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 The articles should be original, unpublished, and not in consideration for publication elsewhere at the time of submission to Educational Technology & Society and three months thereafter.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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MOOCS as Accelerators of Social Mobility? A Systematic Review

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ABSTRACT

Due to their perceived scope and openness to socially underprivileged groups, Massive Open Online Courses (MOOCs) have been presented as tools to enhance social mobility. However, there has also been evidence to suggest that MOOCs are mainly beneficial for privileged groups and could even contribute to an increasing gap in educational opportunities between privileged and underprivileged populations. This systematic review has evaluated 31 empirical studies to examine how MOOCs benefit the socially privileged in comparison to underprivileged groups. The literature has pointed out specific formal barriers that might make MOOCs less accessible for underprivileged learners. In addition, enrollment demographics displayed that the majority of MOOC learners is well educated, employed and from developed countries. Finally, the literature suggested that privileged learners could be more likely to complete a MOOC. Nevertheless, the literature indicated a notable share of underprivileged learners that would otherwise not enjoy higher education. Moreover, it is suggested that certain MOOCs might serve underprivileged learners more than other MOOCs. The implications of these findings and recommendations for future research will be discussed.

Keywords

Massive open online courses, MOOCs, Distance education, Digital inequality

Introduction

Whereas education can be perceived as a means to social mobility, there are still significant barriers towards the equality of educational opportunities (e.g., Konstantinovskiy, 2012; Triventi, 2013). With the upswing of Internet, online education has evolved as a new instrument to reach those less able to enroll in formal institutions (Kuriloff, 2005). Massive Open Online Courses (MOOCs) developed as a specific form of online education, comprising well-structured, mainly university-level, programs. Since MOOCs charge small or no fees and can take up unlimited amounts of students, they are expected to alleviate barriers to higher education (Rohs & Ganz, 2015). More specifically, MOOCs seem to provide viable alternatives for higher education in developing countries where access to education is relatively limited (World Bank Group, 2012) or in countries where annual tuition fees can exceed 10,000 dollars (Usher & Medow, 2010).

However, empirical evidence has shown mixed results with regards to the social mobility in MOOCs. On the one hand, research has demonstrated that MOOCs enable less privileged groups to improve their career trajectory against lower investments than in formal higher education (Zhenghao, Alcorn, Christensen, Eriksson, Koller, & Emanuel, 2015). On the other hand, studies suggested that barriers to enrollment in MOOCs are relatively higher for underprivileged individuals (Yañez, Nigmonova, & Panichpathom, 2014) and that less privileged populations are underrepresented in certain MOOCs (e.g., Emanuel, 2013). Even though these findings seem to contradict, it could be that outcomes with regards to social equality depend on the specific characteristics of the MOOC under study. Considering the large diversity of subjects, pedagogies and languages in MOOCs (Shah, 2014), studying a wider variety of MOOCs might help to identify larger trends of social inequalities. Reviews on MOOC literature, for example, have indicated that especially South-East Asian and African learners are in minority in the MOOC population and that linguistic or cultural difficulties could be the source of these inequalities (LiyanaGunawardena, Adams, & Williams, 2013a; Rolfe, 2015). Moreover, one review indicated that inequalities in MOOC participation could be caused by an uneven occupancy of electronic equipment, Internet and digital literacies (Valentín, 2015). Even though these reviews identified and explained social inequalities in MOOCs, they did not systematically evaluate the scope and the quality of the existing empirical evidence and to what extent these could support general conclusions. These reviews neither compared the social implications of MOOCs against other forms of education, which hampers an intelligible interpretation on the impact of MOOCs in the educational landscape. Addressing these issues in a systematic review will help to understand whether, which and how MOOCs currently enhance educational opportunities for those otherwise underprivileged.
Theoretical background

In order to understand social inequalities and to define privileges in formal education, the social- and cultural reproduction theory forms an intelligible framework (Bourdieu, 1973; Bourdieu, 1986). This theory explains educational participation, success and attainment by different forms of “capital”. On the one hand, it is acknowledged that economic capital, in terms of financial investments and the ability to spend time off paid labor, is an important condition for educational participation (Bourdieu, 1986). Social and cultural capital, on the other hand, represent the knowledge, social ties and cultural conceptions that make it easier to function in educational institutions (Bourdieu, 1973). These latter forms of capital constitute more hidden conditions for educational success, as these tend to be conveyed within families and internalized at an early age (Bourdieu, 1986). Based on these assumptions, those who are raised in culturally and socially dominant contexts and possess a solid financial background could be regarded as privileged in formal education sectors. Underprivileged individuals, consequently, have relatively less resources in the financial and social domain and their cultural understandings might diverge more from those in educational institutions. Considering their usefulness to understand privileges in education, this study will adopt these conceptualizations in order to compare whether and to which extent MOOCs could improve social equality in comparison to formal education.

The present study

This study aims to synthesize empirical evidence on the potential of MOOCs to reach and serve those who are privileged versus underprivileged in formal education. As this study will systematically evaluate empirical findings on social inequalities in MOOCs, it could provide fundamental insights on the scope, strengths and limitations of evidence on this issue. Therefore, the research outcomes could inform MOOC providers on the social implications of MOOCs. In addition, it will help to estimate the validity of previous findings and could inform researchers on specific issues related to studying social inequalities in MOOCs.

Based on these concerns and the theoretically based conceptualizations of privilege, the following three research questions guided the research process:

- To what extent are formal barriers to MOOC participation inequal for underprivileged and privileged groups?
- To what extent is MOOC enrollment inequal between underprivileged and privileged groups?
- To what extent is MOOC completion inequal between underprivileged and privileged groups?

Methods

Literature selection

The literature search for this review was conducted from the 17th to the 26th of October 2015. Three databases, ERIC, Webofknowledge and Google Scholar, were chosen for the reliability, quality and the relevance of their sources. In order to reach a broad scope of literature, “MOOC” was used as a general search term in ERIC and in Webofknowledge. In Webofknowledge this yielded many articles in irrelevant research domains such as chemistry or music history. Hence, a filter for social science domain was added in the literature search. The searches yielded 207 articles in WebofKnowledge and 270 articles in ERIC, with some overlap in the presented articles. To amplify the selection of literature, Google Scholar was searched for “MOOC accessibility,” “MOOC reach,” “MOOC qualitative,” “MOOC quantitative” and “MOOC demographic.” The criteria for the selection of articles were that (a) it concerned an empirical study (b) the study provided of either data on formal barriers, learner demographics or completion and (c) implications of these data could be related to patterns of social equality or inequality. These criteria were considered to lead to a selection of high-quality and relevant studies that would be relevant for answering the three research questions. The final selection of articles comprised 31 studies published in the period of 2013-2015, sorted for their relevance for the three research questions. These studies are marked with an asterisk (see References).

Coding

The analysis started with a process of open coding. In this phase, the first author distinguished text fragments in the studies that could be relevant for at least one of the research questions. Open codes constituted descriptive labels for these text fragments. In the next phase, the first author compared the open codes and grouped the codes
to compose specific sub-domains within the research questions. These sub-domains were labeled, which constituted a proposed code structure. In order to secure the validity of the codes, the second author reviewed the codes in reference to the associated text fragments and provided suggestions for adjustments in case of discordance. Finally, the authors collaboratively associated each of the selected articles with at least one code, along with a specific negative or positive orientation. Table 1 provides a clarification of the codes. An elaborated table on the analyses can be found at www.orhanagirdag.com/jets.

<table>
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<tr>
<th>Research question</th>
<th>Code</th>
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<tr>
<td>What are the formal barriers to participation in MOOCs?</td>
<td>ICT – ICT access</td>
</tr>
<tr>
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<td></td>
<td></td>
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<tr>
<td>To what extent do enrollment rates show patterns of social (in)equality in MOOCs?</td>
<td>EDU – Educational attainment</td>
</tr>
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<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>To what extent do completion rates show patterns of social (in)equality in MOOCs?</td>
<td>EDU – Educational attainment</td>
</tr>
<tr>
<td>Relation to social equality</td>
<td>SKL – Skills and Knowledge</td>
</tr>
<tr>
<td></td>
<td>(+) – positively related to social equality</td>
</tr>
<tr>
<td></td>
<td>(-) – negatively related on social equality</td>
</tr>
<tr>
<td></td>
<td>(+/-) – ambiguously related to social inequality</td>
</tr>
</tbody>
</table>

The codes selected for the first research question represented three formal barriers that were interrelated with privileges in education. The first code, “ICT access” (ICT), represented the requirement of hardware, software and Internet infrastructures, indicating both social and economic privileges. The second code, “Prerequisite Knowledge” (PRK), described the necessity of prior knowledge in MOOCs as a privilege in the cultural domain. The code “Costs” (COS) indicated the social implications of financial requirements in MOOCs. The codes for the second research question represented privileges that could be derived from learner demographics. The code “Educational attainment” (EDU) represented information on learners’ highest obtained diploma, as an indicator of general privilege in formal education. As all articles used the bachelor diploma as a reference category, well-educated learners were defined as “having a bachelor’s degree or higher” and less educated as the remaining population. Furthermore, the code “Occupational position” (OCC) demonstrated information on employment rates within the MOOC population and industries of employment. Employment rates were depicted in four categories: “employed,” “student,” “retired” or “unemployed,” where the full-time, part-time and self-employed populations are all integrated into the “employed” category. The third code, “Geographical Location” (GEO) comprised information on the residence of learners, indicating privileges due to cultural resources or social ties. The codes for the third research question explained or predicted MOOC completion by learner characteristics that could be related to privilege. The code “Educational Attainment” (EDU) addressed the potential impact of educational background, as an indicator of privilege in formal education, on completion. The second code, “Skills and Knowledge” (SKL) represented the influence of prior knowledge and skills on completion. Skills and knowledge were considered as indirect indicators of social, cultural and economic background as they represent the quality of experienced education, the absence of financial constraints to participate in education and a favorable upbringing. All of these codes were complemented with a code for their relation to social equality, indicating either a positive (+), negative (-) or ambiguous (+/-) association with social equality.

Results

Formal barriers to MOOCs

The online availability, absence of pre-selection and low expenses support the expectation that MOOCs alleviate barriers to higher education for those less privileged in formal education. Still, the literature indicated three potential barriers that might hamper the access to MOOCs specifically for underprivileged students. These barriers were related to ICT access, prerequisite knowledge and costs, indicating the necessity of financial, cultural and social resources for MOOC participation.

ICT access

Five studies discussed ICT access as a barrier to MOOC participation. Only one case study did not acknowledge ICT requirements as a barrier, stating: “Personal computer and Internet access, as well as minimal computer
literacy are the only prerequisites to register and access MOOCs” (Leontyev & Baranov, 2013, p. 1534). In contrast, other studies indicated that especially underprivileged learners might be unable to access MOOCs due to this requirement. First, it was emphasized that learners from isolated regions in developing countries experienced more impediments towards MOOC participation than those in urban areas, considering the unreliability of electricity provision, the remoteness of Internet facilities and the poor quality of those facilities (Alcorn, Christensen & Kapur, 2015; Liyanagunawardena, Williams & Adams, 2013b). Although there are initiatives to provide offline content and hardware in rural regions (Hollands & Tirthali, 2014), the impact of these interventions is restricted to certain areas and small supplies. Moreover, it was pointed out that there is a substantial number of families in Western countries that is unable to access Internet in their own homes (Evans & McIntyre, 2014). Computers in public libraries do not provide viable solutions, as learners are often disallowed to download the necessary software or visit the relevant websites on these computers (Audsley, Fernando, Maxson, Robinson, & Varney, 2013). This illustrates that the social context can hamper ICT access as a requirement for MOOC participation.

Prerequisite knowledge

Although MOOCs do not preselect students based on their academic records, seven studies indicated that prerequisite knowledge could be a barrier towards MOOCs. Of all courses on Coursera, Udacity and Edx, 29 percent required some background knowledge, like English proficiency, programming skills, or educational attainment (Audsley et al., 2013). These requirements might depend on the perceived difficulty of the course. A study on humanities MOOCs found that 20 percent specifically stated that an academic background or prior knowledge was required (Evans & McIntyre, 2014), whereas a study on medical MOOCs indicated 47 percent required background knowledge (Liyanagunawardena & Williams, 2014). In these and other domains, there were also courses that either gave conflicting information on the required level of experience (Evans & McIntyre, 2014), suggested prior knowledge was helpful (Liyanagunawardena & Williams, 2014) or did not state any indication on the level of the course (Raposo-Rivas, Martinez-Figuira & Sarmiento Campos, 2015). Even though MOOCs rarely meet the complexity of university level courses (Rhoads, Camacho, Toven-Lindsey, & Lozano, 2015), these ambiguous or compelling messages might dismay those with less background knowledge or academic experience. In this way, cultural or educational factors can play a role in MOOC participation.

Costs

Even though MOOCs are generally perceived as free of cost, six studies discussed their financial barriers. In general, it is noted that MOOCs offer underprivileged populations the opportunity to enjoy higher education due to their affordability (Rhoads et al., 2015). Even for certain courses that require payments for personal certificates, there are financial aid programs for students who can proof they cannot afford these (Audsley et al., 2013). However, the fact that most platforms currently run on unsustainable business models leaves it uncertain what will happen with the height and frequency of the certificate fees (Evans & McIntyre, 2014). If these costs increase in their size and forcefully, it will become less likely that underprivileged students opt for a certificate. Another potential financial barrier is interrelated with the barrier of ICT access. Namely, a substantial share of families with lower incomes is unable to buy the appropriate ICT equipment to participate in MOOCs (Evans & McIntyre, 2014). Especially in countries where Internet provision is unstable or of poor quality, watching online lectures might require relatively expensive extra bandwidth (Hollands & Tirthali, 2014). Other potential costs could evolve from additional learning materials, as many MOOC instructors strongly recommend and a smaller percentage requires the purchase of reading materials, technical gear or other materials (Audsley et al., 2013; Evans & McIntyre, 2014). Even though these costs are marginal in comparison to the overall costs of formal higher education, it shows that financial requirements might have a filtering effect for those less affluent.

Patterns in MOOC enrollment

As demographic data of MOOC learners could characterize their relative privilege, they can be adopted to interpret potential inequalities in enrollment. Most frequently reported demographic data comprise learners’ educational attainment, representing the ability to achieve success in formal education. In addition, the data contains information on learners’ occupational position, which could represent financial advantages and professional relations. Finally, the geographical location could indicate privileges related to cultural understandings and social surroundings that could advance educational opportunities.
Educational attainment

Fifteen of the selected studies provided information on the educational attainment of learners. These studies focused on one or multiple MOOCs on four major platforms. One study revealed the overall data of Coursera, currently the largest MOOC platform (Robinson et al., 2015). Table 2 shows an overview of these studies, including the related subject domain of the MOOC, the facilitating university and university ranking, as well as the percentages and absolute numbers of learners with a bachelor’s degree or higher.

Table 2. Selected case studies, MOOC characteristics and learner data

<table>
<thead>
<tr>
<th>Article</th>
<th>Field of study</th>
<th>University</th>
<th>QS World Ranking (2015)</th>
<th>bachelor’s degree or higher %</th>
<th>Respondents with bachelor or higher / All respondents</th>
</tr>
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<tr>
<td>Alcorn et al. (2015)</td>
<td>All courses</td>
<td>University of Pennsylvania</td>
<td>18</td>
<td>82.1%</td>
<td>122,239/148,955</td>
</tr>
<tr>
<td>Banerjee &amp; Duflo (2014)</td>
<td>Economics</td>
<td>MIT</td>
<td>1</td>
<td>82.0%</td>
<td>3,772/4,600</td>
</tr>
<tr>
<td>Christensen et al. (2013)</td>
<td>Multiple</td>
<td>University of Pennsylvania</td>
<td>18</td>
<td>79.4%</td>
<td>27,630/34,799</td>
</tr>
<tr>
<td>DeBoer et al. (2013)</td>
<td>Electronics</td>
<td>MIT</td>
<td>1</td>
<td>70.9%</td>
<td>2,138/3,014</td>
</tr>
<tr>
<td>Dillahunt et al. (2014)</td>
<td>Multiple</td>
<td>University of Michigan</td>
<td>30</td>
<td>80.0%</td>
<td>33,366/41,709</td>
</tr>
<tr>
<td>Gillani &amp; Eynon (2014)</td>
<td>Business</td>
<td>ns</td>
<td>ns</td>
<td>81.9%</td>
<td>6,009/7,337</td>
</tr>
<tr>
<td>Goldberg et al. (2015)</td>
<td>Understanding</td>
<td>University of Tasmania</td>
<td>379</td>
<td>51.0%</td>
<td>2,637/5,168</td>
</tr>
<tr>
<td>Greene et al. (2015)</td>
<td>Metadata</td>
<td>University of North Carolina</td>
<td>79</td>
<td>81.0%</td>
<td>4,298/5,306</td>
</tr>
<tr>
<td>Guo &amp; Reinecke (2014)</td>
<td>Multiple</td>
<td>MIT, Harvard &amp; Berkeley</td>
<td>1, 2, 26</td>
<td>78.2%</td>
<td>86,191/110,162</td>
</tr>
<tr>
<td>Liyanagunawardena et al. (2015)</td>
<td>Programming</td>
<td>University of Reading</td>
<td>156</td>
<td>69.9%</td>
<td>4,377/6,263</td>
</tr>
<tr>
<td>Robinson et al. (2015)</td>
<td>GiS</td>
<td>Penn State University</td>
<td>101</td>
<td>84.1%</td>
<td>6,350/7,551</td>
</tr>
<tr>
<td>Schmid et al. (2015)</td>
<td>Several</td>
<td>Duke University</td>
<td>29</td>
<td>67%</td>
<td>18,719/27,939</td>
</tr>
<tr>
<td>Sánchez-Vera et al. (2014)</td>
<td>Web Science</td>
<td>University of Southampton</td>
<td>81</td>
<td>43.0%</td>
<td>345/802</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
<td>78.7%</td>
<td>320,646/407,183</td>
</tr>
</tbody>
</table>

*Note. ns = not stated.*

Table 2 shows that, in all studied MOOCs, there was an evident majority of highly educated learners. However, the figures are mainly based on samples with a high level of survey non-response. One study explicitly discussed the large probability for non-response bias (Salmon, Gregory, Lokuge Dona, & Ross, 2015) and was therefore excluded from the analysis. Still, we should interpret the remaining figures as approximations for the actual proportions, keeping in mind the potential bias.

Moreover, as the figures vary somewhat among MOOCs, it could be that particular characteristics of MOOCs could attract or serve underprivileged learners. Withal, the two MOOCs with the lowest proportion of well-educated learners (Goldberg et al., 2015; Sánchez-Vera, León-Urrutia, & Davis, 2014) shared one specific characteristic: They both accommodated their instructional design to the needs of less experienced learners. The Understanding Dementia MOOC, for example, allowed learners to study at a flexible pace and to retake the exams as many times as they would like in order to accommodate learners with different levels of prior understandings and skills (Goldberg et al., 2015). The Web Science MOOC mainly considered the understandability of the reading material for non-native speakers and learners without an academic background (Sánchez-Vera et al., 2014). The fact that these two MOOCs specifically considered the non-academic audience
in their instructions could have had a positive effect on the proportion of less educated learners enrolled in these MOOCs. Nevertheless, as these are only exemplary cases for today’s large supply of MOOCs, these explanations are limited to serve as suggestions.

**Occupational position**

The occupational position of MOOC learners has been the focus of ten selected studies. Table 3 provides an overview of the articles, the reported formal employment rates, industries of employment and the total amount of respondents. Two articles (Liu et al., 2014; Liu, Kang, & McKelroy, 2015) focused on the same MOOC, yet a different cohort of learners. Again, these learner demographics are potentially biased due to selective response to the surveys.

<table>
<thead>
<tr>
<th>Article</th>
<th>Employed</th>
<th>Student</th>
<th>Retired</th>
<th>Unemployed</th>
<th>Industries of employment</th>
<th>Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alcorn et al. (2015)</td>
<td>72.1%</td>
<td>32.1%</td>
<td>ns</td>
<td>20.5%</td>
<td>ICT (22%) Business (14.6%) Management (7.9%)</td>
<td>148,955</td>
</tr>
<tr>
<td>Christensen et al. (2013)</td>
<td>69.3%</td>
<td>17.4%</td>
<td>6.8%</td>
<td>6.6%</td>
<td>ns</td>
<td>34,799</td>
</tr>
<tr>
<td>Greene et al. (2015)</td>
<td>68.0%</td>
<td>29.0%</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>5,306</td>
</tr>
<tr>
<td>Liu et al. (2014)</td>
<td>84.0%</td>
<td>10.0%</td>
<td>1.0%</td>
<td>ns</td>
<td>Journalism (30%) ICT (18%) Education (10%) Business (7%)</td>
<td>409</td>
</tr>
<tr>
<td>Liu et al. (2015)</td>
<td>83.0%</td>
<td>12.0%</td>
<td>ns</td>
<td>ns</td>
<td>ICT (32.8%) Education (14.2%) Business (7.5%) Management (4.3%)</td>
<td>320</td>
</tr>
<tr>
<td>Robinson et al. (2015)</td>
<td>74.9%</td>
<td>ns</td>
<td>3.8%</td>
<td>18.6%</td>
<td>ns</td>
<td>7,551</td>
</tr>
<tr>
<td>Schmid et al. (2015)</td>
<td>57.3%</td>
<td>ns</td>
<td>ns</td>
<td>12.0%</td>
<td>ICT (25.2%) Education (16.6%) Business (9.8%) Management (5.1%)</td>
<td>27,939</td>
</tr>
<tr>
<td>Coursera’s average</td>
<td>73.3%</td>
<td>ns</td>
<td>4.9%</td>
<td>18.0%</td>
<td>ns</td>
<td>ns</td>
</tr>
</tbody>
</table>

**Table 3. Overview of articles, employment rates and respondent rates**

Table 3 shows that the majority of MOOC learners in these studies was employed and that the employed learners most frequently held an occupation in ICT, education, business, management and journalism. Moreover, it demonstrates a substantial proportion of formal students and smaller proportions of retirees. As this illustrates that a large part of the learners has or has had access to formal education, have challenging jobs or are not compelled to work, it seems that a large proportion of the learners is from a privileged background. However, Table 3 also demonstrates unemployment rates that vary from marginal to substantial. This could be due to the fact that some studies included students and retirees in the “unemployed” category. Moreover, there could be a discrepancy between the unemployed population and the population that is actually looking for a job (Alcorn et al., 2015). A more systematic use of specified categories (e.g., “student,” “retired,” “unemployed and looking for a job” and “unemployed and not looking for a job”) might have supported the interpretation of the relative privilege of learners.
**Geographical location**

Of all selected articles, fourteen provided information on the geographical location of MOOC learners. Coverage and reliability of these data are superior to other indicators, since the geographical location of learners can be obtained through IP addresses and is therefore more resistant to non-response bias. However, the reports on learners’ geographical location within the selected studies were barely exhaustive. Some studies only reported the proportion of MOOC enrollees for one country or merely reported absolute numbers without a reference group (Belanger & Thornton, 2013; DeBoer, Stump, Seaton, & Breslow, 2013; Sánchez-Vera et al., 2014). The remaining studies reported proportions for the top few countries, ranging from three (Dillahunt, Wang, & Teasly, 2014) to eleven (Robinson et al., 2015). Table 4 provides proportions of MOOC learners compared to their proportion in the world population among the most frequently reported countries.

### Table 4. Estimated proportion of learners per country in comparison to world population

<table>
<thead>
<tr>
<th>Article</th>
<th>Developed nations</th>
<th>Less developed nations</th>
<th>U.S.A.</th>
<th>India</th>
<th>U.K.</th>
<th>Canada</th>
<th>Brazil</th>
<th>Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alcorn et al. (2015)</td>
<td>ns</td>
<td>ns</td>
<td>13.2%</td>
<td>5.5%</td>
<td>ns</td>
<td>ns</td>
<td>4.0%</td>
<td>1.7 million</td>
</tr>
<tr>
<td>Banarjee &amp; Duflo (2014)</td>
<td>ns</td>
<td>ns</td>
<td>28.0%</td>
<td>10.0%</td>
<td>5.0%</td>
<td>ns</td>
<td>3%</td>
<td>4,600</td>
</tr>
<tr>
<td>Christensen et al. (2013)</td>
<td>67.0%</td>
<td>33.0%</td>
<td>33.9%</td>
<td>7.3%</td>
<td>3.9%</td>
<td>3.4%</td>
<td>4.4%</td>
<td>34,779</td>
</tr>
<tr>
<td>Dillahunt et al. (2014)</td>
<td>ns</td>
<td>ns</td>
<td>28.7%</td>
<td>7.8%</td>
<td>4.5%</td>
<td>ns</td>
<td>ns</td>
<td>37,148</td>
</tr>
<tr>
<td>Diver &amp; Martinez (2015)</td>
<td>ns</td>
<td>ns</td>
<td>20.4%</td>
<td>7.3%</td>
<td>ns</td>
<td>ns</td>
<td>3.6%</td>
<td>11,183</td>
</tr>
<tr>
<td>Gillani &amp; Eynon (2014)</td>
<td>62.0%</td>
<td>38.0%</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>3,631</td>
</tr>
<tr>
<td>Greene et al. (2015)</td>
<td>72.0%</td>
<td>28.0%</td>
<td>36.0%</td>
<td>8.0%</td>
<td>4.0%</td>
<td>4.0%</td>
<td>3.0%</td>
<td>3,875</td>
</tr>
<tr>
<td>Guo &amp; Reinecke (2014)</td>
<td>ns</td>
<td>ns</td>
<td>20.9%</td>
<td>12.9%</td>
<td>6.2%</td>
<td>ns</td>
<td>ns</td>
<td>110,162</td>
</tr>
<tr>
<td>Impey et al. (2015)</td>
<td>ns</td>
<td>ns</td>
<td>45.0%</td>
<td>5.0%</td>
<td>6.2%</td>
<td>4.7%</td>
<td>1.5%</td>
<td>1,991</td>
</tr>
<tr>
<td>Liu et al. (2014)</td>
<td>ns</td>
<td>ns</td>
<td>44.0%</td>
<td>ns</td>
<td>5.0%</td>
<td>4.0%</td>
<td>3.0%</td>
<td>409</td>
</tr>
<tr>
<td>Liu et al. (2015)</td>
<td>ns</td>
<td>ns</td>
<td>30.0%</td>
<td>3.0%</td>
<td>ns</td>
<td>5.0%</td>
<td>4.0%</td>
<td>320</td>
</tr>
<tr>
<td>Robinson et al. (2015)</td>
<td>ns</td>
<td>ns</td>
<td>30.4%</td>
<td>5.7%</td>
<td>3.5%</td>
<td>3.6%</td>
<td>3.1%</td>
<td>7,551</td>
</tr>
<tr>
<td><strong>Coursera average</strong></td>
<td>ns</td>
<td>ns</td>
<td>27.7%</td>
<td>5.6%</td>
<td>3.6%</td>
<td>3.7%</td>
<td>4.7%</td>
<td></td>
</tr>
<tr>
<td><strong>Total World Population</strong></td>
<td>17%</td>
<td>83%</td>
<td>4.4%</td>
<td>17.8%</td>
<td>0.8%</td>
<td>ns</td>
<td>2.7%</td>
<td>7,349 million</td>
</tr>
</tbody>
</table>

**Note.** ns = not stated. *a* = The definition of developed nations and the estimation of their proportions in the total world population is based on data of the United Nations (2015).

