performance and content retention. More research is needed to understand how learning games can be used to increase learning of both foundation and advanced topics. We are also in the process of use our approach in other courses on the University of Houston campus and when these courses are finished we will complete a systematic analysis of our online course effectiveness.

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References


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Textbook Details:
Handbook of Online Learning (2nd Edition)
Edited by Kjell Erik Rudestam and Judith Schoenholtz-Read
SAGE Publications (http://www.uk.sagepub.com/textbooksProdDesc.nav?prodId=Book232276)

Edited by Rundenstam and Scoenholtz-Read, the second edition of the Handbook of online learning (2010) provides an extension to the already rich content of the first one. By including new chapters that analyzed recent topics in the area of online learning, such as globalization, the ethics dimension and the psychology of online learning, open sources possibilities, and the use of new media technologies for teaching and learning, the book constitutes a valuable piece of literature for any library committed to the online learning scenario, and a precious source for instructors, administrators and IT support teams.

The editors are experts in psychology and education, which gives them the academic credentials to support the research and analysis presented in the book. Judith Schoenholtz-Read (EdD Counseling Psychology UBC) is a member of the Psychology Program at the Fielding Graduate Institute in Santa Barbara, California. Kjell E. Rudestam (PhD) is the Associate Dean of the School of Psychology at the same institution.

The book starts with a reflection on the promising growth of adult education around the world. The novelty of this approach resides in the fact that this book targets the new challenges that online brings to the field of teaching and learning, where the learner is at the centre and where information technologies serve not only as resources, but also as possibilities for interaction, motors for critical thinking and opportunities for connecting learning and the workplace.

As the use of Web 2.0 technologies increases in the educational arena, the concept of learning also evolves. From the learner’s perspective, it requires an open mind and a disposition to access and share knowledge. From the instructor approach it demands a different understanding of the learner and his/her approach to knowledge. From the institution point of view, it requires the compilation of policies that will support access to open sources, and an innovative analysis of funding resources.

The book is divided in two big sections following the traditional division of knowledge: theory (philosophy) and practice. The first section of the book includes the different perspectives of nine theorists in the area of online learning with regard to topics such as tele-learning, culture & community implications for online environments, social systems, globalization, ethics and research. The online learning phenomena is framed not only as a tool (that implies synchronous and asynchronous activities), but also as a learning possibility that has radically transformed the way that knowledge is accessed, shared and produced.

The second part of the book focuses on the implementation of online teaching and learning. The editors have divided this section in three areas that target the interest of course developers, instructors and students, and administrators and IT support teams. From a technological perspective, probably the most significant and innovative chapter of this part of the book is chapter 12, which presents an interesting analysis of the use and design of intelligent tutoring systems available for course developers and students (from Web 2.0 to virtual reality) in the framework of the 21st century.

From the students’ and instructors’ point of view, probably the most useful chapter in this section is chapter 15,
where new support techniques and learning strategies to improve online teaching and learning are suggested. Three very useful scorecard measures to examine institutional, instructors’ and students’ readiness for online teaching is presented, where strategies such as institutional mission, peer collaboration among instructors and students’ learning management techniques are stated.

In the global environment where online education is delivered, shared and analyzed, including a chapter that will address issues such as accreditation and learning quality was a must. Chapter 18 addresses precisely this challenges and provides a framework of conduct for those institutions doing the transformation between face to face teaching to online delivery. Issues of students’ funding are presented and practical tips are included.

The final chapter of the book offers a logical inclusion of central role that virtual libraries are playing in online learning. The author in this chapter analyzes the new conception of library as the virtual space where not only texts can be accessed, but also text messages, images, and virtual spaces can be explored. Interesting to note here that, as multimedia resources become available to the instructor and the learner, the possibility of ownership of knowledge is transformed while the capability of accessing it grows beyond physical limits. The library is no longer a real place in a geographical setting, but a virtual reality limited only by the imagination and the capabilities of cyberspace.