Table 4 illustrates that MOOC learners from developing countries take up a small share of the MOOC population compared to their share in the world population, whereas U.S. learners comprised an unrepresentative large proportion of the MOOC population. Possible explanations for this inequal distribution, is that learners appear to be mainly attracted to MOOCs that originate from their own country (Sánchez-Vera et al., 2014), are in their native language (Impey, Wenger, & Austin, 2015) or apply cultural customs that conform to their norms (Liyanagunawardena et al., 2013b). Therefore, MOOC courses and platforms outside of the Western paradigm might serve learners from other regions, like Rwaq for Arabic populations (MacLeod, Haywood, Woodgate, & Alkhatnai, 2015) and Swayam for Indian populations (Alcorn et al., 2015). And although a notable proportion of the MOOC population is from the developing world, 22 to 38 percent, it is also noticed that the majority MOOC learners from developing countries is highly educated (Alcorn et al., 2015; Christensen et al., 2013). This reiteratively underscores the social inequal distribution of MOOC participation. In addition, it raises questions on the purpose of MOOCs as an alternative for higher education, as it is mainly used as an addition to formal education.
Factors contributing to MOOC completion

Knowledge about the impact of privilege on MOOC completion can also be crucial for understanding the social impact of MOOCs. Although MOOC completion rates generally tend to be very low (Jordan, 2014), it might be that privileged learners have better opportunities to successfully complete a MOOC than underprivileged. The selected studies discussed two factors that are related to privilege: educational attainment and skills and knowledge.

Educational attainment

Six selected articles have addressed the potential relationship between educational attainment and MOOC completion. These studies have not shown one consistent outcome. Three studies found a positive association between educational attainment and MOOC completion. Although these studies acknowledged multiple predictors for completion, including age, motivation and prior MOOC experience (Engle, Mankoff, & Carberry, 2015; Greene et al., 2015; Guo & Reinecke, 2014), the relative significance of educational attainment remained unclear. Two studies indicated that, whereas completion was generally higher among those with higher levels of educational attainment, there were also substantial proportions of less educated learners who received a certificate with an excellent evaluation (DeBoer et al., 2013; Dillahunt et al., 2014). Furthermore, there was one study that denied the association between educational attainment and completion (Goldberg et al., 2015). These findings can be explained by the instructional design that allowed more time, flexibility and more opportunities to retake the exams (Goldberg et al., 2015). Even though these studies are not exhaustive, have made use of specific methodological designs or focused on specific MOOCs, it shows that educational attainment does not have to determine MOOC completion.

Skills and knowledge

Six of the selected articles discussed skills and knowledge as potential predictors for MOOC completion. Three studies indicated that subject-specific work- or school experience decreased the likelihood of drop out, increased the likelihood of passing exams and even increased grades (Engle et al., 2015; Greene et al., 2015; Masanet, Chang, Yao, Briam, & Huang, 2014). These quantitative findings were supported by qualitative studies on learners’ experiences. These indicated that shortfalls in knowledge could cause feelings of panic or incompetency among learners, making drop out more likely (Belanger & Thornton, 2013; Park, Jung, & Reeves, 2015). In addition, English proficiency appeared to explain successful MOOC completion (Banerjee & Duflo, 2014; Engle et al., 2015). One study also illustrated that US learners had significantly higher grades and needed less time to watch video lectures (Diver & Martinez, 2015). In turn, non-native speakers seemed to experience less confidence in their ability to pass assignments and exams in MOOCs (Park et al., 2015). Even though these findings imply that native or proficient English speakers might experience fewer barriers in successful MOOC completion, there is an increasing amount of MOOCs in alternative languages (Shah, 2014). Therefore, conclusions on the opportunities for non-native speakers can only be given after extensive comparisons with MOOCs in alternative languages.

Conclusion

This systematic review examined empirical literature to congregate knowledge on MOOCs and to what extent they are able to reach and serve underprivileged learners better than formal higher education. The relative impact of MOOCs is evaluated against theoretical understandings of social reproduction in education (Bourdieu, 1973; 1986). As it is the first review to systematically assess MOOC studies on their reports of social inequalities, the findings have social as well as methodological implications.

The literature substantiated that there are fewer barriers to MOOCs than to higher education. Still, the remaining barriers seem to specifically hamper access for underprivileged populations. Especially for individuals with little resources or in remote areas in developing countries, the necessity Internet access or additional expenses could obstruct their participation in MOOCs. In addition, confusing indications about prerequisite knowledge could hamper the MOOC enrollment for those with little educational experience. Even though MOOCs require less financial investment or social and cultural proximity to higher education institutions, the results show that individuals with little financial resources or in less culturally or socially dominant contexts experience evident barriers towards MOOC participation.
Reported demographic data of learners showed that the majority of the MOOC learners is well educated. Moreover, a large proportion is employed in challenging sectors and an unrepresentative large share is from developed countries. It is suggested that the instructional design, the language of instruction or the cultural origin of the facilitator could play a role in the demographic composition of the MOOC population. Still, as the average level of educational attainment among MOOC learners is high, the findings articulate that those who experience or have experienced privileges in formal education are overrepresented in MOOCs. Moreover, professional relations and the cultural background could function as privileges in MOOC participation.

Finally, the results showed that prior skills and knowledge, as a form of cultural capital, could be explanatory for the completion of MOOCs. There have been mixed outcomes, however, with regards to the impact of educational attainment on completion. Although there is evidence to suggest that educational background influences MOOC completion, several studies nuanced this conclusion. This leads to the implication that certain social privileges might help in MOOC completion, yet that underprivileged learners can still be successful in MOOCs.

**Strengths and limitations**

This review has been able to discuss diverse manifestations of social inequalities in MOOCs, as it focused on formal barriers, enrollment and completion. Moreover, the review encompassed studies from different academic traditions, indicating diverse issues on a large variety of MOOCs. Therefore, this review has been able to apply a relevant degree of nuance in its conclusions.

However, the scope of this review is not exhaustive. In order to assure relevance, quality and reliability of the examined studies, literature was selected from three academic databases using specific search terms and search filters. Still, some potentially relevant sources of literature might have been missed. There were at least some indications that the results might not be representative for the total MOOC population, including the lack of publications on MOOCs from smaller or non-Western platforms as well as the low response rates in MOOC surveys. Therefore, this review holds exploratory value and could serve to inform future research on issues that need to be addressed in order to enhance knowledge on social inequalities in MOOCs. To remind the audience of these restraints in the conclusions, these limitations were considered in the interpretations of the findings. A final limitation of this review is that only a selection of variables was examined, as the empirical studies provided limited information on income, parental education, ethnicity of learners or other socially relevant factors. To be able to examine the effects of these variables on enrollment or completion, more data on these characteristics of MOOC learners is needed.

**Suggestions for future research**

The limitations that were encountered within this review evoke suggestions for future research. As it appeared that most empirical studies on MOOCs rely on surveys with low response rates and with unclear indications of their representativeness, more research is needed in order to make valid generalizations. Consequently, future research could examine strategies to improve knowledge on learner characteristics. For example, researchers could experiment with different surveys modes to examine how this could affect response and representativeness of samples. Furthermore, this review demonstrated a lack of empirical studies on MOOCs on smaller or non-Western based platforms. As these might have other implications for social equality, it is very important that a larger variety of MOOCs will be studied. Specific aspects of concern are the effects of the instructional design or the language of instruction on the learning progress of underprivileged learners. One possibility is to examine whether multilingual platforms can reduce existing inequalities in participation and completion rates (see also Van Laere, Agirdag, & van Braak, 2016). This could yield guidelines for new MOOCs that specifically aim to serve all types of learners. And because the purpose of MOOCs is to increase and enable access to higher education for all people in the world, MOOCs should be responsive to the needs and capabilities of the general global population. In this way, MOOCs might truly enrich the world, and not only the rich.

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Is Group Polling Better? An Investigation of the Effect of Individual and Group Polling Strategies on Students' Academic Performance, Anxiety, and Attention

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ABSTRACT

The purpose of this study was to investigate the effect of polling technologies (clickers or tablets) integrated with strategies (individual or group) on students’ academic performance, anxiety, and attention. The participants were 34 students enrolled in an educational research methodology course. The anxiety scale, pre- and in-class quizzes, brainwaves of attention levels, open-ended questionnaires, and a 20-minute structured interview were used in this study. During the experiment period of three weeks, the instructor conducted three types of polling activities. The results showed that the instant polling strategy helped promote learning performance, and if a team was given an opportunity to discuss a topic after it was announced, this would help reduce students’ feelings of anxiety and increase their attention levels. This study suggests that classroom activities can be designed to incorporate team polling for increased participation.

Keywords

Polling strategies, IRS, Anxiety, Attention

Introduction

The current Interactive Response System (IRS) has already been widely used in classroom voting systems, and many studies have confirmed its positive impact on aspects of learning, including participation, dedication, and motivation (Bachman & Bachman, 2011; Fortner-Wood, Armistead, Marchand, & Morris, 2013; Jones, Antonenko, & Greenwood, 2012; Siau, Sheng, & Nah, 2006). The portable equipment of the IRS allows instructors to design a variety of classroom feedback activities; thus, excellent teaching strategies must accompany the system to allow for its integration into the classroom and the resulting improved learning outcomes. Research by Blasco-Arcas, Buil, Hernandez-Ortega, and Sese (2013) discovered that combining the IRS with cooperative teaching strategies can significantly improve interaction among instructors and students, as well as effectively improve learning outcomes. Previous studies on learning that concerned the effects of the combination of the IRS with cooperative teaching strategies have only studied the combination of a single voting tool with a cooperative teaching strategy, such as SRS pads (Jones et al., 2012) or clickers (Zingaro & Porter, 2014). Therefore, this study examined the effect of the combination of different voting tools and teaching strategies on indicators of learning, including academic performance, anxiety, and attention.

For the classroom interactive feedback systems, there are already preliminary studies that show that students’ electro-encephalogram (EEG) signal reactions vary depending on their use of different voting tools. Students using clickers have a higher EEG signal attention level when voting, while students using smartphones have an increased EEG signal attention level after voting activities (Sun, 2014). However, as for how the use of combined IRS and cooperative teaching strategies affects EEG signal attention level, in-depth research is still required. Thus, this study used a collection of EEGs throughout an entire classroom to record attention levels to data, while also comparing varying levels of attention among different IRS voting tools and cooperative teaching strategies in order to understand the effect of teaching strategies on voting activities concerning attention.

Literature review

Overview of polling strategies

The Interactive Response System (IRS) is a polling technology tool that provides instructors and students with instant feedback and allows them to make effective adjustments to their teaching and learning processes
(Roschelle, Schank, Brecht, Tatar, & Chaudhury, 2005). This technology not only increases the student levels of participation (Fortner-Wood et al., 2013; Salemi, 2009; Sun, Martinez, & Seli, 2014), concentration (Fortner-Wood et al., 2013; Siau et al., 2006), and learning motivation (Jones et al., 2012), but can also improve their learning outcomes (Bachman & Bachman, 2011; Caldwell, 2007). Smith, Annis, Kaplan, and Drummond (2012) noted that the IRS offers an educational medium in modern middle and elementary school coursework that enhances interactive learning, encourages independent student thinking, and inspires them to collaborate with their peers in order to attain their learning goals.

Wireless networking and the breaking down of the space-time limitations of the traditional remote control made the rise of the mobile device possible, and this has had a vast direct impact on education. A significant number of IRS-related applications have been developed, including applications for a variety of operating systems. There are two interactive modes for IRS course integration: interactivity with peers and interactivity with the instructor (Blasco-Arcas et al., 2013). In facilitating interactivity with peers, the IRS allows students to discuss and then vote on an answer. Peers can collaborate to fulfill tasks assigned by their instructor, thereby improving peer relations and the overall academic environment. They are even able to complete tasks more efficiently (Beatty, Gerace, Leonard, & Dufresne, 2006; Caldwell, 2007; Trees & Jackson, 2007). The objective of interactivity with the instructor is for the instructor to provide feedback on the students’ answers using the IRS, to evaluate the students’ learning progress, explain the degree of knowledge assimilation, and deploy a teaching strategy and methodology that is adjusted to the students’ learning pace which also creates a dynamic, interactive teaching environment (Bachman & Bachman, 2011; Trees & Jackson, 2007). It is clear that IRS integration into an academic program can have a positive influence on learning (Beatty; 2004; Beatty et al., 2006; Trees & Jackson, 2007).

**Individual and group polling strategies**

Zhu (2007) proposed that when integrating IRS into an academic program, collaborative learning should be combined with other teaching strategies, such as peer instruction, peer-sharing, or class discussion. Collaborative learning allows for the mutual sharing of opinions, mutual guidance and criticism, and the collaborative resolution of problems among the students in order to efficiently complete related activities (Roschelle et al., 2005). Blasco-Arcas et al.’s (2013) empirical research integrated IRS and a collaborative learning strategy with 198 tertiary business students during a 2-year marketing course. The students provided responses by means of IRS, and the groups interpreted, shared, and discussed the topics in order to complete the question and answer assignments. They found that the IRS-integrated collaborative learning strategy significantly enhanced interaction between teachers and students and between peers, and it also effectively improved the learning outcomes. Another study found that IRS integrated into mobile devices provided more functions than traditional IRS (Roschelle et al., 2005). Specifically, context simulation, by which these systems were integrated into a collaborative learning strategy for the duration of a course, enhanced the mechanisms for posing questions or reading and commenting on articles. Significant improvements were found in the students’ conceptual cognitions and interactions.

The use of peer instruction as a collaborative learning-based teaching strategy can enable students to learn course content and may encourage them to conduct mutual criticism, characterized by discussion and response production, with their peers (Zhu, 2007). The peer instruction method consists primarily of individual students first producing a response to the topic and then discussing and conveying the final answer with their peers. The teacher then displays the students’ answer and finally conducts an explanation and discussion session (Smith et al., 2012; Zingaro & Porter, 2014). The integration of the peer instruction method into the course, together with IRS, can provide students with important learning opportunities and enhance peer discussion and interaction, thus improving the students’ learning outcomes (Smith et al., 2012). McDonough and Foote (2015) explored the effects of collaborative learning (in pairs vs. small groups) and clicker use (shared vs. individual clickers) on learning among undergraduate students who were taking an English grammar course. Their results showed that students had a higher percentage of correct answers in the shared clicker polling activity and a stronger tendency to collaborate, regardless of the format of the groups.

In summary, an integrated course combining IRS with collaborative learning does lead to a better outcome than individual IRS student feedback alone. Furthermore, IRS acts as a tool for formative feedback and can effectively improve student cognitive knowledge acquisition (Jones et al., 2012). Previous investigations into how an IRS teaching strategy combined with peer instruction affects learning have only studied peer instruction strategies combined with single polling tools, such as SRS pads (Smith et al., 2012) or clickers (Zingaro & Porter, 2014). In his study, Sun (2014) compared the differences between two types of polling instruments,
clickers and mobile devices. He found that among the students in a sociology of education course, those using mobile polling had significantly better academic performance compared to those using clicker-based polling. However, the two groups did not differ significantly in terms of their cognitive engagement or anxiety. To date, little research has investigated the combination of different polling tools with teaching strategies in relation to their effects on such indicators as learning outcomes, test anxiety, and ability to concentrate. Therefore, as an exploratory study, we combined two types of IRS polling tools (clickers and tablets) and strategies (individual and group) and divided them into three stages. We hoped to gain a full understanding of the differences in the effects of the traditional IRS clickers, group polling on tablets, and group polling with competition on tablets on student learning performance, anxiety, and attention levels.

**Anxiety and polling**

Anxiety is a form of pressure that affects students’ mood and cognitive performance, and interferes with their attention levels and cognitive processing (Matthews et al., 2006). Test anxiety is frequently found among university students. This hinders the students’ learning, and it has a significant negative impact on their physical and mental health. When a student develops test anxiety, it is generally due to a lack of confidence in his/her own ability and a belief that he/she will not perform well (Damer & Melendres, 2011). Many studies have shown that the level of test anxiety will affect students’ motivation and their academic performance (Damer & Melendres, 2011; Yousefi, Talib, Mansor, & Juhari, 2010). Most studies have found that the classroom performance of students with a comparatively low level of test anxiety is better than that of students with high levels of test anxiety, but when the students are willing to devote great effort to their studies, their levels of test anxiety will be relatively low (Bembenutty, 2009). Although many studies have investigated how test anxiety influences learning, few have focused on how different polling tools integrated with strategies affect their test anxiety. Therefore, this study sought to explore the differences in test anxiety among different polling activities.

**Attention and polling**

Attention levels can be evaluated based on brain activity, which is thought to be able to represent human consciousness, emotions, and health states. When an individual carries out some specific task that requires the investment of attention, such as attending a lecture, reading, or driving, it is possible to use various types of monitoring equipment to measure the degree of attention being used. Most studies have used brainwaves to monitor attention. A widely used brain activity monitoring device is the electroencephalogram (EEG), which is a non-invasive brain imaging technology that can immediately capture the state of activity in the human cerebral cortex (Li et al., 2011; Li et al., 2012). A relatively inexpensive, user-friendly portable wireless brainwave device has now appeared on the market that can be fully exploited in a variety of research settings (Patsis, Sahli, Verhelst, & De Troyer, 2013). A study by Patsis et al. (2013) used it to capture brainwave data from players of the computer game Tetris. At the end of the game, the players were asked to conduct a self-evaluation with the objective of being able to dynamically adjust the degree of difficulty according to the player’s state of attention, while the researchers observed the relation between the degree of difficulty, individual levels of attention, and mental state. Their study found that the degree of game difficulty did indeed affect the individuals’ levels of attention and mental states.

![Figure 1. Research model](image_url)
In Sun’s (2014) study, this type of portable wireless EEG was also used to record students’ brainwave data. The students were asked to use different types of educational technology products to conduct classroom polls, while changes were observed in their attention levels and sense of relaxation to see if they affected their learning outcomes. The results of the study showed that the students did indeed experience different mental and physical reactions when using different classroom activity tools. We hoped that the present study’s use of an EEG to conduct a comparison of different classroom activities would lead to an understanding of different classroom polling activities in terms of their effects on students’ attention levels. The research model of the study is shown in Figure 1.

Research methods

Participants

There were 34 students registered in the educational research methodology course in a national university in Taiwan (27 female; ages 22 to 33). We compared their performance over the final 3 weeks of the course with their pre-class quiz grades, in-class quiz grades, anxiety scale values, and brainwave measurement. We excluded incomplete data from any student who did not participate fully. A total of three students across 3 weeks (voluntarily) chose to wear the brainwave headphones for researchers to obtain brainwave data.

Methods and instructional design

This study utilized a quasi-experimental research design. We collected data from a class at a large research university in Taiwan. This study was conducted over a period of 3 weeks. Each week’s course time consisted of two 100-minute classes, and a pre-class quiz grade was required to be completed by 5 p.m. on the afternoon before the class. The response time was limited to 30 minutes. Subsequently, a classroom lecture was conducted together with group polling, and three students were selected to monitor brainwave changes throughout the process. When the week’s coursework was complete, in the 30 minutes before finishing the class, a closed-book in-class quiz grade was obtained. Meanwhile, an anxiety scale survey and open-ended questionnaire were administered, and nine students were invited to undergo a 20-minute structured interview following each class in Week 3.

Over a period of 3 weeks, the instructor conducted three types of group polling activities (treatments). There was no fixed time for any week’s polling. Individual clickers (Week 1) were issued to each person before class. During class, the instructor projected prepared questions on a screen at the front of the classroom, the students used the handheld clickers to vote, and the selected correct answers were delivered to the instructor. The students were not permitted to discuss their answers with others during this process.

For the group polling on tablets (Week 2), the students were divided before class into groups of three to four people, and each group was issued with a tablet on which the researchers had previously installed an Interactive Feedback-based In-class Teaching (iFIT) application (Sun, Chang, Chen, & Lin, 2016; Sun & Lee, 2016). After the instructor projected a question, each group of students could discuss it together. Following that, each group member would select an answer on the tablet using individual members as the unit, and the answers were delivered to the instructor. Group polling with competition on tablets (Week 3) was similar to the activity in Week 2, but with the distinction that each group’s members had to reach a consensus following their discussion, and an answer was jointly selected by the entire group as a unit before it was delivered to the instructor. In addition, the instructor would convert each group’s polling results into a publicly displayed group score, thus turning the groups’ polling into a team competition. The purpose of the shared tablet for each group was to facilitate small group discussions and avoid distractions which may occur when students use their own mobile devices to vote (Sun, 2014).

The instructor conducted a review and discussion after each poll in order to clarify concepts that were not understood by the students. To avoid any carryover effect during the three treatments, the degree of difficulty of both the pre-class and in-class quiz was equivalent, the course unit concepts were similar, the conceptual themes of the 3 weeks’ teaching were each stand-alone units, and there was no sequential relation between the units (the Week 1 course unit was “threats to internal validity,” Week 2 was “experimental design methods,” and Week 3 covered “investigation and study methods”). The experimental sequence is shown in Figure 2, and the classroom setup is shown in Figure 3.
Figure 2. Experimental design

34 students

Pre-class quiz grade

Week 1:
Lectures & clickers

In-class quiz grade
Anxiety scale
Open-ended questionnaire

Week 2:
Lectures & group polling on tablets

Week 3:
Lectures & group polling with competition on tablets

End of 3 weeks:
Interview

30 min

70 min

3 students’ brainwave data were collected throughout the process

20 min

Figure 3. Classroom setting (group polling with the iFIT application on tablets)
Instruments

We used Pintrich, Smith, Garcia, and McKeachie’s (1991) anxiety scale from their Motivated Strategies for Learning Questionnaire (MSLQ). After the topics were adapted to ensure that they were applicable to the circumstances of this study, this tool was used to measure the degree of anxiety faced by the students during the quiz. This scale has a total of five topics and uses a Likert-type 6-point scale. A representative statement might be, “When I take the quiz on educational research methods, I can feel my pulse speed up.” The scale’s Cronbach’s α values in Weeks 1-3 were sequentially .86, .86, and .84.

The pre-class and in-class quiz grade questions were set by the instructor, and the students were informed in advance as to the scope of the tests. The pre-class quiz consisted of multiple-choice questions, and the in-class quiz included options, padding, and brief questions and answers. For collection of brainwave data, three students were invited to wear an EEG during class time to gather indicators of their attention levels. All of them used the brainwave sensor chips provided by NeuroSky, a company which partners with business and academics to make biosensors. The electrical signal across the electrode is measured to determine levels of attention (based on Alpha waveforms) and is then translated into binary data. NeuroSky has been validated to have good validity and reliability. In a study conducted by Rebolledo-Mendez et al. (2009), the results of this evaluation suggested that the headset provides accurate readings regarding attention, since there is a positive correlation between measured and self-reported attention levels.

The brainwave data were analyzed based on the methods used in previous studies in the field (Crowley, Sliney, Pitt, & Murphy, 2010; Rothkrantz, Wiggers, Wees, & Vark, 2004). We used the first three minutes of the EEG data as the baseline regarding attention levels, since students were in a serene state of mind at this point. We then divided the EEG raw data into two parts: class lecture and in-class activities (in the first and second weeks, the topics and answers were announced; in the third week, the accumulated group points were also displayed). For the class lecture and in-class activities, we calculated the percentage of data that was observed to be in excess of the baseline attention level data. Then, we generalized participants’ brainwave patterns between the lectures and in-class activities based on the observed data, and we plotted the EEG diagram from selected participants. We combined the EEG observations with the results of the pre-class quiz, in-class quiz, post-class surveys, and open-ended questionnaires in order to analyze the students’ in-class learning efficacy. In this way, we could meaningfully explain the variations in brainwave data.

The open-ended questionnaires included the following questions: (1) When you used the polling system in today’s class, did you encounter any problems? Please explain what the problems were and how many times they occurred; (2) What do you think are the advantages of the polling system and polling method (group discussion and competition) used by the instructor to conduct today’s class? and (3) How do you think the instructor might use the polling system to conduct the class? Can you suggest any other innovative approaches? Separately discuss any problems the students had in relation to the advantages and disadvantages of the polling system, the effects of anxiety and attention levels, any recommendations for improvement, and the degree of course difficulty.

Statistical analyses

All quantitative data were coded and prepared for computer analysis using Predictive Analytics Software (PASW) 18.0. Cronbach’s α was computed in order to validate the reliability of each of the measurement scales. The brainwave data were analyzed based on the methods described in previous studies (Crowley et al., 2010; Rothkrantz et al., 2004). For the descriptive statistics, frequencies were computed for nominal variables, and means and standard deviations were obtained for both interval and nominal variables. Finally, paired t tests and a one-way ANOVA with repeated measures (RM-ANOVA) were conducted to examine the differences in means between the treatments.

Research results

Trajectory analysis of academic performance

Descriptive data and paired t-test results for the 3 weeks’ pre- and in-class quiz performance are shown in Table 1. Although the sample size in this study was relatively small, skewness and kurtosis were in an acceptable range and the data approximated to normal distribution. Comparing the significant statistical differences for the pre-
class and in-class quizzes from the paired-samples t tests conducted using different treatments, we found that the pre-class and in-class quiz student performance in Week 1 showed significant differences (t = 7.13, p < .001), with the in-class quiz performance being clearly better than that of the pre-class performance (M = 81.43 > M = 50). There were no significant differences between the Week 2 and Week 3 pre-class and in-class quizzes (t = 1.95, p = .07; t = 0.62, p = .54, respectively). From the table below, it can be seen that after implementing the clicker polling strategy, the extent of quiz performance progress in Week 1 was clearly greater than that of Weeks 2 and 3.

Table 1. Descriptive statistics and paired t test for pre-class and in-class quizzes

<table>
<thead>
<tr>
<th>Weeks</th>
<th>Quizzes</th>
<th>Mean</th>
<th>SD</th>
<th>Skewness</th>
<th>Kurtosis</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st</td>
<td>Pre-class</td>
<td>50.00</td>
<td>14.49</td>
<td>-0.76</td>
<td>-1.58</td>
<td>7.13</td>
<td>&lt; .001</td>
</tr>
<tr>
<td></td>
<td>In-class</td>
<td>81.43</td>
<td>11.08</td>
<td>-0.36</td>
<td>-0.47</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2nd</td>
<td>Pre-class</td>
<td>61.90</td>
<td>28.91</td>
<td>-0.18</td>
<td>-0.61</td>
<td>1.95</td>
<td>.07</td>
</tr>
<tr>
<td></td>
<td>In-class</td>
<td>76.91</td>
<td>17.96</td>
<td>-0.52</td>
<td>-0.59</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3rd</td>
<td>Pre-class</td>
<td>80.95</td>
<td>17.29</td>
<td>-0.61</td>
<td>-0.11</td>
<td>0.62</td>
<td>.54</td>
</tr>
<tr>
<td></td>
<td>In-class</td>
<td>84.52</td>
<td>16.80</td>
<td>-0.63</td>
<td>-0.52</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Using the RM-ANOVA to test whether there were significant differences between different treatments of students’ pre-class and in-class quizzes, the results of the Mauchly Spherical Test show that neither performance violated the spherical test hypothesis, and RM-ANOVA verification analysis could be conducted. The results are shown in Table 2. Prior to implementing the teaching method, there were significant differences between the students’ pre-class quiz performances during the 3 weeks (F = 13.63, p < .001). When post hoc pairwise comparison was conducted post hoc, it was found that in the pre-class quiz, Week 3 > Week 2 > Week 1 (M3 = 80.95 > M2 = 61.90 > M1 = 50). On the other hand, after implementing the teaching methods, there were no significant differences between the students’ quiz performances during those 3 weeks (F = 1.52, p = .23).

Table 2. RM-ANOVA with pre-class and in-class quiz grades

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>p</th>
<th>Partial η²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-class quiz</td>
<td>10238.10</td>
<td>2</td>
<td>5119.05</td>
<td>13.63</td>
<td>&lt; .001</td>
<td>.41</td>
</tr>
<tr>
<td>Error</td>
<td>15028.57</td>
<td>40</td>
<td>375.71</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>In-class quiz</td>
<td>616.67</td>
<td>2</td>
<td>308.33</td>
<td>1.52</td>
<td>.23</td>
<td>.07</td>
</tr>
<tr>
<td>Error</td>
<td>8116.67</td>
<td>40</td>
<td>202.92</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Anxiety

When measuring student anxiety levels after conducting the polling strategy teaching method, we obtained the following measurements: Week 1: M = 3.77, SD = 1.58; Week 2: M = 3.43, SD = 1.23; and Week 3: M = 3.63, SD = 1.39. We used an RM-ANOVA to conduct a comparison of differences between anxiety levels during the 3 weeks. The result shows that the application of the different teaching strategies did significantly influence students’ test anxiety levels (F = 3.89, p = .03, partial η² = .12). When we conducted an equivalent post hoc pairwise comparison, we found that the Week 2 anxiety level was significantly lower than that of Week 1 (M2 = 3.77 > M3 = 3.43).

Attention levels based on brainwave data

Initial comparison was made between changes in participants’ degrees of attention under the teaching methods using the different polling strategies. Table 3 shows that the attention level was greater than the baseline frequency, and the frequencies for Participants A and B were ordered Week 2 > Week 3 > Week 1. Participant C’s frequencies, on the other hand, were ordered Week 1 > Week 3 > Week 2. We found that the sequence was completely inverted, while the frequencies of their attention levels that were greater than the baseline in the highest week were greater than 50% in each case. In the second highest week, the percentage was around 40%, and in the lowest week, the percentage was between 20% and 40%. Dividing the class periods into different activities showed that over the entire course, Participants A and B both showed the optimum degree of attention during Week 2, while Participant C showed optimum attention during Week 1.

Next, comparison was made under each teaching method of changes to participants’ attention levels following periods of course activity. Participants’ attentional indicators were at an optimal level during the 3 weeks of classroom lectures or announced topic with responses. The greatest number of participants displayed optimal
attention during the classroom lectures, while their responses to the announced activities presented during the announced topic with responses came second. Careful examination of the 3 weeks found that both classroom lectures and announced topic with responses showed the highest percentage increase over the baseline in Week 2, and it is clear that attention performance was best in Week 2 out of all 3 weeks.

**Table 3. Frequency of participant attention greater than the baseline**

<table>
<thead>
<tr>
<th>Participant</th>
<th>Week 1</th>
<th>Week 2</th>
<th>Week 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Classroom lectures</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>46.5%</td>
<td>87.8%</td>
<td>19.2%</td>
</tr>
<tr>
<td>B</td>
<td>30.5%</td>
<td>56%</td>
<td>47.9%</td>
</tr>
<tr>
<td>C</td>
<td>62.9%</td>
<td>30%</td>
<td>44.6%</td>
</tr>
<tr>
<td>Announced topic with responses</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>18.5%</td>
<td>75.7%</td>
<td>27.2%</td>
</tr>
<tr>
<td>B</td>
<td>8.5%</td>
<td>48.4%</td>
<td>41.9%</td>
</tr>
<tr>
<td>C</td>
<td>79.4%</td>
<td>33.8%</td>
<td>23%</td>
</tr>
<tr>
<td>Announced answers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>32%</td>
<td>75.8%</td>
<td>5.8%</td>
</tr>
<tr>
<td>B</td>
<td>10%</td>
<td>50.6%</td>
<td>30%</td>
</tr>
<tr>
<td>C</td>
<td>78%</td>
<td>25.4%</td>
<td>40.3%</td>
</tr>
</tbody>
</table>

In addition, it can be observed from Figure 4 that when Participant C in Week 2 completed Activity 2 (announced topic with responses) and Activity 3 (announced answers), there was less change in his attentional performance relative to Activity 1 (classroom lecture), indicating that his attention was in a comparatively stable state. When conducting Activity 1 (classroom lectures), the extent of change in attention level was greater, and although the attention level index was very high, especially low states of attention were also not uncommon. From this, it can be seen that Participant C’s attentional stability was better than during the classroom lectures when conducting activities related to an announced topic with responses and announced answers.

![Figure 4. Participant C’s changes in attention levels during various Week 2 classroom activities](image)

*Note. 1: Classroom lecture; 2: Announced topic with responses; and 3: Announced answers.*

**Table 4. Participants’ attention reaching their highest levels of frequency**

<table>
<thead>
<tr>
<th>Classroom lecture</th>
<th>Announced topics with responses</th>
<th>Announced answers</th>
<th>Entire class</th>
<th>Weekly total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Week Activity</td>
<td>Week Activity</td>
<td>Week Activity</td>
<td>Week Activity</td>
<td>Week Activity</td>
</tr>
<tr>
<td>Week 1</td>
<td>1 2</td>
<td>1 1</td>
<td>1 0</td>
<td>1 -</td>
</tr>
<tr>
<td>Week 2</td>
<td>2 2</td>
<td>2 1</td>
<td>2 0</td>
<td>2 -</td>
</tr>
<tr>
<td>Week 3</td>
<td>0 2</td>
<td>0 1</td>
<td>0 0</td>
<td>0 -</td>
</tr>
<tr>
<td>Total Activity</td>
<td>6 3</td>
<td>0 0</td>
<td>0 0</td>
<td>0 0</td>
</tr>
</tbody>
</table>

Table 4 shows that, in terms of attention, participants most often attained the highest frequency of attention in Week 2, followed by Week 1. In terms of classroom activities, *classroom lecture* was the most focused on.
activity after highest attention, followed by announced topic with responses. From this, we learned that, in terms of group polling on tablets in the second week, the students were more capable of paying attention in the classroom and were more able to urge themselves to concentrate on listening to a lecture in class. They paid more attention, especially, to the classroom lectures. In addition, during the announced topic with responses stage of the activity, group polling on tablets enabled the students to focus their attention more steadily in order to deal with the topics raised by the instructor (as shown in Figure 4).

Open-ended questionnaire and interviews

Individual vote clickers are viewed as a polling tool, which although simple to operate, lacks a feedback mechanism to indicate whether a response has been successfully transmitted. A few students thought they would see whether their peers had submitted a response, which made them feel somewhat nervous (S4). Another classmate said a student could boldly select his/her own answer without worrying about giving the wrong answer or suffering under the gaze of his/her peers (S34). The instructor could also make adjustments to course content in light of a student’s response, but some people considered this kind of technical matching of a single individual’s answers lacking in terms of liveliness and interactivity. They suggested that competition should be added in order to obtain the quickest answer instead.

S4: When I come across confusing options, I don’t have too much time to think because other people have already finished answering. The instructor also wants to announce the answer, but I’m still of two minds about it, and this makes me nervous.

S34: You could increase your understanding of the students’ situation. Most of the students are not used to responding directly to the instructor’s questions in colloquial speech, but this problem can be solved by using the polling system.

In connection with group polling on tablets, the students responded that joint use of a tablet would lead to apprehension about the convenience of seating. Students said that group discussion could increase interaction by first conducting group discussions and then polling people individually to allow those who were lacking in confidence to build it before answering on their own (S5). Conducting activities in this way could offer more variety to question and answer sessions (S6), while designing more controversial questions and answers and allowing students to conduct debates would give fullest play to the effectiveness of group discussion.

S5: First discussing, then voting, could increase confidence in the responses.

S6: The answers to some topics might not be unanimous. Let students divide into subgroups to discuss them.

In the group polling with competition on tablets, the students thought competition could increase their sense of achievement (S15) and their focus on the discussion, but during the question and answer segment, the students would have preferred a greater level of topic difficulty and more room for discussion.

S15: One subgroup showed its score to encourage and motivate others.

To summarize the results of the open-ended questionnaire, in terms of technology use, Week 1 was easiest, while there was no difference between Weeks 2 and 3. In terms of situations that occurred while using technology, Week 1 gave rise to psychological tension, while Weeks 2 and 3 saw a lack of familiarity with the technology. In terms of interactivity, Week 1 was relatively lacking in interactivity, while Week 2 had a greater level of interactivity than Week 1. Week 3 was even more interactive than Week 2.

Regarding the interview results, all of the interviewees thought there was no difference in the degree of difficulty of the topics. Most of the participants preferred the clicker polling method, mainly because it was simple to operate and made it easier to concentrate. However, two participants thought that when they pressed on the clicker, it was not possible for them to know whether they had successfully chosen an answer. There was no way to get feedback, while the interactivity of the tablet computer was more diverse. As regards feelings of anxiety, some participants thought the questions that were too hard or that giving wrong answers would give rise to anxiety, but there were also those who thought that the polling system was fun and could lower feelings of anxiety. Others pointed out that since no names were recorded when voting, it would not directly affect their feelings of anxiety. Concerning attention, the participants universally thought that polling and in-class quizzes would increase concentration levels and cause them to think harder in order to avoid wrong answers, but because
tablet computers were more versatile in terms of capabilities and information handling, they could easily reduce their concentration. Although group competition had the advantage of letting everyone have an opportunity to learn cooperatively, it had the drawback of not being able to allow individual answers, and participants’ ideas were easily influenced by their peers. Furthermore, it was easy to spend a lot of time using it.

I think the strong point of the tablet is that its operating interface and its weak point are the same thing; that is, it tends to limit a group to selecting a group answer. If your answer is different from those of other people, you can still only choose one answer, and you certainly cannot truly reflect the thoughts of each individual in the group. (Interviewee 4)

Discussion and implications

In terms of academic performance, this study found that only the Week 1 pre-class and in-class quiz measurements showed significant progress. In the pre-class quiz, we found that Week 3 > Week 2 > Week 1, while there was no significant difference between the in-class quiz measurements. It is possible that having taken the Week 1 course, the clicker polling aroused the students’ sense of novelty and interest in learning, inducing them to take the initiative after Week 1 to prepare for classes, so that their pre-class quiz performance gradually improved and also led to a reduction in the difference between pre-class and in-class quiz performance. There was no significant difference between the in-class quiz performances, probably because of the experiment’s ceiling effect. Average in-class quiz scores had already reached an overall steady high score level (M1 = 81.43, M2 = 76.91, M3 = 84.52), and the three types of polling strategies were all capable of effectively improving in-class learning outcomes. Although this study did not match previous studies of cooperative learning and peer instruction in terms of the results of improving pre-class and post-class performance (Blasco-Arcas et al., 2013; Smith et al., 2012), given the continued application of teacher-student and peer interactive activities, the students showed distinct progress over the 3 weeks of pre-class quizzes. In-class performance was also fairly good, and both types of polling strategies had their own specific results.

In the investigation of the effect of polling strategies on feelings of anxiety, this study found that the Week 2 anxiety levels were significantly lower than those of Week 1. Possibly, after undergoing group discussion, the students experienced a reduction in their feelings of nervousness and had more confidence in their chosen answers, so their anxiety levels in Week 2 were clearly lower than Week 1’s. Previous studies have found that test anxiety levels significantly affect student performance (Damer & Melendres, 2011; Yousefi et al., 2010). During Week 1, we observed that students had a comparatively high degree of test anxiety, and there was a significant difference between the pre-class and in-class quiz results. This study used a self-report inventory following the in-class quiz to measure the state of anxiety, so it was not possible to measure anxiety levels using objective physiological indicators, yet it remains evident that there existed a partial relationship between anxiety and performance. Sun (2014) found that although they did not attain statistical significance, the anxiety scores of students using mobile devices were lower than when they used clickers, and polling tools will still give rise to a partial difference in anxiety. However, not all students can operate even an easy-to-use tablet without difficulty. During the open-ended questionnaire, segment situations did occur where students were not sufficiently familiar with the technology and were unable to operate the devices.

In relation to attention, investigation of the effect of polling strategies on brainwave attention indicators found that, in terms of the class as a whole, peak attention frequency was the highest in Week 2. If the class as a whole was subdivided into different periods of activity, it was found that attention was most concentrated in Week 3’s classroom lectures, followed by the announced topic with responses, while the level of attention during the announced topic with responses of Week 2 was more stable than during the lecture program. Sun (2014) found that clickers brought about a higher attention level during the polling period, but attention plummeted after polling. Although mobiles could not significantly increase attention during polling, they could increase students’ concentration during the post-polling program. This study has further extended Sun's (2014) results. In addition to the polling tools’ strong effects (clicker or mobile), polling strategies (individual or group) also clearly affected attention levels. Attention during group polling on tablets in Week 2 was certainly higher than during individual polling using clickers in Week 1, and it was more stable in terms of making students pay attention during the announced topic with response. However, this differs from previous views suggesting that collaboration is beneficial to learning outcomes (Blasco-Arcas et al., 2013; Smith et al., 2012; Zingaro & Porter, 2014).

The present study found that group polling with competition on tablets did not meet the expectations of increasing attention levels, and we speculate that this may be an effect produced by the polling strategy. Group
polling with competition on tablets requires groups to select answers based on consensus. The individual’s voting responsibilities were replaced by the group. Students expected to be able to discuss answers with their group members during the response activity, or they were influenced by their peers and relied on their group members to make decisions for them. As suggested by participant S4, an answer that is jointly discussed and decided on cannot reflect an individual’s true ideas. Group polling offers limited opportunities for individual thinking and decision making. On the other hand, for the individual perhaps there was the pressure of not being able to express one’s own opinion. This, therefore, gave rise to low levels of attention to lectures and response polling in the Week 3 teaching because in both the “individual clicker votes” and “group polling on tablets” strategies, the answer must be decided by the students themselves. When the power is in the individual students’ hands, they tend to listen carefully to the lecture, but the added team discussion may be more helpful in terms of increasing students’ attention levels. When implementing a group discussion teaching strategy during polling, compared to the polling approach that takes the group as a unit, the reply method that takes the individual as a unit is better able to promote the student’s level of attention when listening to lectures and providing answers.

Conclusion, limitations, and recommendations for future study

This study investigated a variety of instant polling systems and application strategies and their effects on students’ quiz performance, anxiety, and brainwave-measured attention levels. It was found that: (1) All polling activities clearly increase in-class learning outcomes, while using clickers can help individuals clearly raise their pre-class and in-class quiz performance; (2) Individual voting following group discussion results in lower anxiety levels than individual voting, in which discussion is prohibited; (3) Use of a teaching strategy in which group discussion is followed by individual voting results in optimum attention levels; (4) Under a teaching strategy of individual voting following group discussion, an announced topic with responses results in a more stable attention level than a lecture. Put briefly, instant polling systems help to promote learning outcomes, and if a team is given an opportunity to discuss a topic after it is announced, this would help to reduce students’ feelings of anxiety and increase their attention levels.

One of the limitations of this study was the small sample size and relatively short duration of the experiment (3 weeks), which restricted the generalizability of the study results. Razali and Wah (2011) noted that when the sample size is less than 30 participants and normal distribution testing has a significance level of .05, the statistical power of the experiment will be less than 40%. Therefore, statistically, it is suggested that the sample size should include 30 or more participants, which will generally satisfy the normal distribution assumption of ANOVA. This study included 34 participants and, therefore, this criterion of sample size is fulfilled. However, future research can increase the number of participants and the scope of the research. In addition, there was a lack of wearable brainwave headphones used in this study; further, when wearable brainwave equipment was utilized to collect EEG data in the classrooms, the equipment had to be connected to computers throughout the entire experiment. Moreover, the computer screens had to be monitored by someone who would pay close attention to the connection status of each brainwave apparatus in order to prevent any loss of data due to instabilities in the connection. Therefore, the sample EEGs collected in this study were limited as well. In terms of the duration of the experiment, since it lasted only 3 weeks, the measured effects of the experiment may not be sufficiently robust. It is suggested that in future studies, the time of exposure for the experiment should be extended. Concerning the content of the experiments, the subject explored in this study was educational research methodology. We suggest that future studies could try including content from other disciplines, which will allow us to explore how other course content affects students’ levels of anxiety and brainwave responses. Finally, future studies are needed in order to more thoroughly understand the effect on anxiety and attention when polling. It is suggested that classroom activities can be designed in such a way as to adopt a strategy of team polling in which students can take turns acting as group leader for increased accountability in order to help build a team consensus and to avoid passive group member participation. This would also prevent a scenario in which group members do not dare to express divergent views.

Acknowledgements

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Reference


Creating Interactive E-Books through Learning by Design: The Impacts of Guided Peer-Feedback on Students’ Learning Achievements and Project Outcomes in Science Courses

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ABSTRACT

With the rapid progress of technology, the popularity of tablet computers and the development of e-book applications have brought the use of e-books as a learning tool under the spotlight. In the meantime, the aim of school education lies not only in providing students with knowledge but also in encouraging them to construct knowledge actively. Consequently, in this study, an approach of integrating the guided peer-feedback strategy into e-book design was proposed. An experiment was conducted on an elementary school natural science course to explore its effectiveness in comparison with the conventional e-book development activity. It was expected that the guided peer-feedback approach could engage students in knowledge organizing and in-depth thinking while stimulating more innovative ideas. To assess the impacts of this approach, a quasi-experimental design method was adopted. The students were divided into two groups: the experimental group, in which the students learned with the guided peer-feedback strategy together with the e-book development approach, and the control group, in which the students learned with the conventional e-book development approach. The experimental results indicated that the integrated guided peer-feedback and e-book development strategy had significant impacts on the students’ learning achievements and e-book project outcomes while reducing their cognitive load and increasing their innovative thinking tendency in the design process.

Keywords

Mobile learning, Electronic books, Mobile technology, Peer feedback, Project-based learning

Introduction

As educational settings and strategies have become more diverse, technology-based teaching has gradually become one of the trends in education (Chu, 2014). The popularity of tablet computers and the development of digital reading technologies such as multimedia and interactive facilities have brought the use of e-books as a learning tool under the spotlight (Jenny et al., 2015; Huang & Liang, 2015). Meanwhile, “developing e-books” has become a popular project-based learning activity in schools (Colombo & Landoni, 2013). Scholars have indicated that this approach of learning by design has great potential for fostering students’ innovative thinking and learning achievement if appropriate learning support is provided (Huynh & Ghimire, 2015; Hwang, Hung, & Chen, 2013). In the meantime, researchers have stated the necessity of adopting learning guiding strategies in such project-based activities to enhance students’ learning performance and project quality (Tseng & Tsai, 2007).

Among various learning strategies, learning by design is a well-recognized one, based on constructivism, in which students need to think about what the important parts of the learning content are through the design process, and how to present the key concepts fully to others (Harel, 1991; Jonassen & Carr, 2000). In comparison with conventional instruction, the mode of learning by design allows students to participate more actively and construct their own knowledge step by step for meaningful learning (Minovic, Milovanovic, Evic, Minovic, & Evic, 2011).

In addition, engaging students in peer-feedback is also one of the learning strategies that have positive impacts on students’ learning motivation, attitudes and achievement (Lai & Hwang, 2015; Tseng & Tsai, 2007; Hwang, Hung, & Chen, 2013). It refers to the learning activities that engage students with similar backgrounds in assessing the learning outcomes of peers by playing the role of an instructor, including sharing knowledge and giving feedback or suggestions. Via peer interactions and feedback, students not only have more innovative ideas, but also learn to make reflections through viewing peers’ work.

Most previous studies related to peer feedback were conducted for older age groups (e.g., college or high school students), who were asked to complete artworks, videos or system development projects, such as websites, computer programs or digital games (Ali, Heffernan, Lambe, & Coombes, 2014; Hsia, Huang, & Hwang, 2016; Tseng & Tsai, 2007). In addition to learning achievement, these studies mainly measured students’ learning
motivation, attitudes or the correlations between these variables. Few studies have been conducted to investigate younger students’ innovative thinking and project outcomes as well as their learning achievement and cognitive load, not to mention adopting interactive e-books (i.e., e-book with interactive features) as the target of learning-by-design and peer-feedback activities. Therefore, in this study, an approach of integrating the guided peer-feedback strategy into e-book design was proposed for younger groups. To evaluate the effectiveness of this approach, an experiment was performed on an elementary school science course to investigate the following research questions:

- Can the guided peer feedback-based e-book development approach improve students’ learning achievements in comparison with the conventional e-book development approach?
- Can the guided peer feedback-based e-book development approach improve students’ project outcomes in comparison with the conventional e-book development approach?
- Can the guided peer feedback-based e-book development approach promote students’ innovative thinking tendency in comparison with the conventional e-book development approach?
- Can the guided peer feedback-based e-book development approach reduce students’ cognitive load in comparison with the conventional e-book development approach?
- What are the correlations between the students’ learning achievements, e-book development outcomes, and innovative thinking tendency?

**Literature review**

**Learning by design**

The concept of learning by design derives from “Constructionism,” a concept proposed by educators which emphasizes that students take part in gradually constructing their own knowledge by themselves (Papert, 2000). Students need to consider which information is important and how to present it (Jonassen & Carr, 2000). They will attend courses more actively since they have to gather more information to design their output (Perkins, 1986), which at the same time makes learning more meaningful (Bruckman & Resnick, 1995). Scholars have pointed out that the instruction of learning by design could bring students abundant opportunities to learn (Baytak & Land, 2011). That is, via constructing knowledge in the process of integrating and designing, students can be more impressed by the learning mode (Bruckman & Resnick, 1995; Papert, 2000; Minovic, Milovanovic, Evic, Minovic, & Evic, 2011). In addition, it could arouse the potential of students if presented with a well-designed teaching strategy (Chen, Wei, Wu, & Uden, 2009).

The popularity of technology guides the trend of digital information, the benefits of which have been applied in the education and learning field. Differing from traditional books presented in paper form, electronic books integrate digital information with multimedia (Barker, 1992). Most early studies regarded e-books as the learning medium of instruction (Korat & Shamir, 2008; Moody, 2010; Shamir, Korat, & Shlafer, 2011). For example, Worm (2013) let students learn with e-book teaching material on respiratory physiology and pulmonology, resulting in better learning performance. Thus, it can be seen that the support material provided by e-books provides better learning results (Choi, 2007; Moody, 2010).

On the other hand, researchers have pointed out that by making good use of the multimedia characteristic of e-books, the effect of viewing them as a design tool for students to learn could be a good educational issue for discussion. Jonassen et al. (1995) argued that production of multimedia works is the best knowledge construction activity. Students will construct their own knowledge after integrating a variety of information, instead of always listening to explanations and copying; this is a way of learning that makes students not only pay more attention to their learning but also surpasses their originally equipped ability to reflect and learn via the process of repetitive testing and verifying. Therefore, in recent years, several researchers have indicated the advantages of situating students in the context of learning by design. For example, Minovic et al. (2011) chose game design as a learning tool for a computer networks course, the results of which showed promoted learning effects as well as more creatively developed story works.