In addition to its various analyses, the book includes very useful references for further reading and exploration. Even if a proper chapter where conclusions and further research are presented is missing, these materials make the book an important teaching tool for students and others working in education, learning design, educational technologies, and technology policies. Given the reviewer’s background in e-learning policies for higher education institutions, the investment that Rudestam and Schoenholtz-Read have made to establish the theoretical-practical stage of online learning is appreciated. The work of the authors in this book promises to guide both experts and researchers in the exploration and analysis of online learning.
(Book Review)

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Textbook Details:  
Authored by Andreas Holzinger  

Research Methods is unique. It exacts deeper insights from researchers resulting in validated proofs using rigorous scientific methods while being flexible about the selection and compatibility of the methods, interpretation of the results, and scope of the research. The extent of research methods is emergent in nature. Every significant piece of research not only contributes to the evolution of the human knowledge frontier, the ‘what’, but also enriches the process mechanisms underlying research, the ‘how’. There are hundreds of books, articles, notes, tutorials, guidelines, sites, blogs, cases, and clips on research methods. Many of them attempt to generalise the applicability of methods. That is, a single set of methods could be applied over a wide range of research questions across multiple subject domains. Some of them attempt to specialise, such as ‘research methods in education’, where the methods are grounded and tuned specifically to the domain of Education. This book belongs to the later. Further, it takes a rather extreme approach to customise research methods by outlining specific research processes that researchers in a particular academic institution are expected to adhere to. It still serves as an excellent reference manual for general readers to have an all-encompassing view on research methods in addition to associating institution-specific (Technical University of Graz) processes to methods.

The book outlines 17 key topics including ‘how to find a research topic’, ‘systematic literature review’, ‘English as a language of science’, ‘research methods in HCI’, ‘data analysis’, ‘presenting your work – talk’, ‘target: conferences’, and ‘target: research grants’. Roughly, the first half of the book presents material that seemingly corresponds with workflow processes that a researcher at the Technical University of Graz is expected to follow. The second half introduces research skills such as presenting a piece of research in forms such as poster, talk, and writing, targeting publication avenues such as journals and conferences, and finally securing research grants.

Introduction to the background of research is crisp, quickly enabling the reader to want to read more. This immediately follows a timely introduction to abbreviation and acronyms, which could use some additional entries to cover context-specific abbreviations (for example, LV 706.117 in page 18). The third section is about processes that are meant for researchers at the Technical University. Each step of the process has been outlined, rather than described, and comes with pointers for further reading in sections that follow or elsewhere. This section needs a review for language and formatting.

One of the highlights is the words of wisdom from the author planted throughout the book. For instance, the author asks the readers to seek ‘future outlook’ sections of relevant papers in conference proceedings. Section 4, in particular, has many such practical and strategic points of view borne out of the author’s experience.

Some material could use a revision as in Bloom’s revised taxonomy. Section 5 is a wealth of information on systematic literature review. It categorises the types of literature and exemplifies relevant computational access to securing these literature. The pictures that exemplify could use a higher resolution printing to be able to read what exactly they portray. This section also introduces researchers to popular reference software, reference styles, patents, and citation metrics – important topics for new researchers.
Section 6 on English as the language of science is sympathetic to researchers at the Technical University who might require additional guidance in writing in English. Section 7 is about the format of the thesis, again specific to the University’s requirements. There is some coverage on plagiarism but a discussion on research ethics is surprisingly missing. Sections 8, 9, and 10 introduce research designs and techniques in clear terms with detailed explanations that differentiate multiple designs. Importantly, these designs have been selected for specific use in the domains of computer science and informatics, particularly in the area of human-computer interaction.

Section 11 minimally introduces statistics and their interpretations. Still, these outlines are terse and offer exactly what a new researcher is looking for. Sections 12, 13, and 14 discuss effective ways of presenting posters, giving a talk, and writing a document. Again, these sections are customised for the researchers at the Technical University while offering some guidelines for general readers. Section 14 is particularly impressive with its portrayal of a big-picture approach to writing.

Sections 15, 16, and 17 introduce resources for conference publications, journal publications, and funding avenues, respectively. A brief on prioritising and selecting conferences and journals is missing from these sections. The section on ‘writing project proposals’ is written brilliantly. Undoubtedly, it will be of immense use to all new researchers. The glossary, index and bibliography are expectedly concise.

This book is all about personalised instruction to research methods. It includes highly personal opinions such as ‘avoid wikipedia’ or ‘I require my research students to…’. At the same time, it offers generic introduction to research designs. Those researchers who look for a rather quick introduction to research methods will benefit immensely from this book. Advanced researchers are better served with further readings. This down-to-earth introduction to research methods and research processes will be a revelation to many computing schools. This reviewer highly recommends that schools develop such custom material and offer custom courses on research methods with specific extensions to underlying research processes.