The teaching mode of learning by design brings students new learning experiences (Kolodner et al., 2003). Students can design without constraint after integrating what they have learned in learning by design activities. In addition, they can establish their ideas and implement their program of work or material through manipulating it themselves. In this way, students can maintain their interest and motivation to learn while the outcomes are also enhanced since the process of exploration brings about the reinforcement of knowledge and desire to move on to higher learning levels (Papert, 2000). However, researchers have pointed out that it is not only necessary to take strategic and flexible design into consideration, but it is also essential to provide students with suitable
learning support to avoid unnecessary disturbance (Warren, Dondlinger, & Barab, 2008). Consequently, an important issue is how to provide appropriate guidance which would enable students to take care of the development of both creation and academic knowledge in the process of learning by doing (Kafa & Peppler, 2011).

**Guided peer-feedback**

Among various learning strategies, guiding students to play the role of a “teacher” or “reviewer” has been identified by scholars as an appropriate strategy for enhancing students’ learning performance and critical thinking ability, and further promoting the interaction between teachers and students (Spandorfer et al., 2014; Tseng & Tsai, 2007; Merrill & Gibert, 2008). It is a learning setting in which students are guided to play the role of “instructors” or “reviewers” based on the criteria established by the teacher (Topping, 1998). In addition to scoring peers’ work, students also provide comments to peers during the peer-feedback process. On the other hand, they accept the recommendations of others, producing the interaction of sharing, querying and discussing with each other. Thereby, they could make reflections and self-assessment considering the conflict caused by the various opinions of their peers (Boud, Cohen, & Sampson, 1999).

There have been many studies concerning peer-feedback in recent years. For example, El-Mowafy (2014) conducted an experiment in a university geography on-the-spot investigation course, and found that the students learned the knowledge content in more detail and strived harder to achieve the learning objectives after the peer-feedback activity. In addition to the objective of improving students’ learning achievement, researchers have further integrated the use of the peer-feedback strategy into tooth extraction competency (Ali, Heffernan, Lambe, & Coombes, 2014), dance performance (Hsia, Huang, & Hwang, 2016) and environmental issues (Hwang, Hung, & Chen, 2013), the result of which indicated that the learning mode could be a potential strategy to reinforce and enrich the learning experience of students, while also cultivating positive attitudes and self-efficacy toward learning.

The purpose of guided peer-feedback is to provide guidance to promote the students’ vision of viewing work and comprehension of knowledge. The evaluation criteria for assessment are thus quite important. For example, to help students prove that they have enough ability to succeed rather than reducing their confidence, the evaluation items need to be appropriate; that is, the content of each item should match the students’ ability (Chen et al., 2009; van den Berg & Cillessen, 2013). In addition, it is important to consider the time needed for students to make reflections and improve their work or performance (Jenkins, 2004). On the other hand, students need to understand the evaluation criteria so that they have a firm basis on which to score or give comments. Not only should the distance between students and teachers be shortened to enhance their confidence in accomplishing the goals set by the teacher, but the interaction among peers should also be improved (Tsitvitanidou, Zacharia, & Hovardas, 2011). In the meantime, the teacher could encourage students to appreciate different opinions to avoid influencing the peer-feedback results. That is, students would make reflections via the process of viewing the strong and weak points of their work as pointed out by their peers or giving advice to others, making the learning more flexible as well as helping them develop more active attitudes (Chen, 2010).

**Method**

In this study, a quasi-experimental design method was adopted. The independent variables were the learning modes, that is, the integration of the guided peer-feedback into the e-book design, and the conventional e-book design, while the dependent variables were the results of the students’ learning achievement, innovative thinking tendency and cognitive load. The experiment was conducted for the “knowing plants and the ecology” unit of the elementary school natural science course. The objectives of the course unit are to teach students to identify the features of the representative plants on school campus and the relationships between the features and growing environments of the plants. It should be noted that training the review ability of students was not the main purpose of this study; instead, we aimed to guide students to better organize what they have learned while developing the e-book and make in-depth thinking during the peer-feedback process. It was expected that via interpreting learning contents and realizing the relationships between the learning contents, the students’ learning achievements could be improved. Therefore, the guided peer feedback-based e-book development approach played the role of a knowledge construction tool, as indicated by Jonassen et al. (1995).
Participants and procedures

The participants were 72 students from two classes of fifth graders in an elementary school in southern Taiwan. One of the classes was selected as the experimental group \((n = 36)\). The other class was assigned to be the control group \((n = 36)\). The experimental group learned with the guided peer-feedback-based e-book design approach and the control group with the conventional e-book development approach. Moreover, to avoid unnecessary experimental error, both groups of students learned the same course content, used the same software to design their e-book, and were taught by the same instructor who had more than twenty-year experience in teaching the course.

In this study, we chose the e-book design software, ShineCue, developed by the Hama-Star Technology Company in Taiwan. This software was chosen because it is easy to learn and effortless to create an e-book, so the students did not need to spend much time learning how to operate it. Several e-book development functions, such as “insert photos,” “insert videos,” “insert hyperlinks,” “insert text,” “link to other objects” and “jump to other pages” were provided in this tool; thus, the students were able to put more effort into organizing their knowledge and further integrating it with multimedia into an e-book, as shown in Figure 1.

Taking the learning topic from the science curriculum, we picked out 16 kinds of plants for the students to study by surfing the Internet for relevant information in order to complete the e-book design. In the first two weeks of the learning activity, both groups of students received the basic knowledge of natural science, instruction in using the e-book software, and they completed the pre-questionnaire, all in a total of 80 minutes. In the following six weeks, the students in both groups were asked to use the same tool to design their personal e-books for 40 minutes per week. In the third week, the teacher gave the orientation to help the students understand the evaluation criteria of the e-book design.

During weeks 4-8, all students freely designed and developed their e-books using the provided software in the computer classroom. In weeks 5 and 7, the students in the experimental group evaluated the performance of their peers by playing the role of instructor based on the evaluation criteria; on the other hand, the control group students received feedback from their teacher. All of them could revise their e-book design based on the comments or recommendations in order to perfect it.

Finally, the students took the post-test and scales of innovative thinking tendency and cognitive load after the e-book design activity, which took 30 minutes.

Evaluation criteria for assessing the e-books

As mentioned previously, in addition to designing their own e-books, the experimental group students were randomly assigned to evaluate the e-books designed by peers. Consequently, assessment criteria were developed by the researcher and the teacher who had more than ten years’ experience of teaching, referring to the similar research by Hwang, Hung, and Chen (2013). Besides, the criteria were also advised by an experienced e-learning expert for expert validity. There are six evaluative dimensions, presented with a three-point scheme, from 0 to 2, where “0” represents that the e-book design needs major revisions, “1” represents that it needs minor revisions and “2” represents that the e-book design is almost perfect. Apart from scoring, the student could also write some compliments or suggestions. The purpose of the evaluation activity is to stimulate the behavior of sharing or
reflecting via the process rather than the final total score of each student. To balance the students’ focuses on the completeness and correctness of the learning content as well as the innovation of the e-book design, the assessment rubrics consisted of two dimensions: Content and Design, each of which contains three assessment items. The “content” dimension consisted of three items, that is, Structure (whether the content of the e-book is coherent and easy to read), Completeness (whether the complete learning objectives required by the teacher were included) and Accuracy (whether the contents of the e-book were presented correctly, including the concepts and the relationships between the concepts). The “Design” dimension consisted of three items, that is, Appearance (whether the interface of the e-book is nice to look at, such as font size, color and mockup), Innovation (whether the e-book design has some innovative or creative ideas) and Interaction (whether the interactive function in the e-book design software is used appropriately, such as video, drag or question setting). Detailed criteria of the assessment rubrics are given in Table 1.

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Items</th>
<th>0</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Content</strong></td>
<td>Structure</td>
<td>More than two thirds content of the e-book isn’t coherent or comprehensible.</td>
<td>Some part of (1/3 ~2/3) the e-book isn’t coherent or comprehensible.</td>
<td>The e-book is well-structured; the content is coherent and comprehensible.</td>
</tr>
<tr>
<td></td>
<td>Accuracy</td>
<td>More than three pages in the e-book are incorrect (typos, wrong concepts or descriptions)</td>
<td>One or two pages in the e-book are incorrect.</td>
<td>The content in the e-book is all correct.</td>
</tr>
<tr>
<td></td>
<td>Completeness</td>
<td>More than three points or concepts that are important are not presented in the e-book.</td>
<td>One or two points or concepts that are important are not presented in the e-book.</td>
<td>All important points and concepts are presented in the e-book.</td>
</tr>
<tr>
<td><strong>Design</strong></td>
<td>Appearance</td>
<td>The layout of the e-book is not reader-friendly.</td>
<td>Some part of (1/3 ~2/3) the layout of the e-book is not reader-friendly.</td>
<td>The layout of the e-book is reader-friendly.</td>
</tr>
<tr>
<td></td>
<td>Innovation</td>
<td>The content of the e-book is boring.</td>
<td>There are one or two interesting and innovative ideas in the e-book.</td>
<td>The content of the e-book is creative and includes more than three innovative ideas.</td>
</tr>
<tr>
<td></td>
<td>Interaction</td>
<td>Most learning content in the e-book is presented in an interactive way (e.g., pop quizzes, word matching and dragging interaction).</td>
<td>Only some (1/3~2/3) learning content in the e-book is presented in an interactive way.</td>
<td>All of the learning content in the e-book is presented in an interactive way (e.g., pop quizzes, word matching, dragging interaction). It can improve learning motivation.</td>
</tr>
</tbody>
</table>

Figure 2 shows an illustrative example of an e-book with a high score in the “Content” dimension. It can be seen that the e-book is developed with a proper layout, abundant materials (photos from diverse perspectives), and accurate descriptions of the learning content. Figure 3 shows another example of an e-book with a high score in the “Design” dimension. In this e-book, a map is provided to replace the outline of the content. The map not only shows the physical locations of the corresponding learning targets, but also provides direct links to the relevant e-book pages.
Clearly present the name and descriptions of the plant
Properly arrange the layout of the learning content
Provide photos to show the characteristics of the plant from various perspectives

Figure 2. Illustrative example of a student’s e-book with a good score in the “Content” dimension

Using different colors to represent the links to information of different categories of plants.
Presenting the outline of the e-book in the form of a map showing the physical location of each learning target

Figure 3. Illustrative example of a student’s e-book with a good score in the “Design” dimension
Measuring tools

The measures employed in the present study included the tests of knowledge and work performance, and the questionnaires of innovative thinking tendency and cognitive load.

The pre-test and post-test were developed by two teachers who had more than 10 years’ experience of teaching the science curriculum. On the one hand, the objective of the pre-test was to assess whether the two groups of students had equivalent basic knowledge before participating in the learning activity, and included yes-or-no items, multiple-choice items, matching questions and short answer questions with a total score of 100. On the other hand, the post-test aimed to evaluate the students’ knowledge of the 16 kinds of plants, consisting of basic multiple-choice, advanced multiple-choice matching questions and short answer questions, with a total score of 100.

Apart from this, we also collected the performance of the students’ e-book design work. The researchers and educational experts graded the students’ e-book work separately based on the six evaluation criteria we developed, consisting of the design dimension (kappa = 0.82) and content dimension (kappa = 0.92).

Following this, the questionnaire of innovative thinking tendency was modified from the measure developed by Lin and Wang (1994). It consisted of six items (e.g., “I like to ask some questions that no one have ever thought of before” and “I like to imagine about something that I want to know or want to do”) on a five-point Likert scale. The Cronbach’s alpha value of the questionnaire was 0.8. The reason why we wanted to measure this was because innovative thinking tendency is highly related to learning by design (Breivik, 2005). In developing an interactive e-book, the students were encouraged to design the layout of the content as well as the interactive features in innovative ways.

Moreover, the questionnaire of cognitive load was modified by Hwang, Yang and Wang (2013) for elementary school students based on the measures developed by Paas (1992) and Sweller, van Merriënboer and Paas (1998). It consists of 8 items in two dimensions, including mental load (e.g., “The learning content of the activity is difficult for me”) and mental efforts (e.g., “I need to put lots of efforts to follow the instructional way of the teacher during the learning activity”). Mental load is related to the complexity of the learning content that students need to handle, while mental efforts is related to the learning approaches or strategies used in the learning activities. The Cronbach’s alpha values of the mental load and mental effort dimensions were 0.86 and 0.85, respectively.

Results

Learning achievement

After examining the heterogeneity of the pre-test scores of the two groups, ANCOVA was used to compare their post-test scores. Table 2 illustrates the ANCOVA results of the post-test scores using the pre-test as a covariate in which the adjusted mean values of the post-test scores were 69.29 for the experimental group, and 58.6 for the control group. It was found that the students in the experimental group had significantly better achievements than those in the control group ($F = 14.82, p < .001$), implying that the teaching strategy of guided peer-feedback had a positive impact on the students’ learning performance.

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental group</td>
<td>36</td>
<td>69.29</td>
<td>1.95</td>
<td>14.82***</td>
</tr>
<tr>
<td>Control group</td>
<td>36</td>
<td>58.60</td>
<td>1.95</td>
<td></td>
</tr>
</tbody>
</table>

*Note.*** $p < .001$.

E-book design project outcomes

In terms of the project outcomes, two teachers who had more than 10-year experience in teaching the course scored the students’ e-books separately based on the six evaluation items. The consistence of their scores for the content dimension (kappa = 0.92) and the design dimension (kappa = 0.82) showed high inter-rater reliability.
As shown in Table 3, the means and SDs of the work performance scores in the content dimension were 11.58 and 3.18 for the experimental group, and 9.50 and 3.05 for the control group. The $t$-test result ($t = 2.84, p < .001$) shows that there was a significant difference between the two groups. For the design dimension, the scores were 11.00 and 8.40 for the experimental group, and 9.50 and 3.05 for the control group. The $t$-test result ($t = 6.51, p < .001$) shows there was also a significant difference between the two groups for this dimension. Consequently, we can conclude that the integration of guided peer-feedback into the course had significantly positive effects on the students’ project outcomes. The reason seems to be that the students performed better when the learning shifted from the teacher-centered to the student-centered mode, requiring them to not only construct knowledge actively through the creating process, but also to modify their personal productions based on the comments of their peers after the scoring activity.

**Table 3.** $t$-test result of the ratings on the students’ e-books of the two groups

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Group</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>$t$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Experimental group</td>
<td>36</td>
<td>11.58</td>
<td>3.18</td>
<td>2.84***</td>
</tr>
<tr>
<td>Content</td>
<td>Control group</td>
<td>36</td>
<td>9.50</td>
<td>3.05</td>
<td></td>
</tr>
<tr>
<td>Design</td>
<td>Experimental group</td>
<td>36</td>
<td>11.00</td>
<td>1.57</td>
<td>6.51***</td>
</tr>
<tr>
<td></td>
<td>Control group</td>
<td>36</td>
<td>8.40</td>
<td>1.80</td>
<td></td>
</tr>
</tbody>
</table>

*Note.*** $p < .001$.

**Innovative thinking tendency**

In terms of students’ innovative thinking tendency, the $t$-test results of the pre-questionnaire showed no significant difference between the two groups ($t = 1.20, p > .05$) before the learning activity. After the activity, the students completed the innovative thinking tendency post-questionnaire. As shown in Table 4, the $t$-test results showed that the students in the experimental group had significantly higher innovative thinking tendency than those in the control group ($t = 2.21, p < .05$). Therefore, it is concluded that the integration of the guided peer-feedback strategy into the e-book design had a positive impact on the students’ innovative thinking tendency in comparison with the conventional learning mode.

**Table 4.** $t$-test result of the innovative thinking tendency post-questionnaire of the two groups

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>$t$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental group</td>
<td>36</td>
<td>3.93</td>
<td>0.83</td>
<td>2.21*</td>
</tr>
<tr>
<td>Control group</td>
<td>36</td>
<td>3.55</td>
<td>0.61</td>
<td></td>
</tr>
</tbody>
</table>

*Note.*** $p < .05$.

**Cognitive load**

As given in Table 5, the means and standard deviations of the cognitive load ratings were 3.18 and 1.11 for the experimental group, and 3.92 and 0.99 for the control group. According to the results ($t = -2.98, p < .01$), there was a significant difference between the two groups, implying that the e-book design activity with the guided peer-feedback was able to reduce the cognitive load of the students in the learning process. Moreover, there was a significant difference between the two groups of students in terms of cognitive load ($t = -2.54, p < .05$) and mental efforts ($t = -2.90, p < .01$). These finding confirmed that the guided peer-feedback approach was an effective strategy for helping the students comprehend the course content and complete the learning task.

**Table 5.** $t$-test result of the cognitive load of the two groups

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Group</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>$t$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cognitive load</td>
<td>Experimental group</td>
<td>36</td>
<td>3.18</td>
<td>1.11</td>
<td>-2.98**</td>
</tr>
<tr>
<td></td>
<td>Control group</td>
<td>36</td>
<td>3.92</td>
<td>0.99</td>
<td></td>
</tr>
<tr>
<td>Mental load</td>
<td>Experimental group</td>
<td>36</td>
<td>2.98</td>
<td>1.10</td>
<td>-2.54*</td>
</tr>
<tr>
<td></td>
<td>Control group</td>
<td>36</td>
<td>3.65</td>
<td>1.13</td>
<td></td>
</tr>
<tr>
<td>Mental efforts</td>
<td>Experimental group</td>
<td>36</td>
<td>3.51</td>
<td>1.36</td>
<td>-2.90**</td>
</tr>
<tr>
<td></td>
<td>Control group</td>
<td>36</td>
<td>4.36</td>
<td>1.13</td>
<td></td>
</tr>
</tbody>
</table>

*Note.*** $p < .05$; ** $p < .01$.
Correlation coefficients between the different variables

This section discusses the correlation coefficients between the different variables in order to examine the relationships between them, including learning achievement, ratings for the “content” and “design” dimensions of the e-books, and innovative thinking tendency.

The statistical results are shown in Table 6. It was found that the students’ learning achievement and innovative thinking tendency had a positive correlation ($r = 0.26$, $p < .05$), implying that the students who were engaged in the learning activity more enthusiastically benefited greatly in terms of learning achievement as well as innovative thinking tendency. In other words, it is important to take both the content and the design aspects into consideration when designing assessment rubrics.

In addition, the e-book design consisted of both content and design dimensions, with the statistical results revealing that the students’ work in the “content” dimension of the teacher assessment and in the “design” dimension of the teacher assessment had a positive correlation ($r = .38$, $p < .01$), implying that the organization of information is related to the quality of the students’ e-book design work.

Besides, we further found that the students’ work in the “design” dimension of teacher assessment and innovative thinking tendency after the learning activity also had a positive correlation ($r = .23$, $p < .05$), representing that the scores of the students’ project work were quite closely correlated to their innovative thinking tendency after the learning activity. To sum up, the students not only had higher innovative thinking tendency, but also had better creative performance in real e-book design according to the guidance of the peer-feedback strategy.

Table 6. Pearson correlation for the different variables

<table>
<thead>
<tr>
<th></th>
<th>Learning achievement</th>
<th>Ratings for the “content” dimension</th>
<th>Ratings for the “design” dimension</th>
<th>Innovative thinking tendency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning achievement</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ratings for the “content” dimension</td>
<td>.31**</td>
<td></td>
<td>.40**</td>
<td>.26</td>
</tr>
<tr>
<td>Ratings for the “design” dimension</td>
<td>-</td>
<td>.38**</td>
<td>-</td>
<td>.23</td>
</tr>
<tr>
<td>Innovative thinking tendency</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note.* $p < .05$; $**p < .01$.

Discussion and conclusions

In this study, an approach of integrating the guided peer-feedback strategy into e-book design has been proposed and applied to a learning activity in an elementary school natural science course. From the experimental results, it was found that the students learning with the guided peer-feedback-based e-book development strategy showed better learning achievements, project outcomes and innovative thinking tendency, while having lower cognitive load than those learning with the conventional e-book development strategy.

The good performances on the students’ learning achievements and project outcomes can be attributed to the features of integrating guided peer-feedback in to the learning by design activity that engages students in reviewing peers’ work, providing feedback to peers and making reflections on their own work as well as organizing the learning content and trying innovative thinking during the e-book development process. In the peer-feedback stage, the students would be able to appreciate the different opinions of their peers and make reflections as well as sharing knowledge and giving comments to peers during the peer-feedback process. As indicated by the researchers, playing the role of a reviewer is important to students since they have chance to see peers’ and their own work from the teacher’s viewpoints and make in-depth reflections, which is usually omitted in conventional learning by design activities in which teachers directly give comments and scores to individual students (Topping, 1998; Fallows & Chandramohan, 2001). The e-book design activity engaged the students in organizing what they have learned, while the peer-feedback strategy engaged them in reconsidering the developed content and the e-book structure in depth, which enabled them to better comprehend the concepts in the learning content and the relationships between the concepts.

In the term of the innovative thinking tendency, when playing the role of a reviewer, the students needed to learn and know the evaluation principles in depth before providing comments to peers’ work, implying that they could have the opportunity to see thinking from different viewpoints (i.e., the teachers’ viewpoints). Moreover, they
also had the opportunity to see different design concepts implemented by peers. As indicated by researchers, receiving different or even conflicting concepts or comments could stimulate more innovative ideas (Gibbs, 2006; Planas Lladó et al., 2014). The findings in this study might provide another evidence for this point.

Regarding cognitive load, researchers have indicated that there might be a negative impact on learning effect when cognitive load is excessive during the learning (Paas & van Merriënboer, 1994). In the present study, it was found that the peer-feedback strategy was able to reduce the cognitive load of the students when designing the e-books. That is, this learning approach could help the students better organize the required information that they had learned as well as understand the learning content and tasks. During the peer-feedback stage, the students scored peers’ work and provided feedback to them after having in-depth comprehension to the evaluation criteria, which enabled them to have a clearer concept of the learning task as well as better knowledge of organizing the content. This is likely to be the reason why their mental efforts were reduced. On the other hand, mental load is related to the relative difficulty of the learning materials to individual students. Although both groups of students were arranged to learn the same subject content and participated in the same learning activity, the students in the experimental group revealed that learning the content was not so difficult to them after the learning activity. It is inferred that the experimental group students had better comprehension of the learning content and the relationships between the concepts to be learned, and hence they showed lower cognitive load than the control group. This finding is consistent with the students' learning achievements.

In the near future, in addition to examining the potential of peer-feedback in fostering students’ critical thinking ability, it would be worthwhile to investigate the effects of peer-feedback-based e-book development activities on students’ critical thinking and reflection levels. Moreover, it would also be worth analyzing and exploring the learning behaviors of students if the e-book design and the peer-feedback process could be recorded. In that case, we could better understand students’ behavior under different teaching treatments based on the recorded data, such as what kind of learning mode would have a positive impact on students’ learning performance, or the relationship between learning behavior, and so on. Finally, the participants in this study were restricted to elementary school students; this strategy could, however, be adopted by learners of all ages. Consequently, it would pay to employ the guided peer-feedback strategy with different age groups in order to gain a more diversified perspective.

Acknowledgements

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Interaction Analysis for Supporting Students’ Self-Regulation during Blog-based CSCL Activities

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ABSTRACT
Self-regulated learning is an important means of supporting students’ self-awareness and self-regulation level so as to enhance their motivation and engagement. Interaction Analysis (IA) contributes to this end, and its use in studying learning dynamics involved in asynchronous Computer-Supported Collaborative Learning (CSCL) activities has rightfully increased in recent years. This paper presents a case study regarding the impact IA graphs have on students’ self-regulation, during a blog-based learning activity. More specifically, 52 secondary education students – a control group (25 students without IA toolkit support) and an experimental group (27 students with IA toolkit support) – used a blog, as a communication and information management medium for creating Scratch games. The statistical analysis of their responses to the Self-Regulation Questionnaire, before and after the activity, indicates that IA graphs facilitated their self-regulation capacity. The results support the initial hypothesis, namely that IA constitutes an important module for self-regulation in CSCL settings, enhancing the collaborative learning activity.

Keywords
Interaction analysis, Self-regulation, CSCL, Blogs

Introduction
In all cases of CSCL, developments in learning theories – such as the sociocultural theory (Vygotsky, 1986) or the social constructivism theory (Kim, 2001) – underscore the significance of contextualisation and social interactions as fundamental constituents of the learning process (Brattis, 2010). This paper focuses on asynchronous communication (with peer support being the core objective), which is nowadays widely used in formal and informal educational contexts (Lucas, Gunawardena, & Moreira, 2014). This way of learning is most likely to further grow and expand in the near future, due to the fact that the development rate and availability of social software applications – often collectively referred to as “Web 2.0” – has set new challenges, and offers novel opportunities for the learning technology community (Duffy & Bruns, 2006). Tools, such as blogs, discussion fora and wikis, are often utilized within CSCL, primarily for communicative purposes (Brattis, 2010). Blogs, especially, have emerged as social software catering for asynchronous communication, having the potential to become a space for reflection through discussion. Not only do blogs highlight the collaborative dimension of interaction, but may also contribute to metacognitive processes and collaborative construction of knowledge, thus influencing learning (Pavo & Rodrigo, 2015). Recent research offers evidence of the numerous benefits of using blogs, often associated with the improvement of students’ critical thinking, problem-solving, and communication skills (Kim, 2008). For example, as all blog contributions remain at the disposal of the participants, referencing during discussion, as well as further revision and reflection, become more specific and accurate (Van den Boom, Paas, Van Merriërboer, & Van Gog, 2004). As Ellison and Wu (2008) suggest, blog writing incites critical and analytical thinking, since it allows students to experience a broader perspective when interacting, as well as review their interactions with their peers.

Much of the research conducted in the field of social knowledge construction focuses on the application of computer-based IA for the automated analysis and visualization of the social learning dynamics indicated by written interactions, in asynchronous blog-based environments (Dettori & Persico, 2008; Lucas et al., 2014; Pavo & Rodrigo, 2015). The participants of the learning environment are presented with the IA results, usually in a graphical format that can be interpreted by users, in order to encourage their participation in controlling the activity (Brattis, 2012). According to Dimitracopoulou (2009), the primary goal is to develop IA tools that could provide all actors involved (i.e., students and teachers) with an insight into their own current or previous activity, contributing to awareness, allowing them to reflect on a cognitive or metacognitive level, and, therefore, act in order to self-regulate their activities. Students, however, often find it difficult to have an overview of their performance and that of their peers on a group or community level, and this has a negative effect on their motivation to improve that performance (Brattis & Dimitracopoulou, 2009). In this vein, metacognitive skills are deemed necessary in order to manage one’s cognitive skills and, thus, one’s thinking process, through
regulating and controlling one’s actions (Jermann, 2004). As Kitsantas and Dabbagh (2010) suggest, for students to self-regulate and navigate their own behavior, they must also be inherently motivated to attain goals. Processes linked to effective Self-Regulated Learning (SRL) include goal-setting, task strategies, self-monitoring and self-reflection (Pintrich, 2000; Zimmerman, 2000). Especially self-monitoring and self-reflection of the learning procedure, mainly through the analysis of social interactions, are core components of the SRL process in blog-based learning environments (Chen, 2009; Dettori & Persico, 2008). In this context, IA graphs allow students to self-regulate their activity, as research shows that such graphs activate metacognitive processes (Dimitracopoulou, 2009), and offer substantial help in raising students’ awareness regarding their strengths and weaknesses (Bratitis & Dimitracopoulou, 2009).

Addressing some of the aforementioned issues, the authors have developed an IA toolkit for blogs, which analyses and graphically visualizes, in real time, the complex social interactions that take place during blog-based collaborative activities. The toolkit enables teachers and students to use the automatically produced IA graphs in order to support monitoring, awareness, and self-regulation of the collaboration process. The present research aims to investigate the impact IA graphs have on students’ self-regulation when involved in blog-based CSCL activities. Against this background, this paper presents research findings from a case study evaluating the application of our IA toolkit within a secondary education learning context. The paper is organized as follows: first, the related work supporting this case study is discussed, followed by a description of the research design and the research questions addressed in this paper. After the research findings are presented and discussed, conclusions and suggestions for future research can be found in the last section of this paper.

Related work

Pintrich (2000) describes SRL as an active, constructive process, whereby students set specific learning goals, select strategies purposefully in order to attain those goals, employ certain skills to assess progress, and make modifications when facing a problem. In that respect, Zimmerman (2000) conceptualized the SRL process as a three-phase model (forethought, performance, self-reflection), which was used by several studies to support self-regulation in online and blended environments (Kitsantas & Dabbagh, 2010). By engaging in these cyclical self-regulatory phases, students gradually become interested in the task, and reach a high level of self-efficacy in their ability to accomplish these goals (Zimmerman, 2008). Although SRL in web-based learning environments has received considerable academic attention (Zimmerman, 2000; Zimmerman, 2008), SRL, especially in educational group blog contexts, has not been studied extensively. Huang, Huang, Wang, Liu, and Sandnes (2012) classify the pertinent studies in three main categories: (a) analysis of online SRL behavior of learners (Perry & Winnie, 2006; Dettori & Persico; 2008); (b) application of the SRL strategy to web-based activities so as to assess its impact (Lee, Shen, & Tsai, 2008; Wong & Bakar, 2009); and (c) development of SRL-based tools, where providing IA graphs to help learners monitor self-learning is the prime objective.

Nonetheless, reviewing the literature in the field, one can detect a lack of available tools for the automated IA support of student awareness and self-regulation in blog-based CSCL. Focusing on asynchronous communication CSCL activities, one finds systems like the Knowledge Forum (Scardamalia, 2004), which provides metacognitive tools, assisting students to reflect upon their performance and improve their learning strategies in problem-solving situations, or the i-Tree for asynchronous discussion fora (Nakahara, Kazaru, Shinichi, & Yamauchi, 2005). The DIAS system (Bratitis & Dimitracopoulou, 2009) is a discussion forum platform offering an extensive set of IA indicators addressing all actors involved in discussion learning activities. Similarly, the Web2SRL system (Huang et al., 2012) provides learners with the means to regulate learning, including planning, practice, and reflection. Furthermore, Chen (2009) has developed a personalized e-learning system with mechanisms that help learners improve their SRL ability. On the other hand, research on the self-regulation skills of students participating in blogs without any supporting IA tools has produced encouraging results in various settings (Dettori & Persico, 2008; Fessakis, Dimitracopoulou, & Tatsis, 2008; Bratitis & Dimitracopoulou, 2009; Bratitis, 2010; Fessakis, Dimitracopoulou, & Palaiodimos, 2013). It is true, however, that most of the cited researchers have studied self-regulation mainly by ex-post messages activity analysis of student interaction. Moreover, the IA graphs were produced off-line and in a non-automatic manner, usually in scheduled time intervals. Finally, research on the self-regulation level of participants has also been conducted in other areas, like Shared Knowledge Awareness (Collazos, Guerrero, Redondo, & Bravo, 2007), where the need to develop tools for self-controlling and self-monitoring the learning process is also highlighted. The main idea is the use of awareness visualization mechanisms as part of the knowledge management system, in order to help every member of the group complete the task in a more effective way.
Up to now, learning-oriented, fully-automated, and real-time evaluative or supportive tools, based on IA methods, have not yet been implemented specifically for blogs. Taking into account the above, and the fact that actual blogging systems offer limited IA support – often more useful to an administrator rather than a teacher or student – the authors of this paper have deployed a newly developed IA toolkit for blogs. This paper presents a case study of a CSCL blog-based activity in secondary education, while focusing on the impact the IA graphs of the toolkit have upon students’ self-regulation during collaboration. These IA graphs are presented to the students as dynamically produced feedback information, in order to assist them in reflecting upon their own activity, as well as upon the overall activity by all participants, allowing them to self-regulate their actions and/or behavior. To the best of the authors’ knowledge, there is no other significant input or comprehensive research work on the self-regulation effects of supporting automated IA tools for blogs, especially for secondary education students.

Research design

In essence, the current research constitutes a case study, where the pedagogical design of the CSCL activity was based on Zimmerman’s model of SRL (2000) and Project Based Learning (PBL), which, according to Lee et al. (2008), can support and enhance the practice of SRL, especially in online learning.

Material

The main material employed for the purposes of this research was our IA toolkit, which can be seamlessly integrated in any WordPress blogging platform (as a plug-in), allowing teachers and students to use it so as to support monitoring, awareness, and self-regulation of the collaborative process (Michailidis & Tsiatsos, 2014). The innovative aspect of the toolkit resides in the fact that the IA graphs are produced automatically, and not after the completion of the blogging activity, by measuring quantitative activity data, such as the number of posts and comments written and read by someone, the identity of the writer or reader of those comments/posts, the time when they were written or read, etc. Furthermore, the effectiveness of the approach has been tested in real class teaching scenarios (Michailidis & Tsiatsos, 2014; Michailidis, Chondrouli, Katmada, & Politopoulos, 2015). In total, 32 visualized IA graphs (including all possible variations) can be produced and displayed by the toolkit, varying from simple statistical awareness information to complex cognitive and metacognitive IA graphs. For example, the graph entitled Comments on All Articles (Figure 1) is based on a gauge type chart, representing an overview of the active participation of the user, by displaying the total number of his/her comments (blue pointer) compared to the average number of comments made by all users of the blog (black pointer), and also the average number of comments made by the members of the user’s team (white pointer). The graph provides metacognitive insight, by positioning the user in a colored 3-scale zone, using a predefined algorithm.

Research questions

The following questions have been set in order to assess the research goals:

RQ1: Is there a difference between the group of students being presented with the IA graphs from the toolkit and the group without exposure to the toolkit, in terms of message contribution in CSCL blog based learning environment?
We expect to find a positive relationship and an increase in message contribution, anticipating that the presence of the IA graphs from the toolkit will increase message contribution by the students belonging to the experimental group.

RQ2: Are there any statistically significant differences between student groups supported by the IA toolkit and student groups with no support from the IA toolkit for blogs, in terms of their self-regulatory capacity?

It is expected that the self-regulation level between student groups will differ, depending on the presence or not of the IA graphs from the toolkit. We assume that the experimental group members will report higher mean scores in self-regulatory capacity than students belonging to the control group.

Methodology

According to Dimitrov and Rumrill (2003), the design of this research could be characterized as “randomized control group pretest - posttest design.” In this respect, participants are randomly divided into control and experimental groups, ensuring thus that they are of a similar average level in terms of technological expertise. As depicted in Figure 2, the overall activity conditions were the same for both groups (see section entitled “Procedure”). In order to explore the impact IA graphs have on students’ self-regulation during blog-based collaboration, the only difference between the two groups was that only experimental group members had access to the toolkit’s IA graphs.

Participants

A total of 52 secondary education students (27 females, 51.9%, and 25 males, 48.1%), one teacher and one assistant teacher from a Junior High School in Thessaloniki, Greece, participated in the study. The average age of the participants was 13.5 years (SD = 0.5 years), since all students came from the same class. Out of the 52 students, only 25% had previous experience in blogging systems, while 53.8% of them had previous experience in other Web 2.0 environments. However, students had a satisfactory sense of confidence in using blogs (73.1%), with 52.6% of them declaring that they like using blogs, 42.1% being neutral, and only 5.3% of them being negatively inclined to blogging.

Instruments

The experimental instruments employed in this study include: (a) the published content of the blog (posts and comments), (b) the questionnaire that all students answered before and after the activity, (c) a semi-structured interview that was conducted after the completion of the activity, and (d) the graphs produced by the IA toolkit for blogs. The participating students were asked to complete two questionnaires: (a) the pre-test questionnaire, before starting the activity, and (b) the post-test questionnaire, after the activity. The statistical analysis was conducted via the use of SPSS package ver.22, with the level of significance set to 0.05. Both questionnaires used in this study were based on the Self-Regulation Questionnaire - SRQ (Brown, Miller, & Lawendowski, 1999). The SRQ is an instrument assessing the self-regulatory capacity of students through self-report, and it comprised 63 items specially designed to mark each of the seven sub-processes of the Miller and Brown (1991) model. The selected measures used a five-point Likert scale, ranging from “strongly disagree” (1) to “strongly
agree” (5). Cronbach’s alpha statistics was performed to test the reliability of the pre- and post-task questionnaires; this revealed values of $\alpha = .894$ and $\alpha = .703$ respectively, showing high internal consistency for the applied questionnaires.

**Procedure**

The experiment was conducted during the 2nd trimester of the 2015-2016 school year. The activity was launched over a period of 8 weeks, and was a compulsory module for the successful completion of the Informatics course, contributing 10 units (out of 20) to the students’ final mark. In order to achieve the objectives of this case study, a WordPress blogging network using our IA toolkit was deployed. Students were randomly divided into 12 teams, each of which had access to a team blog from the network, where they could post their articles and game designs and to a central blog, where they could read announcements. Only members of the experimental group were given access to the toolkit’s IA graphs, and they were advised to consult them on a daily basis, throughout the activity. Students were assigned the task to design and develop a computer game using the Scratch programming environment (see https://scratch.mit.edu/). The role of the teacher was to monitor all the available IA graphs, providing guidance and support to students during the blog activity, and answering any questions during weekly 45-minute long face-to-face meetings. In order to support and encourage social interactions, the learning activity was organized with a collaboration script of 5 distinct phases:

- **Phase 1 – Socialization**: Students worked individually, in order to post an answer to a game design question, and comment on at least five answers of their fellow-students (1 week).
- **Phase 2 – Group Game Scenario**: Students had to post the scenario of their game as a team, and constructively comment upon at least five other group scenarios (2 weeks).
- **Phase 3 – Group Game Development**: Students had to work together as a team, and develop a beta version of their game in Scratch (3 weeks).
- **Phase 4 – Group Game Revision**: Students were obliged to interact with the rest of their peers in the blog by commenting freely upon the Scratch Games they had created, suggesting possible ways of improvement. Each team had to revise the beta version of their game, taking into account the comments of their peers, and post the final version of their game (1 week).
- **Phase 5 – Peer Marking**: Students had to suggest a mark, rating the final versions of the Scratch games, on a scale from 1 to 5 using a star-based system (1 week).

**Results**

Evaluating self-regulation based on number of comments

Overall, students produced a total of 1,665 messages. The groups which had no access to the IA graphs posted fewer comments (446 messages) than the students in groups that had access to the IA graphs (1,219 messages). In order to test if the presence of IA graphs did, in fact, contribute to the increase in the number of comments, the authors measured the significance of the difference between the students’ comments of the two groups. Thus, two variables called COM (for comments coming from each student) and GROUP (to show whether a student belonged to the experimental or the control group) were created. Table 1 depicts the basic statistics for COM and GROUP variables.

<table>
<thead>
<tr>
<th>Variable</th>
<th>GROUP (value)</th>
<th>$N$</th>
<th>Min</th>
<th>Max</th>
<th>Sum</th>
<th>Mean</th>
<th>$SD$</th>
</tr>
</thead>
<tbody>
<tr>
<td>COM</td>
<td>Experimental (1)</td>
<td>27</td>
<td>10</td>
<td>115</td>
<td>1,219</td>
<td>45.14</td>
<td>33.04</td>
</tr>
<tr>
<td></td>
<td>Control (2)</td>
<td>25</td>
<td>7</td>
<td>33</td>
<td>446</td>
<td>17.84</td>
<td>8.34</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>52</td>
<td>7</td>
<td>115</td>
<td>1,665</td>
<td>32.01</td>
<td>27.91</td>
</tr>
</tbody>
</table>

First, a Shapiro-Wilk test was conducted to check if variables were approximately normally distributed. The results of the test showed that both variables were not normally distributed; ($S-W_{COM} = 0.749, df = 52, p = .00$), ($S-W_{GROUP} = 0.636, df = 52, p = .00$). Therefore, a Mann-Whitney test was conducted and indicated that the number of comments of students belonging to the experimental group ($M = 45.14$, $SD = 33.04$) were significantly higher than that coming from the control group teams ($M = 17.84$, $SD = 8.34$); $U = 136.50, p = .00$ (Neuhäuser, 2002). It is important to stress here that the effect size for this analysis ($r = 0.51$) was found to exceed Cohen’s (1977) convention for a medium effect ($r = 0.5$).
Evaluating self-regulation based on the Self-Regulation Questionnaire (SRQ)

Regarding the evaluation of self-regulation, the SRQ was used to measure the self-regulatory capacity of the students before and after the study. The objective is to investigate whether there is a significant difference in the mean score of the self-regulation level between the control and the experimental group. Generally, in order to ensure that under all conditions the results deriving from the analysis supported our expectations, the following steps were taken. First of all, the fact that there was no difference in the mean score of the SRQ between the experimental and the control group before the activity had to be proven. In that way, our assumptions concerning a significant difference between the groups after the activity would be supported, proving that this difference was modified during the activity and specifically because of the use of the IA toolkit. Following this, the fact that the SRQ score for the control group students before the activity was not significantly different compared to that after the activity had to be put to the test as well. Finally, the fact that the toolkit had an impact only on those who used it, and that their SRQ score after the activity was significantly higher compared to their score prior to the activity also had to be tested.

For all the aforementioned reasons, a one-way ANOVA test was conducted, testing the difference before and after the activity, and ensuring that before the activity there was no difference between the groups concerning the SRQ score. In this case, the one-way ANOVA produces the same results as an independent sample t-test, since we aim to compare means of only two groups (Moore & McCabe, 1989). To this end, two dependent variables, called PRE and POST, were, therefore, created so as to keep the score of each student, as well as an independent variable, called GROUP, which aimed at indicating whether a student belonged to the experimental or the control group. Table 2 presents the basic descriptive statistics concerning the variables mentioned above.

Table 2. Descriptive statistics for the SRQ instrument

<table>
<thead>
<tr>
<th>Variable</th>
<th>GROUP (value)</th>
<th>Name</th>
<th>N</th>
<th>Min</th>
<th>Max</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRE</td>
<td>Experimental (1)</td>
<td>PRE_EXP</td>
<td>27</td>
<td>186</td>
<td>263</td>
<td>223.77</td>
<td>19.19</td>
</tr>
<tr>
<td></td>
<td>Control (2)</td>
<td>PRE_CON</td>
<td>25</td>
<td>203</td>
<td>247</td>
<td>221</td>
<td>11.78</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>52</td>
<td>186</td>
<td>263</td>
<td>222.44</td>
<td>15.97</td>
</tr>
<tr>
<td>POST</td>
<td>Experimental (1)</td>
<td>POST_EXP</td>
<td>27</td>
<td>207</td>
<td>278</td>
<td>242.51</td>
<td>18.28</td>
</tr>
<tr>
<td></td>
<td>Control (2)</td>
<td>POST_CON</td>
<td>25</td>
<td>199</td>
<td>252</td>
<td>221.8</td>
<td>13.07</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>52</td>
<td>199</td>
<td>278</td>
<td>232.55</td>
<td>18.97</td>
</tr>
</tbody>
</table>

In order for the ANOVA to be applicable, there are specific prerequisites that need to be met, namely that the samples should be random and independent, and the variances of the populations should be equal. In our case, the samples were fairly random, because teams were formed using a list where the surnames of the students appeared randomly. In addition, the samples were independent, since they did not have any students in common. Moreover, a Shapiro-Wilk test was conducted and, based on the findings, all variables were approximately normally distributed ($W_{PRE} = 0.976, p = .367, a = 0.05$), ($W_{POST} = 0.963, p = .108, a = 0.05$). The homogeneity of variances was explored with the use of Levene’s Test for Equality of Variances, which indicated the equality of variances, ($F_{PRE} = 3.515, p = .067$ and $F_{POST} = 3.356, p = 0.073$).

The one-way ANOVA test indicated that the mean score of the SRQ in the experimental group before the study ($PRE_{EXP}: M = 223.77, SD = 19.19$) was not significantly different from that of the control group ($PRE_{CON}: M = 221, SD = 11.78$); $F(1,50) = 0.388, p = .536$. Regarding the SRQ score after the study, the ANOVA test manifested that there was a significant difference between the experimental group ($POST_{EXP}: M = 242.51, SD = 18.28$) and the control group ($POST_{CON}: M = 221.8, SD = 13.07$). More specifically, the mean score of the experimental group was considerably higher than that of the control group; $F(1, 50) = 21.775, p = .00$. Concerning the effect size of the test, the one before the study ($\eta^2 = 0.007$) is considered to be small ($\eta^2 < 0.13$) and the one after the study ($\eta^2 = 0.3$) is regarded as large ($\eta^2 > 0.26$) (Cohen, 1977).

The research findings described above illustrated that, on average, the students belonging to the experimental group achieved a higher SRQ score than the students from the control group after the completion of the experiment. This can be an indication that the experimental group did, in fact, significantly raise its self-regulation level, when compared to the control group, after the successful completion of the activity. This is a factor which was not present before the beginning of the activity. In other words, this can be an indication that the presence of the IA graphs produced by the toolkit supported and enhanced the self-regulation level of the participants.

The next step in order to prove that our IA toolkit for blogs had an impact only on the students that actually used it was to conduct a paired samples t-test for the scores of the control group before and after the study. Two
variables named \textit{PRE\_CON} and \textit{POST\_CON} were created for the purposes of the test, which was to keep the score of each student of the control group before and after the study. With respect to the assumptions employed in the paired sample \textit{t}-test, it is obvious that the samples are paired, since all of their members are common, except for the fact that the two variables measure the same score but in different times. Moreover, a Shapiro-Wilk test was conducted, and according to the results, all variables were approximately normally distributed ($W_{\text{PRE\_CON}} = 0.949, p = .235, a = 0.05$), ($W_{\text{POST\_CON}} = 0.960, p = .415, a = 0.05$).

As evident in the paired samples \textit{t}-test, the mean score of the SRQ in the control group after the study ($POST\_CON: M = 221.8, SD = 13.07$) was not significantly different from that before the study ($PRE\_CON: M = 221, SD = 11.78$); $t(24) = -0.288, p = .776$. As expected, the effect size of the test is limited, only $d = 0.027$, which is considered to be small (Cohen, 1977). Moreover, the difference before and after the study was 0.8 units higher on average, indicating that the absence of the toolkit’s IA graphs did not help students raise their level of self-regulatory capacity to a considerable degree.

Finally, in order to investigate if there is any significant difference as for the mean SRQ score of self-regulation of the experimental group only, before and after the activity, a paired samples \textit{t}-test was also conducted. For the test, two variables named \textit{PRE\_EXP} and \textit{POST\_EXP} were created in order to keep the score of each student before and after the study. Concerning the assumptions of the paired sample \textit{t}-test, the samples are paired, since all of their members are common, except for the fact that the two variables measure the same score but in different times. Moreover, a Shapiro-Wilk test was conducted, and according to the results, all variables are approximately normally distributed ($W_{\text{PRE\_EXP}} = 0.976, p = .760, a = 0.05$), ($W_{\text{POST\_EXP}} = 0.975, p = .750, a = 0.05$).

The results of the paired samples \textit{t}-test showcase that the mean score of the SRQ in the experimental group after the study ($POST\_EXP: M = 242.51, SD = 18.28$) was significantly higher than that before the study ($PRE\_EXP: M = 223.77, SD = 19.19$); $t(26) = -7.805, p = .000$. Concerning the effect size of the test, that is 0.723, which is considered to be medium (Cohen, 1977). More specifically, the difference before and after the study was 18.74 units higher on average, indicating that the presence of the toolkit’s IA graphs helped students raise their level of self-regulatory capacity significantly.

### Semi-structured interviews results

The increase in message writing activity was also confirmed by data collected during the semi-structured interviews of the students. Students admitted that the presence of the IA graphs from the toolkit motivated them to read and write more messages. As a student of the experimental group stated, "...the graphs gave me extra enthusiasm for reading and writing more comments on my co-students' blogs and Scratch Game designs...", while another one claimed that "...by monitoring the toolkit's IA graphs it was easier to write to more fellow students, even those I was not so familiar with...". Moreover, many students pointed out that they reflected upon and revised their posts and messages, if they realised through the IA graphs that their collaborators did not read as many of those as they had expected. In addition, this feature motivated students to be more careful when composing their messages, so as to support their design with references and examples. One could argue that the IA graphs functioned as additional motivation for the students to regulate their actions (increasing and improving their message contribution, while interacting more with their team members). As a member of the experimental group stated, "...the graphs assisted my activity awareness and the contribution of my fellow students, and this made me write more constructive messages...". Indeed, not only was activity considerably increased, in terms of message reading and writing, but students tried to improve the quality of their participation as well. This can, consequently, be considered a form of self-regulation, stemming from the students' tendency to balance out their activity with that of the group they belong to. Motivation is directly connected to the students' self-regulation processes, and, as the majority of the students acknowledged during their interviews, it originates in their desire not to stand out, whether in a positive or negative manner.

### Main findings and support data summary

This paragraph summarizes the main findings and support data concerning the research questions.

Regarding RQ1:

- The number of comments of students belonging to the experimental group were significantly higher than that coming from the control group students (Mann-Whitney test results: $U = 136.50, p = .000$).
The main conclusion drawn from the comments the students made during the semi-structured interview was that the IA graphs from the toolkit functioned as additional motivation for them to regulate their actions.

Concerning RQ2:

- The mean score of the SRQ of the experimental group before the study was not significantly different from that of the control group (ANOVA test results: \( F(1, 50) = 0.388, p = .536 \)).
- For the experimental group, the SRQ mean score after the study was significantly higher than that of the control group (ANOVA test results: \( F(1, 50) = 21.775, p = .000 \)).
- The respective score of the control group after the study was not significantly different from that before the study (paired samples \( t \)-test results: \( t(24) = -0.288, p = .776 \)).
- Finally, the mean score of the SRQ of the experimental group after the study was significantly higher from that before the study (paired samples \( t \)-test results: \( t(26) = -7.805, p = .000 \)).

Discussion

The findings presented in the previous section can be further discussed in terms of the two RQs.

RQ1: Is there a group difference between the group of students being presented with the IA graphs from the toolkit and the group without exposure to the toolkit, in terms of message contribution in a CSCL blog based learning environment?

Based on the research findings presented in this paper, there is strong evidence that the presence of the IA graphs from our toolkit have a positive effect on comment production. This endorses our conclusion that the IA graphs generated from the toolkit have a significant impact on collaborative groups, helping them self-regulate during the blog activity, in order to increase their participation and overall engagement in the activity. These research results are consistent with those of previously conducted studies in the field (Fessakis et al., 2008; Fessakis et al., 2013). It is for this reason that the use of the IA toolkit is linked to amplifying learning, since the high-rate of message production and the overall increased interaction amongst blog participants are fundamental components of meaningful dialogue. Writing and posting more messages, revising these messages, as well as constantly commenting on answers by other blog participants, the students using the toolkit are more likely to diffuse opinions, constructive criticism, and eventually knowledge. Moreover, because of the IA graphs, students are often under the impression that their overall performance is constantly evaluated by teachers, thus motivating students to participate and collaborate further with their peers. All in all, it can be argued that, in terms of message production, the overall activity was enhanced, due to the presence of the IA graphs.

RQ2: Are there any statistically significant differences between student groups supported by the IA toolkit and student groups with no support from the IA toolkit for blogs, in terms of their self-regulatory capacity?

The real-time IA graphs produced by our toolkit raise individual and community awareness, as well as aim to facilitate rivalry among team members, and cater for drawing a comparison among groups. Taking into account the results from the SRQ, which measures the level of self-regulation capacity, we have detected that the statistical difference between the control and experimental groups is not present before the activity, but becomes considerably evident after the completion of the activity. This means that the IA toolkit’s graphs used in the experiment had a significant impact on collaborating groups, assisting them to self-regulate during the implementation of the learning scenario in order to increase their participation and intensify their efforts. This is a strong indication that the presence of the toolkit’s IA graphs not only supports, but can also enhance the self-regulation level of the participants, a result consistent with previously conducted studies in the field (Bratitsis & Dimitracopoulos, 2009; Bratitsis, 2010).

Conclusions, limitations, and future research

The current study recommends the application of an IA toolkit for blogs developed by the authors. This proposal is endorsed by other studies suggesting that computer-based IA provides educators with a tool to raise students’ self-awareness and self-regulation level through analysing and monitoring interaction among users in asynchronous communication activities (Collazos et al., 2007; Dimitracopoulos, 2008). This paper advances the
research presented in previously published relevant studies (Michailidis & Tsiaotsos, 2014; Michailidis et al., 2015), in order to examine the effect that the toolkit’s IA graphs have on students’ self-regulation, when participating in a blog-based CSCL activity. The research results are fairly positive, and consistent with those of previous studies (Fessakis et al., 2008; Bratitsis & Dimitracopoulou, 2009; Bratitsis, 2010; Fessakis et al., 2013). More specifically, the research data of the case study provide evidence to argue that the IA graphs automatically produced by our toolkit do, indeed, support and improve the self-regulatory capacity of students. The detected significant impact of the graphs generated by the IA toolkit on enhancing student’s self-awareness and self-regulation level in group blog-based context may have implications for the design strategy of CSCL activities. As Collazos et al. (2007) confirm, the automated IA area of study is very important, because it can determine in what way collaborative activities could be designed in a better way. The quality and frequency of student’s participation was also upgraded, due to fact that IA graphs assisted students while engaging in blog-based learning activities as members of collaborative groups. Moreover, it is very much appreciated by teachers, as the alternative, that is manual IA, is rather labor-intensive (Bratitsis, 2012).

The limitation of this study can be detected in the relatively small sample size. Aiming at further evaluating and validating the results presented in this paper, new case studies should be carried out in different educational and technological contexts, with larger sample sizes. This is actually one of our future work priorities, as we have already begun planning the same experiment shortly, but with a larger sample size. Moreover, teachers have increased information needs, due to the difficulty in identifying and evaluating each student’s contribution and participation in group blogging. As Bratitsis (2012) argues, teachers are in need of support mechanisms in the form of automated IA tools. Thus, new case studies should be designed and implemented, with the teachers’ special needs in mind. The main idea is to offer teachers the opportunity to see how they can be supported during blog-based CSCL activities, by further utilizing and evaluating our IA toolkit. Moreover, evidence has illustrated that IA graphs do not affect all students in a similar way or to the same extent. This calls for a larger number of thorough and sophisticated studies, which could eventually focus on tailor-made IA graphs, that is on detecting the most suitable sets of graphs for a specific learning situation or context.

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Middle School Student Perceptions and Actual Use of Mobile Devices: Highlighting Disconnects in Student Planned and Actual Usage of Mobile Devices in Class

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ABSTRACT
Discussion surrounding the inclusion of mobile devices in K-12 classrooms has escalated since the early 2000s, and the literature base dedicated to mobile devices, mobile-learning, and e-learning has likewise grown. The majority of the research related to mobile devices and their inclusion in educational settings has largely revolved around efficacy and mobile-learning management systems. Additionally, several large-scale surveys have been conducted to assess the perceptions of students, teachers, parents, and administrators concerning mobile devices in educational settings. Despite these efforts, relatively little is known about students’ perceptions of how they would use mobile devices, if given the chance, and the realities surrounding their actual use when given the opportunity. This research surveyed 458 middle-school students regarding their perceptions of how they would use mobile devices, if given the opportunity, during school. Students were allowed to use mobile devices during a two-week engineering design unit and asked to report their actual use of mobile devices. Several gaps between perceptions of how mobile devices would be used and the actual use by students emerged. Students did not use mobile-devices as often as they planned and student use, or lack thereof, displayed a potential disconnect between ways mobile devices are being marketed for use in K-12 classrooms and the ways mobile devices will actually be used by students.

Keywords
Mobile devices, Mobile learning, Middle school, K-12 education

Introduction

Today’s students, growing up in an electronic age of connectivity, carry more computing power every day to school than previous generations encountered in a lifetime. This powerful computing power—embodied in student’s mobile devices—represents one of the great unknowns of today’s educational landscape. How do students perceive these devices? Are mobile devices strictly for communication, entertainment, and photo storage? What exactly is the potential of these mobile devices in school settings? If mobile devices were introduced in the classroom, what would students do with them? The purpose of this paper is to share the perceptions and actual usage characteristics of middle-school students who were given the opportunity to use mobile devices in the classroom during a two-week engineering design challenge.

Mobile devices in middle-school classroom settings

The presence of mobile devices among youth ages 4-14 has experienced double-digit growth since 2005 (CommonSense Media, 2013; NPD Group, 2008; Shuler, 2009) and a similar trajectory is expected moving forward. This explosion of mobile devices among school-aged children has led many to argue for, and against, the inclusion of mobile devices in K-12 classroom settings. The possibilities of mobile devices, and their potential for classroom inclusion, is poised for research and exploration (Hwang & Tsai, 2011). In one meta-analysis of research related to mobile learning in K-12 Education (Liu et al., 2014) the authors note that “literature has shown a significant increase in recent years in terms of publications reporting both projects relating to and studies being conducted on mobile technology use in education” (p. 326). In another meta-analysis (Hwang & Tsai, 2011) identified several themes in their review of research trends in mobile and ubiquitous learning:

• Mobile and ubiquitous learning research has greatly advanced (32 articles during 2001-2005 versus 122 articles during 2006-2010).
• The majority of research is being conducted with higher education and elementary school students.
• The majority of studies were not specific to any specific learning domain; instead they mainly focused on the investigation of motivations, perceptions, and attitudes of students toward mobile and ubiquitous learning.
The majority of research conducted related to mobile learning has been conducted outside of the United States—specifically in Taiwan. The authors cite Taiwan’s national program for e-Learning as a likely source for this disparity.

Liu et al. (2014) specifically looked at the findings from 63 articles related to mobile devices in K-12 settings and found that 21% of the studies compared the effectiveness of mobile learning to traditional learning settings, while 79% represented exploratory investigations of mobile learning in K-12 settings. The majority of these studies took place outside of the United States (89%), with over half of the studies cited originating in Taiwan. Only 14% of the studies related to middle-school students—the majority revolved around elementary school students. For subject matter, the natural sciences, mathematics, social studies, language arts, and English as a second-language were the dominant academic areas researched.

Benefits associated with mobile devices in classroom settings

Liu et al. (2014) identified four primary affordances of mobile learning from the literature:
• offering students multiple entry points and learning paths and allowed for differentiated learning,
• enabling multiple modality via mobile devices by which students have a tool to create a different learning artifact to suit their needs,
• supporting student improvisation in situ—student may improvise as needed within the context of learning (e.g., take pictures to illustrate learning connections), and
• supporting learning creation on the move with an ease of creating and sharing artifacts. (p. 356)

Additional reported benefits of mobile devices in the classroom included the support for language and content learning, differentiated instructional support, and extended learning time away from the classroom (Liu et al., 2014). Other studies have cited demonstrated better academic achievement and improved learning attitudes (Hwang, Shi, & Chu, 2011), increased student engagement (Huang, Lin, & Hwang, 2010), improved language acquisition (Hwang & Chen, 2012), greater interaction with peers in problem-solving (Sung, Hou, Liu, & Chang, 2010), increased motivation, high levels of self-efficacy, high interest in activities, and increased interest in collaboration (Seifert, 2015).

Challenges of mobile devices in K-12 classrooms

As with any new tool or technique introduced into a classroom several challenges associated with the inclusion of mobile devices have been identified. These include, but are not limited to:
• Student distraction (Alberta Education, 2006; Alberta Education, 2012; Project Tomorrow, 2011; Shuler, 2009),
• Potential for harassment (Lenhart, Ling, Campbell, & Purcell, 2010),
• Student privacy concerns (Crichton, Pegler, White, 2012; Project Tomorrow, 2011),
• Potential for cheating (Shuler, 2009),
• Increased student disciplinary problems (Project Tomorrow, 2011; Shuler, 2009; Thomas & McGee, 2012),
• Lower academic achievement (Kitchen, 2014),
• Decreased student engagement (Swan, van’t Hooft, Kratcoski, & Unger, 2005),
• Issues with school technology infrastructures (Liu et al., 2014), and
• The potential for digital inequity situations to arise (Liu et al., 2014).

In addition to challenges directly associated with the inclusion of mobile devices in the classroom other hurdles have been highlighted which may stand in the way of effectively incorporating mobile devices in the classroom. These challenges include: the uniqueness of each class, school, and district and the status quo; for the most part, mobile devices are currently prohibited in public K-12 class settings (CommonSense Media, 2009; Project Tomorrow, 2011; Project Tomorrow, 2012a; Thomas & McGee, 2012) and changing this may be difficult.

Perceptions related to mobile devices in K-12 classrooms

Several surveys related to perceptions of mobile devices in K-12 settings have been conducted (Harris Interactive, 2013; Project Tomorrow, 2011; Project Tomorrow, 2012b). Overall, the excitement, support, and perceptions of including mobile devices appear to be positive. Harris Interactive (2013) report that 69% of students want to use their mobile devices more often in the classroom, seven out of 10 students would like to see
mobile devices used more often in their classrooms, and among students who have used a mobile device for school work this year, 60% have used their device for school work at least a few times a week. The most popular school-related activities on mobile devices were researching, homework, and checking assignments and 44% of students reported using a smartphone for schoolwork.

While teachers, parents, and administrators have traditionally been opposed to the inclusion of mobile devices in the classroom (Project Tomorrow, 2011; Project Tomorrow, 2012b), recent years has seen a shift in these opinions (Project Tomorrow, 2014). In 2010, over 60% of principals said it was unlikely that they would allow students to use their own mobile devices in school. In 2013, however, that number was almost cut in half—down to 32%. Additionally, 41% said they were likely to allow such usage today and 10% said they already do allow students to use their own mobile devices to support schoolwork in class (Project Tomorrow, 2014). Over 86% of parents say that the effective implementation of technology within instruction is important to their child’s success and 50% label it as “extremely important.” Despite the cited interest, only 64% say that their child’s school is doing a good job of using technology to enhance student achievement, and only 12% strongly agree with that statement (Project Tomorrow, 2012b). In the 2013 Speak Up survey, completed by more than 400,000 K-12 students, parents, teachers, and administrators (Project Tomorrow, 2014), 60% of all parents surveyed said they would like their children to be in a class where using one’s own mobile device was allowed. Furthermore, two thirds said they would purchase a mobile device for their child to use within class, if that was allowed by the school.

Despite the literature related to the benefits, challenges, and perceptions of stakeholders, and possibilities for the inclusion of mobile devices in K-12 education, relatively little is known about students’ perceptions and plans for mobile device use when given the opportunity (Project Tomorrow, 2011; Tossell, Kortum, Shepard, Rahmati, & Zhong, 2015). Similarly, a gap remains in how these perceptions of potential mobile device use would translate into reality when students were given access to mobile devices.

Methodology

With competing ideas related to the inclusion of mobile devices in K-12 classrooms it is important to further investigate student perceptions and practices of use. The purpose of this study was to gather middle-school student perceptions regarding the ways in which they would engage with and use mobile devices if given the opportunity in a K-12 classroom setting. Additional inquiry was conducted related to how students actually used mobile devices when given the opportunity. The research questions guiding this study were:

- What are students’ perceptions and beliefs related to the use of mobile devices in K-12 classroom settings?
- When give the opportunity, how do students actually use mobile devices in K-12 classroom settings?
- What differences, if any, exist between student perceptions of mobile device use and actual student use of mobile devices?
- What relationship exists, if any, between student achievement and student perceptions and use of mobile devices?

The study, located in a suburban area of a state in the western United States, used a sample of 442 middle-school students from 5 different schools (6 teachers, 18 total classes). Students were surveyed about their perceptions of personal mobile device use in class as part of a two-week unit involving an engineering design project. This design unit was completed during the students’ Exploring Technology class—an elective Career and Technical Education (CTE) course (USOE, 2014). The unit, which was uniform across schools and teachers, required the students to work in groups to complete a portfolio and produce a physical solution to a provided engineering design challenge (i.e., design a medicine dispenser for an elderly person). Following the initial survey, all students were given instruction on appropriate mobile device use, privacy, and security following Ribble’s (2011) outline for Digital Citizenship. This was done in an effort to lay a suitable groundwork prior to permitting mobile device use in classrooms. Half of the students (3 teachers, 9 classes) were informed that they were allowed to use mobile devices for the remainder of the unit (2 weeks, 5 class periods). Students in this group were permitted to use mobile devices (either their own or one provided by their teacher) in any way they saw fit—as long as it was beneficial to their completion of the provided task. School-provided devices were made available to any students in these classes that did not have access to a personal device. The other 9 classes (3 teachers) proceeded with the design unit but did not permit students access to mobile devices during the task.

At the completion of the unit all student groups submitted group design products and portfolios for grading (see Figures 1 and 2 for examples of completed student work) and completed another questionnaire. Students were asked about their own perceptions of mobile device use in classrooms. Students were also asked to rank several
tasks numerically according to how often they perceived themselves using a mobile device to perform each task if given the opportunity. Separately, the students that were permitted access to mobile devices were asked to self-report how often they actually used a mobile device, what tasks they used the device to accomplish, and how much time they spent with each task on the device. Finally, several qualitative questions were posed to students related to mobile devices in K-12 classrooms—responses to all questions were collected through an online survey collection tool.

Student qualitative responses were coded, first descriptively, and second thematically using techniques outlined by Saldaña (2013) and Gibbs (2007). This process was undertaken in an effort to identify overarching themes related to each question. Descriptive coding, also called “topic” coding (Saldaña, 2013), involves reading a response from a participant and identifying the basic topic of the passage. This process is used to identify overarching topics stemming from the qualitative questions. Following this process, a thematic approach was used during a second round of qualitative data analysis. In thematic coding topics and passages are identified that are linked together by a common theme or idea (Gibbs, 2007). The resulting final themes were used, in conjunction with the qualitative responses and quantitative data, to explore students’ perceptions and experience with mobile devices in K-12 settings.

**Findings**

Utilizing student responses to both the pre—and post—study questionnaires several ideas related to the research questions emerged. Themes arising from the qualitative responses of students and the subsequent coding were used to illuminate and clarify the findings from the quantitative survey responses. Findings related to each question are presented here:
**Research question #1: What are students’ perceptions and beliefs related to the use of mobile devices in K-12 classroom settings?**

Students believe that mobile devices can and should be integrated into K-12 classrooms—over 80% of students surveyed (80.5%, \( N = 451 \)) responded that they believed students should be allowed to use mobile devices in their K-12 classrooms. Students were asked to clarify the ways in which they would use mobile devices if they were given access to them in the classroom (see Table 1). Students answered that they were most likely to use mobile devices to send files (audio, video, and photo) to someone else (80.8%), access the Internet for information (79.7%), and learn new skills (68.8%). Less than half of students (39.5%) reported they would use mobile devices for communicating with others (via text message or phone call) while only 21.6% of surveyed students reported that they would use a mobile device to create, edit, manipulate, or manage photo or video files.

<table>
<thead>
<tr>
<th>Possible use of mobile devices</th>
<th>Yes (%)</th>
<th>No (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>To send audio, video, or photo files to someone else</td>
<td>80.8% ( (n = 370) )</td>
<td>19.2% ( (n = 88) )</td>
</tr>
<tr>
<td>To access information via the Internet</td>
<td>79.7% ( (n = 365) )</td>
<td>20.3% ( (n = 93) )</td>
</tr>
<tr>
<td>To learn new skills</td>
<td>68.8% ( (n = 315) )</td>
<td>31.2% ( (n = 143) )</td>
</tr>
<tr>
<td>To communicate with someone else (i.e., text message, phone call, etc.)</td>
<td>39.5% ( (n = 181) )</td>
<td>60.5% ( (n = 277) )</td>
</tr>
<tr>
<td>To create, edit, manipulate, or manage photos and/or videos</td>
<td>21.6% ( (n = 99) )</td>
<td>78.4% ( (n = 359) )</td>
</tr>
<tr>
<td>I would not use it</td>
<td>11.6% ( (n = 53) )</td>
<td>88.4% ( (n = 405) )</td>
</tr>
</tbody>
</table>

Student qualitative responses appear to align with these quantitative findings. When asked about potential advantages of mobile devices in K-12 classrooms, students overwhelmingly cited access to information as the chief advantage (coded 293 times). As an example one student noted:

*If someone were to have a question about the subject, he/she could quickly look up the answer on the presentation.*

Two students commented that access to information would help prepare students for future, out-of-school opportunities, where restrictions on mobile devices do not exist:

*They can get used to what life will be like when they have their own jobs. They can get used to the unlimited knowledge and information on the internet.*

*They get to learn how to use it for their future jobs, because a lot of teachers that I know use their phone a lot.*

Another common theme from the student responses was “improved learning” for students through mobile devices in classrooms (coded 100 times). Students mentioned a variety of ways mobile devices could improve learning, including supplementing classroom instruction, access to a variety of learning tools online and through apps, and ability to learn through a variety of medium (e.g., pictures, videos, text). One illustrative comment related to improved learning scenarios related:

*[Students] can use them to supplement the info the teachers is teaching with pictures because some people learn better with pictures, or something like that.*

Not all students perceive mobile devices as beneficial for classrooms with several disadvantages highlighted by students. When questioned about potential disadvantages of mobile devices in K-12 classrooms students identified distraction (374 coded times), cheating (coded 25 times), and viewing inappropriate material (coded 25 times) as the three biggest disadvantages of including mobile devices in K-12 classrooms. Students highlighted the lack of control, by the teacher or school, inherent with allowing access to mobile devices in their comments:

*Teachers really have no real control in what students do on their device.*

*Students can use their devices for things other than their school work. The good thing about having computers and using them in school is that the teacher is able to see what every student is doing online and monitor their devices. With phones and other mobile devices, this is not possible for them to monitor and make sure that they are on task at all times.*

*Everyone will get distracted with their cell phone, either with social media or communicating with others. There is no way for teachers to tell if they are misusing their phone.*

Interestingly, some students also seemed to identify how mobile device could potentially remove the onus for learning from the students by allowing them to rely completely on the device:
They may also take advantage of the ease to look up an answer so they won’t have to do work. It seems to make them not need creativity because they don’t have to think hard and solve their own problems because someone on google probably already did

I think if mobile devices were allowed [sic] in class people wouldn’t work they would ask Siri.

Overall students appear to view the ability to access information as the chief benefit on including mobile devices in the classroom. The distraction that accompanies this access to mobile devices was perceived by students as the largest detractor.

Research question #2: When give the opportunity, how do students actually use mobile devices in K-12 classroom settings?

All students provided with access to mobile devices as part of the study were asked to self-report their own access and uses of mobile devices during the study. Interestingly, despite wanting access to mobile devices, less than half of the students actually used a mobile device for longer than 20 minutes during the study and the study took place over a total of 400 minutes (i.e., five 90-minute class periods). The remaining students chose to not use a device or use a mobile device for less than 20 minutes total (see Table 2). In light of these lower usage reports it should be noted that every student in the experimental group was given access to either a personal or a school-provided mobile device as part of this study.

<table>
<thead>
<tr>
<th>Mobile device use in class</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>I didn’t ever use a mobile device</td>
<td>16.0% (n = 36)</td>
</tr>
<tr>
<td>0-10 Minutes total</td>
<td>20.4% (n = 46)</td>
</tr>
<tr>
<td>11-20 Minutes total</td>
<td>14.2% (n = 32)</td>
</tr>
<tr>
<td>21-30 Minutes total</td>
<td>16.4% (n = 37)</td>
</tr>
<tr>
<td>31-40 Minutes total</td>
<td>8.9% (n = 20)</td>
</tr>
<tr>
<td>41-50 Minutes total</td>
<td>4.4% (n = 10)</td>
</tr>
<tr>
<td>51-60 Minutes total</td>
<td>8.0% (n = 18)</td>
</tr>
<tr>
<td>More than 1 hour total</td>
<td>11.6% (n = 26)</td>
</tr>
</tbody>
</table>

In addition to quantifying the amount of time spent using a mobile device during the design unit students were also asked to identify the ways in which they actually used a mobile device during this unit in class. Table 3 demonstrates the ways students, as a group, actually utilized mobile devices in class during this unit. The most popular ways to employ mobile devices were learning new skills (\( \bar{x} = 22.48 \) minutes) and accessing information via the internet (\( \bar{x} = 17.32 \) minutes).

<table>
<thead>
<tr>
<th>Mobile device use in class</th>
<th>Mean time spent by students (in minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>To communicate with someone else (i.e., text message, phone call, etc.)</td>
<td>( \bar{x} = 12.24 ) minutes</td>
</tr>
<tr>
<td>To access information via the internet</td>
<td>( \bar{x} = 17.32 ) minutes</td>
</tr>
<tr>
<td>To create, edit, or manage photos or videos</td>
<td>( \bar{x} = 14.29 ) minutes</td>
</tr>
<tr>
<td>To learn new skills</td>
<td>( \bar{x} = 22.48 ) minutes</td>
</tr>
<tr>
<td>To send audio, video, or photo files to someone else</td>
<td>( \bar{x} = 10.15 ) minutes</td>
</tr>
</tbody>
</table>

Using a one-way ANOVA, the total number of minutes spent using a mobile device was compared with the different ways mobile devices were utilized. The analysis revealed a significant relationship between number of total minutes spent using a mobile device in class and using a mobile device to create, edit, or manage photos or videos \( [F(7, 144) = 2.13, p = .044] \), suggesting students were significantly more likely to use a mobile device to create, edit, or manage photos or videos. Similarly, a one-way ANOVA comparing the number of minutes spent in total using a mobile device during class and using a mobile device to learn new skills was significant \( [F(7, 159) = 5.62, p < .001] \), demonstrating a significant relationship between high users of mobile devices and those that used mobile devices to learn new skills. All other relationships were not significant.
**Research question #3: What difference, if any, exist between student perceptions of mobile device use and actual student use of mobile devices?**

While 80.5% of students (N = 451) involved in the study responded that they believed students should be allowed to use mobile devices in their K-12 classrooms the average number of minutes that mobile devices were used by students that had access to them was less than 30 minutes (\( \bar{x} = 28.5 \) minutes). Students were asked to identify specific ways in which they would use mobile devices in the future if they were given access to these devices in K-12 classrooms. These responses were compared with the actual time values reported by these students for using mobile devices during class. Using correlational techniques each possible relationship was analyzed (see Table 4), with the only significant correlation related to communicating with others, \( r(134) = .209, p < .05 \). This suggests a possible disconnect between student planned and actual use of mobile devices related to these tasks.

<table>
<thead>
<tr>
<th>If you had access to a mobile device during all your classes in school, how would you use it?</th>
<th>Correlation with student reported use (in minutes) for each task</th>
</tr>
</thead>
<tbody>
<tr>
<td>To communicate with someone else (i.e., text message, phone call, etc.)</td>
<td>( r(134) = .209 )</td>
</tr>
<tr>
<td>To access information via the internet</td>
<td>( r(134) = .019 )</td>
</tr>
<tr>
<td>To create, edit, or manage photos or videos</td>
<td>( r(134) = .107 )</td>
</tr>
<tr>
<td>To learn new skills</td>
<td>( r(134) = .098 )</td>
</tr>
<tr>
<td>To send audio, video, or photo files to someone else</td>
<td>( r(134) = .113 )</td>
</tr>
</tbody>
</table>

Using one-way ANOVA techniques, the total number of minutes, and the number of minutes spent using mobile devices for each reportable task, was compared with student beliefs about whether mobile devices should be allowed during class in school. The results were not significant indicating student beliefs about whether mobile devices should be allowed in school during class were independent of their actual usage.

Several students chose not to use a mobile device, despite being given access to mobile devices in class. These students were asked to why they chose to not use a mobile device despite access. Student qualitative responses generally revolved around not needing a mobile device for the assignment (coded 21 times) and the worry that they would become distracted by the devices (coded 5 times). Two students noted that they did not use a mobile device, despite having access: “because I didn’t need to.” Another student echoed a similar sentiment: “[We] didn’t really need to use [a mobile device] since we had everything provided for us.”

**Research question #4: What relationship exists, if any, between student achievement and student perceptions and use of mobile devices?**

The students involved in this study were assessed through their design portfolios and the design products turned in by each group. All portfolios and products were assessed using a method of assessment called Adaptive Comparative Judgment (ACJ). ACJ is a method of assessment where products are compared in various combinations until a rank order is produced (see Bartholomew, Reeve, Veon, Goodridge, Stewardson, Lee, & Nadelson (in press) for a discussion of the ranking process). In order to evaluate the possible relationship between student achievement, as measured by rank received on portfolios and products, a variety of possible correlations were explored for both the products and the portfolios. There were no significant correlations between the final student product score, as demonstrated by their rank ordering, and any of the student perceptions or uses of mobile devices. There were several significant correlations between the student portfolio rank and the student perceptions and use of mobile devices (Table 5). Student beliefs regarding whether or not mobile devices should be allowed in classes during school were negatively correlated with the student rank orders—signifying that students who did not believe mobile devices should be allowed in schools performed better on the portfolios (lower rank order). Relatedly, students that marked that they would not use mobile devices in school, even with permission, were significantly correlated with higher scores on the portfolio (lower rank order). Student who marked that they would use mobile devices in school to access tutorials on video-hosting platforms demonstrated a significant correlation with better portfolios. Conversely, students which planned on creating, editing, manipulating, or managing photos and students which planned on accessing written instructions or informational websites were both significantly correlated with lower portfolio scores (higher rank order).
<table>
<thead>
<tr>
<th>Student portfolio rank</th>
<th>Pearson correlation</th>
<th>Sig. (2-tailed)</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do you believe students should be allowed to use mobile devices during classes in school?</td>
<td>-.164**</td>
<td>.000</td>
<td>449</td>
</tr>
<tr>
<td>If you had access to a mobile device during all your classes in school would you use it to communicate with someone else (i.e., text message, phone call)?</td>
<td>.088</td>
<td>.060</td>
<td>456</td>
</tr>
<tr>
<td>If you had access to a mobile device during all your classes in school would you use it to access information via the Internet</td>
<td>.019</td>
<td>.690</td>
<td>456</td>
</tr>
<tr>
<td>If you had access to a mobile device during all your classes in school would you use it to create, edit, manipulate, or manage photos and/or videos</td>
<td>.129**</td>
<td>.006</td>
<td>456</td>
</tr>
<tr>
<td>If you had access to a mobile device during all your classes in school would you use it to learn new skills</td>
<td>.029</td>
<td>.537</td>
<td>456</td>
</tr>
<tr>
<td>If you had access to a mobile device during all your classes in school would you use it to send audio, video, or photo files to someone else</td>
<td>-.099*</td>
<td>.035</td>
<td>456</td>
</tr>
<tr>
<td>If you were using a mobile device to access information on the Internet during school how would you use it?</td>
<td>.060</td>
<td>.227</td>
<td>410</td>
</tr>
<tr>
<td>If you were using a mobile device to access information on the Internet during school how would you use it? Access tutorials on a video-hosting platform (i.e., Youtube)</td>
<td>-.170**</td>
<td>.001</td>
<td>410</td>
</tr>
<tr>
<td>If you were using a mobile device to access information on the Internet during school how would you use it? Access written instructions or informational websites</td>
<td>.120*</td>
<td>.015</td>
<td>410</td>
</tr>
<tr>
<td>If you were using a mobile device to access information on the Internet during school how would you use it? Access images via a search engine (i.e., Google)</td>
<td>.019</td>
<td>.699</td>
<td>410</td>
</tr>
<tr>
<td>How many minutes total did you use a mobile device during this unit in class (if ever)?</td>
<td>.106</td>
<td>.084</td>
<td>267</td>
</tr>
<tr>
<td>How much time (in minutes) did you spend communicating with someone else (i.e., text message, phone call)?</td>
<td>.138</td>
<td>.076</td>
<td>166</td>
</tr>
<tr>
<td>How much time (in minutes) did you spend accessing information via the Internet?</td>
<td>.081</td>
<td>.253</td>
<td>200</td>
</tr>
<tr>
<td>How much time (in minutes) did you spend creating, editing, or managing photos or videos?</td>
<td>.118</td>
<td>.116</td>
<td>179</td>
</tr>
<tr>
<td>How much time (in minutes) did you spend learning new skills?</td>
<td>.125</td>
<td>.076</td>
<td>201</td>
</tr>
<tr>
<td>How much time (in minutes) did you spend sending audio, video, or photo files to someone else?</td>
<td>.090</td>
<td>.291</td>
<td>139</td>
</tr>
</tbody>
</table>

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

Discussion

While the overwhelming consensus among students surveyed suggests that students want mobile devices in the classroom our findings suggest that mobile devices may not be a positive influence in middle school classrooms. While there was no significant correlation between increased time with mobile devices and higher grades, the correlation between lower final student grades on the portfolio and the amount of time spent using a mobile device ($r = .106, p = .084$) did approach significance. This suggests that time on mobile devices may actually be correlated with lower achievement by students. Additional findings from this study appear to show that despite
wanting these devices in classrooms, students were aware and fully recognized that the potential negatives associated with mobile devices could be detrimental to their learning.

Students cited distraction as the main factor mobile devices could have negative consequences in K-12 classrooms. Relatedly, a correlation was found between higher grades and a students’ belief that mobile devices should not be included in the classroom. These findings build off of similar ideas shared in the recent literature related to mobile-devices (Alberta Education, 2006; Alberta Education, 2012; Project Tomorrow, 2011; Shuler, 2009).

Student perceptions of how they would use mobile devices and the actual student practices of using mobile devices demonstrated a possible disconnect and area for further research. Over 80% of students said that mobile devices should be allowed in K-12 classrooms, yet, when given the opportunity, the majority of students used mobile devices less than 5% of the time. While students identified sending audio, video, or photo files and accessing information as the most likely uses for mobile devices the students reported different actual usage of the mobile devices—learning new skills was the most commonly reported use of mobile devices by students during this study. The correlational analysis revealed several incongruences between students’ planned use and actual use of mobile devices.

In the study, students were asked to describe measures a school could take to make mobile device use in class effective. The themes emerging from these qualitative responses revolved around implementing restrictions (coded 226 times), either at a district, school, or classroom level. Students expressed comments such as:

**Make sure that everyone is on task. Like, randomly calling on students to answer a question and rewarding them if they get it right. Motivation I guess is the key here. Also, mobile devices open up the whole internet. This gives us so many more opportunities to learn new skills.**

**They could possibly use an app that allows teachers to monitor their devices when they are logged into that specific application. This way, they can see what they are doing to make sure they are on task but they won't have full responsibility over the device.**

**Have an app that you sign into and that app only allows you to do things that are appropriate or related school. And if you want to use your device you have to sign in to the app.**

**They would stand at the back of the classroom watching what the students are doing to prevent them from doing something that they should not be doing.**

Other student suggestions revolved around a theme of using mobile devices to improve learning through new and innovative activities. One student suggested:

**One thing that would take some time is have a state or district wide app that allows you to select your classes and have all the notes, explanations of the classes and what you did and work that will help you understand what you are doing better. That way you can connect to the internet it will update and then you have all the information and if you want to study and you don't have internet you are allowed to still study. Maybe even it could allow you to turn in assignments.**

**Conclusion and recommendations**

While mobile devices may be a “hot-topic” on the educational agenda, it appears that introducing them into K-12 classrooms may actually be detrimental to student achievement. Although mobile-devices are largely hailed as catalysts for communication, findings from this study suggest that further exploration is needed into the actual usage of mobile-devices by students (e.g., the students in this study used mobile devices in ways other than communication more frequently than solely for communication purposes). Furthermore, although students almost unanimously report wanting these devices, access to mobile devices may not always translate into use and utility in K-12 classroom settings. Before teachers, administrators, parents, or professionals introduce mobile devices into K-12 classrooms further research should look to clarify a variety of important questions. For example, further inquiry should focus on identifying specific ways mobile device improve or harm student learning. Research related to the classroom impacts of mobile devices (e.g., student achievement, student demeanor, classroom environment) needs additional exploration and emphasis is needed on the apparent disconnect between student plans and practices for the use of mobile devices. Ways that mobile devices can balance restriction and freedom of access in classroom settings is another promising area for future research. Inasmuch as mobile devices provide access to a variety of information the issues surrounding data and personal
privacy and mobile device integration should be studied. Additionally, inquiry exploring why students do not choose to use mobile devices in all classroom and lesson settings despite the overwhelming desire to have access to these devices would help decision-makers and key stakeholders as the increasingly ubiquitous presence of mobile devices demands answers to these questions.

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Technologies to Enhance and Extend Children’s Understanding of Geometry: A Configurative Thematic Synthesis of the Literature

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ABSTRACT

Empirical evidence indicates that students are not learning geometry with relational understanding of the concepts. Studies have shown that digital technologies can support students in mathematics. The purpose of this study was to find which technologies and technological affordances are specific to learners of geometry. This paper presents the results of a configurative thematic synthesis of empirical studies and theoretical papers to show that dynamic geometry environments (DGEs: including 3D DGEs) and logo-based environments were the main types of technologies used to support geometry learners. The results of this study also reveal that there are five main technological supports provided to geometry learners – visualization, manipulation, cognitive tools, discourse promoters, and ways of thinking.

Keywords

Mathematics, Dynamic Geometry Environments, Visualization, Manipulation, Cognitive tools, Discussion promoters

Introduction

Geometry is the study of properties, relationships, and transformations of spatial objects, within an interconnected network of concepts and representational systems. Spatial reasoning undergirds geometry, enabling students to cognitively construct and manipulate mental representations of those spatial objects (Clements & Battista, 1994). Therefore, concomitant study of geometry and spatial reasoning should take place (Battista, 2007). The study of geometry provides students with opportunities to better understand the physical environments in which they live. Unfortunately, mathematics is often taught through lecture, which affords surface understanding, merely requiring students to memorize mathematical facts. The epistemological nature of geometry is called into question, as the findings of copious studies (e.g., Ubuz & Üstün, 2004) indicate that students are not learning geometry with relational understanding of the concepts (Skemp, 1976).

For students to develop a full understanding of the geometry, they must take an active role in the learning process (Piaget & Inhelder, 1967; Vygotsky, 1978). The learner-centered philosophy, stemmed from Bruner’s (1966) discovery learning and since then has included constructivist learning, constructionist learning, and socio-constructivist learning. In a dual progression, throughout the learner-centered pedagogical epoch, technology was becoming affordable and accessible for use in schools, and educators witnessed the explosive growth of technologies available for the teaching and learning of geometry (Fey et al., 1984). These technologies provided a way for students to take that active role in learning geometry.

The purpose of this study is to find out what types of digital technologies can be used to support the learning of geometry and what affordances the digital technologies can provide to geometry students. To that end, the two questions guiding this study are:

- What types of digital technologies support the learning of geometry?
- How can the use of digital technologies enhance and extend children’s understanding of geometry?

Literature review

Configurative thematic synthesis

A systematic review is the art and science of identifying, selecting, and synthesizing studies to provide a comprehensive and trustworthy picture of the topic being studied (Oakley, 2012). There are two broad modes of synthesis: aggregation and configuration (Sandelowski, Voils, Leeman, & Crandlee, 2011). Aggregation
syntheses are conducted by counting the numbers of studies and particular components of those studies. Configuration studies as those that generate new theories with the studies similar to pieces in a mosaic slotted together to form a gestalt image (Sandelowski et al., 2011). In this study, a configuration approach is used to determine what technologies are available for learning about geometry and how they support the learner.

A thematic synthesis is intertwined with a configurative approach. It is a systematic approach to bringing a variety of findings together to provide a perspective on a particular theme that emerges. Those findings can be empirical studies and theoretical papers (Thomas & Harden, 2008). This study employs the configurative, thematic synthesis approach to answer the two research questions guiding this study.

**Past reviews**

Laborde, Kynigos, Hollebrands, and Strässer (2006) conducted a review of teaching and learning geometry with technology over three decades. This synthesis of research was organized studies using four categories; (a) the nature of geometry mediated by technology, (b) technology and the learning of geometry, (c) the design of tasks, and (d) the use of geometry by teachers. Zbiek, Heid, Blume, and Dick (2007), published a study about technology in mathematics education. This study was not focused on geometry in particular, but specifically referenced technological tools and technology-based mathematical activities, students’ behavior in the context of technology, teaching issues related to technology in mathematics education, and effects of technology on mathematics curriculum content. The most recent synthesis of the literature was conducted by Sinclair and Robutti (2013) and was focused on two areas: the evolution of proof in school mathematics and the impact on the kinds of research questions and studies over the last decade; and the epistemological and cognitive nature of dragging and measuring, and their connection to proof.

These prior syntheses reported about positive influence that technology has on teaching and learning of geometry. However, the purpose of this study is to identify exactly what those positive benefits are. In this synthesis the researchers initially provide an overview of the technologies that are available for learning geometry concepts and then a configurative thematic synthesis methodology is used to identify specifically what those technologies do that extend and enhance students’ understanding in this area.

**Methodology**

To answer the two research questions guiding this study, a configurative thematic synthesis (Thomas, Harden, & Newman, 2012) of the literature was conducted. Empirical studies and theoretical papers primarily from the 21st Century were selected from the intersection of geometry and technology. Literature was identified using electronic and hand searching (Brunton, Stansfield, & Thomas, 2012). The hand searching process included recommendations from scholars and historically literatures recognized for yielding foundational findings or theory with sustained relevance. The literature for this review is illustrative, not exhaustive.

The literature was coded using an inductive process. Several themes emerged from deduction. The use of inductive and deductive reasoning is common practice in a thematic synthesis (Thomas et al., 2012). Line by line coding revealed core themes, followed by axial coding that yielded: (a) two types of technologies – Dynamic Geometry Environments (DGEs) and logo-based environments; and (b) five ways that these technologies extend and enhance geometric learning – visualization, manipulation, cognitive tools, discourse promoters, and ways of thinking. An example of part of the intricate coding process can be found in this extensive mind map (see http://bit.ly/1nF2CE3).

Six subject experts (three technology and three mathematics professors from two research intensive universities in the south west of the United States) selected the 105 papers based on their fundamental theoretical and empirical value. Of the 105 papers, 45 were omitted due to redundancy. In other words, if multiple scholars agreed on a particular point, only one or two of the most recognized scholar names were included in this manuscript. 60 papers were included in this configurative thematic synthesis.
Findings

Types of technologies

As many different types of geometry software flooded the market, a trend toward two types of computer environments have developed: Dynamic Geometry Environments (DGEs, which includes 3D Dynamic Geometry Software); and Logo-based environments. There are approximately 70 different two-dimensional and three-dimensional DGEs available worldwide; the majority of these programs are based on the Geometer’s Sketchpad, Cabri-Géomètre, Geometric Supposer, and Thales (Laborde et al., 2006).

Two-dimensional DGEs appeared in the 1980’s and provide students with objects (e.g., lines, points, circles) and basic tools (e.g., for drawing perpendicular lines from a specific point) to create composite figures. Also, dynamic transformations can be performed, and the ability to trace actions for later visual inspection. Three-dimensional DGEs were introduced in the mid-2000 with software such as Cabri3D and Geogebra3D. This software allows learners to observe the movement of objects from different perspectives, while maintaining its properties.

Logo is a basic programming language used for programs such as Logo-based Turtle Geometry (TG) and the related Microworlds. TG typically involves a robotic turtle directed around the screen using commands; as the turtle moves, it draws lines creating various shapes. Microworlds are computational environments in which students can engage in exploration and construction activities (Sarama & Clements, 2002). More recent versions of Logo-type geometry programs use virtual reality learning environments (VRLEs), which provide students opportunities to study three-dimensional shapes via a variety of semiotic resources (Yeh & Nason, 2004).

In the last decade, mobile technologies, such as smart phones and tablet computers, offering new types of DGEs, TG, and Microworlds for students on mobile devices. Using geometry programs on mobile devices provide additional opportunities for mathematics to be learner-centered. Students can learn geometry on mobile devices pertaining to particular concepts using real-life artifacts to solve authentic problems (Traxler, 2011). In addition, unlike mouse operated computers, students interact with mobile devices using multi-touch screens, allowing them to directly manipulate geometric objects.

Enhancing and extending students’ learning

To consider the role of technology in mathematics requires an understanding of two different types of activities, technical and conceptual (Zbiek et al., 2007). The technical dimension describes mechanical or procedural performance; the ways students interact with technologies to construct, manipulate, and measure geometric figures. While performing technical tasks, they are developing sequences of mathematical actions. Conceptual activities involve students understanding, communicating, and developing mathematical connections, relationships and structures (Zbiek et al., 2007). Although a dichotomy between the two activities has been described, students need to engage in both activities for technology to positively influence student learning (Borwein, 2005).

With consideration for technical and conceptual activities, this configurative thematic synthesis reviewed empirical and theoretical findings to collate a record of the different ways DGE and Logo environments promote students’ geometric understanding. The findings were organized into five broad categories – visualization, manipulation, cognitive tools, discourse promoters, and ways of thinking.

Visualization

Visual representation

Computer graphics provide visual representations that can promote learning beyond those representations within traditional instruction (Clements & Battista, 1994). This claim is supported by empirical findings; Fesaki, Sofronious and Mavroudi (2011) found that preschool children benefit from computer representations when learning about shapes. Many cultural influences, such as picture books, text books, posters, toys, and school supplies, typically provide students with rigid conceptions of shapes, which are detrimental to hierarchical shape categorizations (Clements, 2004). Researchers reported that students’ continual exposure to rigid shape depictions, misconceptualized non-essential attributes of shapes as important (Burger & Shaughnessy, 1986).
Computer programs provide visual representations of shapes with greater variety of graphical and symbolic components, and afford construction and manipulation tools (Ben-Zvi, 2000). Thus enabling students expanded repertoire of representations, beyond prototypical shape depictions (Zbiek et al., 2007).

The multirepresentational software (Ben-Zvi, 2000) provided by geometry programs, is described by Kaput (1992) as action notation systems that involve construction, using calculations and transformations versus being limited to visual interpretation only. As students have the ability to create and manipulate objects, this assists students in perceiving objects as geometric entities, rather than just visual objects (Zbiek et al., 2007). Therefore, students are more likely to reflect on properties for categorizing shapes, as they are able to simultaneously take into account the specific and grounded with the abstract and generalized. As students come to recognize properties of shapes, this facilitates their movement from the van Hiele level one to level two (van Hiele, 1984); from perceiving shapes as gestalt-like unanalyzed visuals to understanding that properties uniquely define shapes (Battista, 2007).

As students create visual representations using geometry software, the process provided opportunities to externalize their mathematical ideas; they externalized intuitive expectations. Once intuitions are translated as shapes on computer screens, the act is obtrusive and students may reflect on what they produced (Papert, 1980). Students drawing shapes using pencil and paper may not be required to provide descriptions as they are for geometry programs. For instance, on the computer, the square’s properties must be explicitly articulated via commands or actions to produce a square. Geometry environments also allow representations to be saved for later analysis and reflection, and they can be edited, manipulated, transformed, separated into parts, or combined (Ben-Zvi, 2000). Miyazaki et al. (2012) posited that three-dimensional DGEs connect better with the real world than geometrical constructions in two dimensional DGEs. They argued that three-dimensional DGE explorations encouraged student dispositions for recognizing examples of geometry within the real world.

Spatial visualization

Spatial visualization is the skill that enables students to understand and perform imagined movements of objects in two-dimensional and three-dimensional spaces (Gutiérrez, 1992). This skill is different than visual thinking, as the image is more abstract, malleable, and less focused than a fully formed picture (Giaquinto, 2007). The students’ interaction between the mechanical (spatial), and the theoretical (geometrical) supports the development of spatial reasoning (Laborde et al., 2006). The interconnected nature of spatial-graphical and theoretical reasoning are made explicit through active manipulation of objects and studies have recorded students’ spatial/theoretical development while using DGEs (viz., Clements & Sarama, 2007). The three-dimensional DGEs fully encourage development of spatial/theoretical understanding with the ability to create mathematical models of real-world objects and their dynamic movements clarifying that correspondence between the real phenomenon and mathematical structure (Miyazaki et al., 2012).

Manipulation

The manipulation of objects plays a significant role for developing spatial visualization, and it also makes other substantial contributions to geometrical understanding. Students’ initial representations are developed through action (Battista, 2007), and students need opportunities to manipulate mathematical objects to develop overarching geometric and spatial understandings (Kamina & Iyer, 2009). Computer programs can provide representations that are as real and personally meaningful to students as physical representations (Sarama & Clements, 2009). Furthermore, the programs offer significantly more flexibility than physical representations (i.e., concrete materials), allowing changes to be made to best meet the educational needs of students. The size and shape of the objects can be changed, altering all, or just some of the components (Sarama & Clements, 2009). For instance, a computer generated geoboard could be adjusted to include additional pegs, or the overall shape of the geoboard can be changed. One of the key elements within DGEs is the drag feature; the mathematical counterpart to drag would be variation (Laborde et al., 2006). Within DGEs, students are able to drag elements of an object and the visual display provides fluid motions to reflect changes, while maintaining the geometric relationships used to construct object. Therefore, when students drag one element of the shape, it is modified proportionately to maintain geometric properties of the construction. The shapes quasi-independence from the student is a feature of DGEs that is likely positively impact student geometrical understanding (Battista, 2009; Yu, Barrett, & Presmeg, 2009).
Battista (2007) posits that students do not initially recognize properties of shapes, even through technology enabled dragging. This development exemplifies student’s geometric thinking at level one of the van Hiele (1984) model – the figure is recognized as a gestalt-like entity. As students continue to interact using the drag feature of DGEs, Battista postulated that students start to notice constraints on shapes, then conceptualize constraints as regularities or invariants, and finally constraints are conceptualized as formal geometric properties of shapes. Paper-and-pencil shapes can be altered, although they often become distorted as students try to make the shape correspond with their expectations (Laborde et al., 2006). In a study involving Cabri3D, researchers found that students were able to explore and formulate conjectures and verify them through proof (Mammana, Micale, & Pennisi, 2012). This encouraged an atmosphere of mathematical exploration.

Computer software can allow students to engage in ways that are not easily duplicated using physical manipulatives (Sarama & Clements, 2009). Within the elementary Common Core State Standards (CCSSO/NGA, 2010) in geometry, students are required to partition shapes into parts with equal areas. Olive and Lobato (2008) make the case that compared with other methods, partitioning can be performed easier and with more precision using computer tools. They argued that to partition shapes, students must mentally dissemble parts from the whole. With physical materials it is not possible to remove a part from the whole without destroying the original whole… the child has to mentally unitize one part of the whole while maintaining the unity of the whole and compare these two abstracted units. With static pictures the part is either embedded in the whole or is drawn separate from the whole…the child has to compare the separate units while imagining that one is embedded in the other. Using a computer tool that provides the child the ability to dynamically pull a part out of a partitioned whole while leaving the whole intact, the child can enact the disembedding operation that is necessary to make the part-to-whole comparison. (Olive & Lobato, 2008, p. 6)

Sarama and Clements (2009) also described the ways shapes can be partitioned into other shapes. For example, a regular hexagon can be cut into two trapezoids. Using computer tools to manipulate shapes brings the geometric motions conducted by students to an explicit level of awareness (Clements & Sarama, 2007), and with this awareness, students can further mathematize their actions. However, students can forget the sequence of their actions. Many geometry programs can record and replay sequences of actions; this feature supports recall and affords opportunity for students to reflect on past actions (Sarama & Clements, 2009).

Real-world contexts enable students to develop a solid base for understanding geometry (Clements & Sarama, 2007). Mobile devices provide the opportunity to develop ideas within a real-world environment rich in architectural and natural geometrical formations. For example, using tablet devices (e.g., iPad), students within DGEs can take photographs of real-world artifacts and use tools to measure angles. Research findings indicate that students are able to understand geometric concepts easier with real-world connections, as the concepts were more interesting, familiar, and logical to the students (Duatepe-Paksu, 2009). Logo-based Microworlds were developed to represent real-world environments; they offer students opportunity to manipulate objects, make them move to specific commands, and construct other representations.

Cognitive tools

Cognitive tools are defined as technologies that act as external aids to amplify students’ cognitive capacities during thinking, learning, and problem solving (Lajoie & Azvedo, 2006). Other terms have been used to name these tools; Pea (1987) described them as cognitive technologies; Zbiek et al. (2007), as cognitive technological tools; and Hoyles (1995), as computational scaffolding. Hoyles and Noss (2003) used the term expressive tools, to specifically refer to DGE environment tools. Visualization and manipulation play a significant part in enhancing students’ cognitive processes. However, this section specifically describes geometry software as a cognitive tool.

The tools provided within DGEs, Logo, and other similar geometry programs, provide students with a way to access the mathematical characteristics underlying geometry and spatial reasoning (Laborde et al., 2006). The software tools become an extension of the students’ thinking once students begin to use the programs. Hoyles (1995) described this extension as computational scaffolding; a support process to aid in constructing situated abstractions. “The software tools exploited by the students provide them with the hooks they need on which to hang their developing ideas” (Hoyles, 1995, p. 5). The tools affect the ways students’ think about and solve tasks.

As students create or access visual representations within software, cognitive tools act as a user agent (Kaput, 1992) to perform geometric actions under student direction (Zbiek et al., 2007). Cognitive fidelity refers to the
degree that the computer’s supported method reflects the students’ independent method for solving a task (Dick, 2007). Researchers have concluded geometry software can provide cognitively faithful manipulation of objects, and is more faithful and easier than methods involving physical tools (see Olive & Lobato, 2008).

Cognitive tools have the potential to enhance and extend students’ learning of geometry in several ways. Pea (1987) described one way as amplifying intellectual activity – computers can increase the speed of mathematical tasks with higher accuracy. In addition, students can work with tools within geometry software to support discerning regularities, which might otherwise remain hidden. Meagher (2006) extended Pea’s theory to two-way amplification, he reiterated how students can be amplified by technology, but also described the way students amplify the technology as they refine educational goals so the technology provides the best fit for the goals. Vérillon and Rabardel (1995) postulated, there is a difference between the artifact and an instrument; the software or device (artifact) should not be regarded as a tool (instrument) as it only becomes that after someone appropriates it as such. This transformation into a tool is called instrumental genesis which indicates the bi-directionality in which this process takes place, which is towards the self and towards outside reality. Vérillon and Rabardel (1995) describe that in instrumental genesis, the artifact has to be integrated into a person’s cognitive structure which is a complex process connecting to the artifacts affordances and constraints and the knowledge of the user.

Pea (1987) also elucidated the role computers have as reorganizers. As a reorganizer, technology can bring about structural changes to students’ cognitive and sociocultural operations (Ben-Zvi, 2000). Technology can provide novel representations, uncover geometric concepts, and offload tedious or time consuming tasks (Sherman, 2002). Kaput (1992) also highlighted the benefit of offloading routine computations, suggesting that it compacted and enriched students’ learning experiences. Ben-Zvi (2000) proposed several ways mathematical software can reorganize students’ activities, including: (a) tools shifting students’ activity to higher levels, as they integrate tasks and focus attention on detailed planning; (b) tools changing objects and form of activities; (c) tools focusing activities on transforming and analyzing representations; (d) tools supporting situated cognitive modes of thinking and problem solving; and (e) tools enabling students’ constructing conceptual meanings by using representative ambiguity.

Feedback is another crucial component in advancing students’ geometric understanding. For cognitive tools to be effective they must react in response to student actions and provide clear observable consequences to their actions, and the cognitive tools of geometry software provide such feedback to students through clear visuals that are direct and immediate (Clements, Battista, & Sarama, 2001). Physical tools do not react to students’ actions via feedback, and often mistakes can go unnoticed or be misinterpreted by students (Zbiek et al., 2007). In addition, computer environments provide a view of students’ conceptions and understandings. Researchers reported designing such technological contexts that prevent students from hiding what they do not know, unlike traditional learning activities, which can mask misconceptions and misunderstandings (Clements & Battista, 1994). Therefore, geometric technologies may support greater opportunities for educators to plan appropriate tasks and activities to fill gaps that can be clearly identified and enhancing students’ geometric understanding.

**Discourse promoters**

The feedback computers provide can act as a catalyst for large or small group discussions (Mariotti, 2000). Students need opportunities to interact with others and share mathematical ideas and findings to develop rich understanding (Chaplin, O’Connor, & Canavan-Anderson, 2009). Computers foster mathematical discourse, augmenting communication from teacher-to-student, or computer-to-student, to a richer student-to-student communication (Van de Walle & Lovin, 2006). In addition, interactive geometry software allows discussion of geometric objects in a manner that was once impossible with traditional paper and pencil representations (Yu et al., 2009).

Computers enable students to produce detailed external representations of their internal mental representations. Once externalized, they are visible phenomena that can be shared and discussed with others. Although the representations are idiosyncratic, the visuals and computer activities provide a common context for students to effectively share their ideas (Yu et al., 2009), and the mediating function of the computer could be used to facilitate communication based on shared language and context. Students can have difficulty describing geometric transformations. As students execute processes of creating and/or moving objects using geometric technology, they can become aware of and mathematize their actions. This awareness, afforded by technology, could be used to help students describe procedures or the motions they have enacted.
Discourse enhances students’ learning when students collectively reflect on mathematical ideas (Van de Walle & Lovin, 2006). Geometry software provides instant feedback to students. When software images do not perform as expected, for example the turtle moves in a different direction, students typically want to know why; technology use may be an impetus for some questions that may not come up naturally. Working in pairs or small groups, students can reflect and discuss reasons for unexpected phenomena. The features embedded in the software can be used to undo and repeat actions, or study command sequences to check for accuracy. DGEs offer students interesting arenas to push boundaries of geometric understandings, and in doing so can create disequilibrium that need resolution, and providing opportunities for discourse.

Clements and Battista (1994) highly recommend the use of large monitors or projectors to enable students to see technology displays during whole class discussions. This can increase the already high motivation of cooperative, meaningful computer explorations in geometry with students of all ages and abilities. The record and replay feature within geometry software can be used to incorporate student work into group discourses that might include learning from errors, uncovering misconceptions, and justifying solutions.

The necessity of a justification for the solution comes from the need to explain why a certain construction works (that is, passes the dragging test). This need is reinforced through collective discourses, when different solutions are compared, by validating one’s own construction in order to explain why it works and/or to foresee whether or not it will function (Mariotti, 2000, p. 32). Computers can be used to call explicit attention to students’ actions and understandings encourage students to re-examine and refine their mathematical understandings through discourses with educators and peers.

Ways of thinking

van Hiele (1984) emphasized that successful students construct networks of relationships, linking geometrical concepts and processes, not isolated facts, rules, and names. Corresponding with learner-centered philosophies, thinking is altered by experiences and interaction with mathematical phenomena (Piaget, 1967), thus enabling students to become mathematical thinkers (Soto-Johnson, Cribari, & Wheeler, 2009). In addition, Papert (1980) reported that computers provide environments that allow students engage as mathematicians, instead of environments that teach children about mathematics. However, this epistemological shift towards students being mathematical thinkers is not only a shift for educators, but also for students.

Computers can facilitate the development of autonomous learning (rather than seeking authority), and towards positive beliefs about the creation of mathematical ideas (Clements & Battista, 1994). Students are provided with computational scaffolding within geometry software, encouraging students to explore possibilities, rather than declaring themselves “stuck.” Borwein and Bailey (2003) listed several activities in which students’ thinking processes were positively influenced by using technology, including (a) gaining insight and intuition, (b) discovering new patterns and relationships, (c) testing and falsifying conjectures, (d) exploring reasonableness of results through proof, (e) suggesting approaches for formal proof, and (f) replacing lengthy hand derivations.

Qualitative findings have highlighted the conceptual change in students’ thinking after using Logo (viz., Clements et al., 2001). The study showed that without additional intervention, the geometry program tools enabled students to become more cognizant of their thinking in regards to geometrical ideas, and more analytic, precise and general. In the more recent Diedro-3D study, students reported preferring to use the DGE to explore shapes rather than listening to explanations by the teacher. The program allowed students to think mathematically while working within an environment that provided context that the teacher’s lecture could not (Martín-Gutiérrez, Gil, Contero, & Saorín, 2013).

Connecting geometry concepts to the real-world setting is another shift in thinking which can be enhanced with the use of technologies. Gainsburg (2008) described an urgency for connections between mathematics and the real-world, and how many students fail to make this connection. Technologies, such as geometry software, can assist students in making this bridge. Computers provide a connection to the real-world using physical representations of objects and environments (Sarama & Clements, 2009). With the use of mobile computing platforms, students can interact with real-life artifacts (Traxler, 2011). Researchers reported that students using mobile devices for learning mathematics, not only noticed mathematics in the real-world, but they were “turning into mathematicians who looked for real-life phenomena to investigate mathematically” (Daher, 2011). This shift in thinking is not the norm experienced by most students in traditional learning spaces.
Conclusion

A good milieu for the emergence of mathematical knowledge is an environment providing the relevant combination of technological tools, problem situations and mathematical discourses (Kordaki & Potari, 2002). Technologies, such as DGEs can provide both the technical and conceptual activities needed for students to fully understand mathematical concepts. From this review of empirical and theoretical evidence, it is clear that technological affordances are far reaching, and provide a way to extend and enhance children’s understanding in geometry. The findings of this configurative thematic synthesis show that technology promotes students’ knowledge and understanding of geometry in five ways; visualization, manipulation, cognitive tools, discourse promoters, and new ways of thinking.

Within visualization, both visual representation and spatial visualization are highlighted as technology provides a way for students to experiment with objects beyond their non-technological counterparts. Students have the opportunities to visualize the shapes as geometric entities (Zbiek et al., 2007). Manipulation was a theme that emerged from this study as being particularly enhanced with technology. For example, students can manipulate objects while they keep their geometrical properties. This is often impossible with concrete manipulatives and paper-and-pencil shapes can be altered to what the student Brunton perceive to be correct (Laborde et al., 2006).

Cognitive tools was described by Lajoie and Azevedo (2006) as ways that technology can act as an external aid to amplify students’ cognitive capacities during thinking, learning, and problem solving. Examples from this study show that technologies can allow a student to use the tools to access mathematical characteristics underlying geometry and spatial reasoning.

Mathematical discourse is a valuable practice in enhancing student understanding. From the findings it appears that technology can enhance that understanding with the undo and repeat actions, options to study command sequences, and other similar technological options. The new ways of thinking was the final theme articulated in this study. Compared with the other themes, it appears that this is relatively less topic discussed in the literature and appears to be a new finding emerging from this study. New ways of thinking describes how students shift to become mathematical thinkers. This includes how students can engage as mathematicians in the technological environments (Papert, 1980), the thinking processes described by Borwein and Bailey (2003), and by providing students with context that would not be available in a teacher’s lecture (Martin-Gutierrez et al., 2013).

These five categories connect with a learner-centered framework as the student is actively involved in creating cognitive networks of relationships that link geometric concepts and processes (Clements & Battista, 1994). However, despite the potential that technology can have on learning, technology integration in mathematics is proceeding far slower than one may have predicted (Jones, 2011). Hopefully, the evidence provided in this paper can act as a catalyst to establish a dialectical link between the research findings and approaches to the teaching and learning of geometry in schools.

As we move towards learner-centered pedagogies, it would be prudent for researchers to explore opportunities to better contextualize mathematics to enable students to personally connect to the mathematical concepts. Therefore, further studies should involve more recent technologies, such as the virtual reality learning environments that enable students to study three-dimensional shapes via a variety of semiotic resources. Furthermore, learning with mobile devices, such as cell phones and tablets is a relatively new tool. It would be interesting to see how these 21st Century devices can be used to further contextualize learning and allow students to connect with mathematics in the real world learning rather than try to replicate 20th Century pedagogies.

References


Application-driven Educational Game to Assist Young Children in Learning English Vocabulary

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ABSTRACT

This paper describes the development of an educational game, named My-Pet-Shop, to enhance young children’s learning of English vocabulary. The educational game is underpinned by an application-driven model, which consists of three components: application scenario, subject learning, and learning regulation. An empirical study is further conducted with 30 fourth-grade students to examine its influence on the aspects of performance, flow, self-regulation, and behavior related to learning. The results demonstrated that the system contributed to enhanced flow experience and better learning self-regulation when compared to using a quiz game system without the support of the application-driven model. In addition, behavior analysis revealed that the component of learning regulation played a critical role. Some implications about the application-driven model and its future development are also discussed.

Keywords
Application-driven model, Vocabulary learning, Educational games, Children

Introduction

The learning of new vocabulary items plays a fundamental role in mastering any foreign language, including students struggling to learn English as a second language (Nguyen & Khuat, 2005). However, it has been found that rote learning can be boring and it is difficult for students to remain interested and engaged in such learning activities. In addition, it has also been reported that it is better for knowledge acquisition to occur in meaningful contexts, not separated from the learning situations. To overcome these types of problems, more and more studies (Huang & Yang, 2012; Yip & Kwan, 2006) seek to incorporate digital games with learning scenarios to support language learning, which often involves a virtual world to allow students to explore every place or interact with each other (Toscano et al., 2015; Chien et al., 2013). In other words, such an interactive environment can create various scenarios to enrich students’ learning experience (Lin & Lan, 2015). In this way, students can be situated in a 3D multi-user environment to communicate with computer-simulated characters or interact with other students for learning foreign language (Di Blas & Paolini, 2014; Ibáñez et al., 2011).

These types of educational games have the potential to enhance students’ participatory motivation and provide meaningful contexts (Schultz & Fisher, 1988). Thus, research efforts are made to apply digital games to English language learning and to systematically examine their influence and benefits. For instance, Chen and Yang (2013) developed an adventure game aimed at assisting college students with second language acquisition. Their results indicated that such games could stimulate student motivation and further foster their reading, listening, and vocabulary skills. In another study, a multiplayer game was developed for the promotion of English language learning, where native and non-native adolescent speakers interacted through avatar-embodied collaboration (Zheng et al., 2009). The results demonstrated several potential benefits for students in the game-based environment. Chen and Tsai (2009) developed a location-based game for the promotion of English learning at the college level, where as part of the game students received learning scenes based on their locations with mobile devices. The results indicated that using this type of game-based system could increase students’ interest and willingness to learn.

Although the aforementioned studies do offer encouraging findings, most studies have primarily examined the influences on student motivation and performance (Pesare et al., 2016; Toscano et al., 2015; Tsai, Yu, & Hsiao, 2012; Kebritchi, Hirumi, & Bai, 2010; Papastergiou, 2009), ignoring learning behavior and meta-cognition aspects. In addition, most of them focused on learning by adolescent or college students, rather than young students. Thus, there is a need to extend this type of investigation to understand how game-based learning can support young students’ English language learning, especially from the aspects of learning behavior and self-regulated learning. More specifically, self-regulated learning (Schunk & Zimmerman, 1998) has been attracting increasing attention because it offers a theoretical foundation for the development of metacognitive strategies. Its
significance has led to the incorporation of self-regulation into different learning technologies. For instance, some studies have used the Internet and hypermedia technologies to promote the application of strategies of self-regulated learning in a web-based learning system (Narciss et al., 2007). Social media and communication technologies have also been adapted to provide the necessary support for promoting self-regulated learning (Shih et al., 2010; Elgort et al., 2008). In addition, several researchers have investigated the application of mobile and wireless technologies to explore new learning possibilities from the perspective of self-regulated learning (Sha, Looi, Chen, & Zhang, 2012; Sha et al., 2012; Shih et al., 2010).

Although digital games have come to be accepted as a useful learning technology (Qian & Clark, 2016; Jabbar, & Felicia, 2015; Gee, 2003), it is still unclear how digital games can support self-regulated learning in younger students, and what their comprehensive influence on student learning would be. In this vein and to address some of these issues, an educational game-based system, My-Pet-Shop, is developed to assist elementary students with the learning of English vocabulary. The study examines the use of a digital game to offer students more opportunities to practice English vocabulary. Additionally, an empirical study is conducted to investigate its comprehensive influence. Specifically, this study seeks to answer two questions: (1) How do we develop a learning system to support young students’ English vocabulary learning? (2) What are the comprehensive influences of such a learning system in terms of performance, flow, self-regulation, and behavior?

My-Pet-Shop system

The My-Pet-Shop system is developed based on an application-driven model comprised of three components: application context, subject learning, and learning regulation, as illustrated in Figure 1. More specifically, the model first assesses students’ applicability in set of learning scenarios, and then promotes their awareness of learning status via visual representation, and encourages them to improve learning status.

Application scenario

For application scenario, the purpose is to drive student learning through scenario-based learning (Clarke, & Mayer, 2011; Clark, 2009; Kindley, 2002). It is assumed that learning should be situated in a specific context, or embedded in a particular social and physical environment, rather than carried on out of context (Kindley, 2002). Underpinned by situated learning theory (Lave & Wenger, 1991), scenario-based learning first offers students in authentic scenarios, allowing them to integrate the knowledge and skills needed in this context, instead of offering decontextualized knowledge such as is the case with rote learning (Clarke, & Mayer, 2011). Scenario-based learning advocates learning in concrete situations and by examples. Such attempt is realized by two mechanisms: pet-shop scenarios and response tracing.

- Pet-shop scenarios: the students in the My-Pet-Shop system play the role of “shop manager” who needs to satisfy the needs of computer-simulated customers, and interact with them in different scenarios. Specifically, customers go to the pet-shop to ask for different services, such as buying food to feed their pets, taking their pets for grooming, or seeking medical attention (see Figure 2). In other words, in these situations, the students are required to apply appropriate vocabulary to respond to the customers via a set of
multiple-choice questions. The students need to choose the correct word in the given scenario. Therefore, the application scenario offers situations for the students to apply what they have learned.

- Response tracking: while the students choose a word as an answer in the multiple-choice question, whether their choices are correct or not are recorded. Those responses could serve as indicators to further analyze students’ learning status and understanding. More specifically, the mechanism of response tracking is a fundamental function that enables the My-Pet-Shop system to conduct data analysis, and show in a visual way (see data visualization), or offer possible warning (see color-coded warning), suggestions for improving the learning status (see learning suggestions).

![Figure 2. Snapshot of some of the application scenarios in My-Pet-Shop](image)

**Learning regulation**

The purpose of learning regulation is to promote students’ awareness of self-regulated learning (Schunk & Zimmerman, 1998) by emphasizing the regulation of effort in three cyclic phases: forethought, performance, and self-reflection. More specifically, the forethought phase involves goal-setting, strategy selection and resource allocation. In the performance phase students monitor task performance, while in the self-reflection phase they assess their learning outcomes and regulate their learning efforts. Self-regulation is a significant learning strategy, because it can contribute to students’ meta-cognition. Such attempt is realized by two mechanisms: data visualization and color-coded warning.

- Data visualization: to enhance the student’s awareness of regulated learning, the My-Pet-Shop system allows students to monitor their learning status via visualization tools: a reporting table that illustrates their learning status based on the system logs for students’ answers in the application scenarios. For instance, their responses (correct or incorrect) are analyzed to further present their mastery level of vocabulary knowledge in this reporting table (see Figure 3). More specifically, this mechanism will show students’ learning status based on the mechanism of response tracking to make students easily understand their learning status.

- Color-coded warning: to empower the data visualization, a color-coded warning mechanism is further used to present students’ the mastery levels of vocabulary knowledge in different colors: green means “mastered”; yellow means “could-be-better”; red means “not mastered,” and gray indicates “not attempted.” This warning mechanism offers a complete picture so that the students can quickly and easily understand their learning status, and regulate their learning. In addition, students can also observe what they have learned and have not learned, which might deliberate the gap between what they have planned (goal), what they do (performance), and what they obtain (outcomes). Thus, they are encouraged to become self-regulated learners.
Subject learning

The purpose of subject learning component is to offer students more opportunities for distributed practice (Kapp, 2012), where the learning materials are broken up into a set of short sessions. Distributed practice is widely used in the gamified learning or instruction settings, emphasizing students’ learning efforts over multiple sessions, where each session focuses on the subject matter to be learned, instead of rote memorization or cramming. Such attempt is realized by two mechanisms: theme-based tasks and learning suggestions.

- Theme-based tasks: in the My-Pet-Shop system, each English word item is designed as pet goods requiring to be packed (see Figure 4). Thus, to have better quality goods for their management, the students need to learn these English word items. Additionally, according to dual-coding theory (Clark & Paivio, 1991), materials are easier to learn when presented visually and verbally. Thus, in addition to illustrating the pictures of word items (i.e., imagery channel), the pronunciation (i.e., verbal channel) is also offered in the theme-based learning. When students click the vocabularies in the list, they can see the illustration of the word and hear the pronunciation. Although both of application scenarios and subject learning offer opportunities for students to learn, a major difference between them lies in that the former focuses on the application usage of words in specific situation, and the latter highlights the basic learning and practice for each word one-by-one.

Figure 3. Snapshot of the learning regulation table used in My-Pet-Shop

Figure 4. Snapshot of a subject learning scenario in My-Pet-Shop
• Learning suggestions: in addition to the learning flows based on the themes, the students can also learn these words according to the learning suggestions, which are analyzed based on the aforementioned color-coded warning mechanism. Precisely, the list will show the words that belong to the master level of yellow (i.e., could-be-better) and red (i.e., not mastered) to suggest students master them first. In this way, they can have better performance in the application scenarios in the future.

Method

A quasi-empirical experiment was conducted to investigate the influence of the My-Pet-Shop system. Two different learning systems (i.e., the My-Pet-Shop system and a quiz game) were developed and their influence on student learning was examined.

Participants

In total, 30 fourth-grade elementary students (approximately 10-years-old on average) from two classes at an elementary school in Taiwan participated in the quasi-experiment. The elementary school had a policy of normal distribution and randomly assigned students on that basis to classes at the start of the school year to make sure that each class included students with various levels of background and knowledge. Accordingly, it can be assumed that the students in each of the two classes had uniform learning backgrounds and learning abilities. The two classes were randomly assigned to either an experimental group (EG, \( n = 15 \)) who used the My-Pet-Shop, or the control group (CG, \( n = 15 \)) who used a quiz game. Table 1 shows the number of students in the two groups.

Table 1. Number of students in the two groups

<table>
<thead>
<tr>
<th>Groups</th>
<th>Number of students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental group (EG)</td>
<td>15</td>
</tr>
<tr>
<td>Control group (CG)</td>
<td>15</td>
</tr>
</tbody>
</table>

System instruments

Both of the learning systems used in the experiment included 60 English words as the subject domain. The major difference between the two systems lay in the type of game it was. Thus, the My-Pet-Shop system used in EG was developed based on the application-driven model, where the pet-shop scenarios drove students to master English vocabulary items. On the other hand, the quiz game (My-Pet-Rush) used in CG was developed with the same subject learning. The differences between the two systems are summarized in Table 2 and Figure 5.

Table 2. Interventions between the two systems

<table>
<thead>
<tr>
<th></th>
<th>My-Pet-Shop</th>
<th>My-Pet-Rush</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application scenario</td>
<td>O</td>
<td>X</td>
</tr>
<tr>
<td>Learning regulation</td>
<td>O</td>
<td>X</td>
</tr>
<tr>
<td>Subject learning</td>
<td>O</td>
<td>O</td>
</tr>
</tbody>
</table>

Figure 5. Use of the two different systems
Procedures

The procedures employed are illustrated in Figure 6: (1) before the experiment, students were asked to take a performance pre-test. Then, they were given 5 minutes of instruction on how to use the system; (2) as noted above the two groups used different systems. The experimental group used the My-Pet-Shop for two 35-minute sessions over two weeks while the control students used My-Pet-Rush for the same number and length of sessions; (3) at the end of the experiment, students were asked to take another performance test, the post-test. In addition, they were also asked to fill out the flow and self-regulation scales.

Data collection

- Performance: To measure the participants’ learning performance, two performance tests were developed by the second author of this paper, a pre-test and post-test. Each test contained 18 items, where students were asked to choose the correct answer from four choices for a given picture. To prevent rote learning, the items in the two tests had similar levels of difficulty but were different. The tests were scored in the range from 0 to 100. In addition, to increase the validity of the achievement test, a pre-service elementary school teacher was asked to proof-read the sentences, to make sure that items were appropriate and that students could easily understand them.

- Flow experience: To assess the students’ motivation status, a flow scale modified from EGameFlow (Fu et al., 2009) was used. The scale consisted of six dimensions: concentration (2 items), goal clarity (2 items), feedback (2 items), challenge (2 items), autonomy (2 items), and immersion (2 items). Each item was scored on the 7-point Likert scale, ranging from “strongly disagree” (point = 1) to “strongly agree” (point = 7). The reliability (Cronbach’s alpha) of the scale was 0.79.

- Self-regulation: To understand the influence of self-regulation, we adopted a Chinese version of the self-regulation scale used by Lee (2006) for fourth-grade elementary student English learning. The scale contained three dimensions, including forethought (14 items), performance (12 items), and self-reflection (5 items). Each item was scaled on the 5-point Likert scale, ranging from “strongly disagree” (point = 1) to “strongly agree” (point = 5). The Chinese version of the self-regulation scale had an appropriate reliability (Cronbach’s alpha = .85).

- Behavior: To trace behavior patterns in the My-Pet-Shop system, the students’ behaviors were further recorded in system logs using the “index-user-behavior” format, where “index” is an automatically increasing number that identifies the order of the behaviors; “user” refers to the name of the student; “behavior” refers to the function that the student has used. The system logs are further analyzed using a coding scheme to record their behaviors in the three components. To be more specific, the coding scheme contains three codes that represent students’ locations and actions in the three components, including Application scenario (A), Subject learning (S), and Learning regulation (L). For a detailed description see Table 3.

<table>
<thead>
<tr>
<th>Code</th>
<th>Behavior</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Application scenario</td>
<td>Students complete the task-based activities and accomplish the given learning tasks.</td>
</tr>
<tr>
<td>S</td>
<td>Subject learning</td>
<td>Students buy pet food, items, or related services that can make their virtual pets healthy and strong.</td>
</tr>
<tr>
<td>L</td>
<td>Learning regulation</td>
<td>Students feed or equip their pets so that their pets have a greater chance of winning the competition.</td>
</tr>
</tbody>
</table>
Data analysis

The independent variable was the learning system, each with two levels, whereas the dependent variables were the influences of the systems on student learning, including performance, flow, self-regulation, and behavior. Three different analyses were carried out: (1) paired-sample t-tests for the two groups were conducted to examine the differences regarding the performance tests, the flow scale, and the self-regulation scale. (2) In addition to t-tests, a performance test was further carried out by one-way analysis of covariance (ANCOVA) to examine the differences between the two groups, with system instruments as the independent variable, pre-test scores as the covariant, and post-test scores as the dependent variable. (3) Sequential analysis of coded behaviors based on a time sequence (Jeong, 2005; Bakeman & Gottman, 1997) was conducted to explore behavior patterns.

Results

Performance

The means and standard deviations (SD) for the pre-tests and the post-tests in each group are presented in Table 4. The results of the t-tests revealed that the scores of the post-test were significantly higher than those of the pre-test in both EG ($t = 6.72, p < .01$) and CG ($t = 7.72, p < .01$). The result implies that both of the systems were beneficial for enhancing student performance. In addition, a further ANCOVA results shows no significant difference between the post-test scores of the two groups. In other words, the My-Pet-Shop system did not have more enhanced impact on learning performance than the other system.

A possible explanation was that both of the systems contained theme-based materials, which might offer students opportunities to effectively improve their vocabulary learning. Thus, both of the students in EG and CG obtained significant improvement in the performance tests. This might be the reason why no significant difference existed between the two groups. In addition, although My-Pet-Shop had additional components (i.e., scenario application and learning regulation) that might be helpful for students’ goal setting and reflection, this study is a short-duration experiment (only two 35 minutes sessions). It might be a possible reason for not revealing significant difference between the two groups.

Table 4. t-test performance test results

<table>
<thead>
<tr>
<th></th>
<th>Pre-test</th>
<th>Post-test</th>
<th>t</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Means</td>
<td>SD</td>
<td>Means</td>
</tr>
<tr>
<td>EG</td>
<td>79.33</td>
<td>12.93</td>
<td>95.67</td>
</tr>
<tr>
<td>CG</td>
<td>72.00</td>
<td>11.14</td>
<td>93.33</td>
</tr>
</tbody>
</table>

Note. **p < .01.

Flow experience

Table 5 displays the mean and the SD for the six dimensions of the flow scale. Further t-tests were conducted to assess the impact of the two learning systems, and the results showed significant differences for four of the measures – Goal clarity, Feedback, Autonomy, and Immersion – between the two groups ($t = 2.48, p < .05; t = 2.52, p < .05; t = 2.49, p < .05; t = 3.10, p < .01$, respectively). The findings demonstrated that the My-Pet-Shop provided students with enhanced goals, feedback, autonomy, and immersion over the My-Pet-Rush system.

Table 5. t-test results for flow scale in terms of six dimensions

<table>
<thead>
<tr>
<th></th>
<th>EG</th>
<th>Mean</th>
<th>SD</th>
<th>CG</th>
<th>Mean</th>
<th>SD</th>
<th>t</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Means</td>
<td></td>
<td></td>
<td>Means</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Concentration</td>
<td>4.30</td>
<td>0.77</td>
<td></td>
<td>4.06</td>
<td>0.77</td>
<td></td>
<td>0.82</td>
</tr>
<tr>
<td>Goal clarity</td>
<td>4.56</td>
<td>0.53</td>
<td></td>
<td>4.03</td>
<td>0.63</td>
<td></td>
<td>2.48**</td>
</tr>
<tr>
<td>Feedback</td>
<td>4.83</td>
<td>0.36</td>
<td></td>
<td>4.43</td>
<td>0.49</td>
<td></td>
<td>2.52**</td>
</tr>
<tr>
<td>Challenge</td>
<td>4.56</td>
<td>0.49</td>
<td></td>
<td>4.40</td>
<td>0.78</td>
<td></td>
<td>0.69</td>
</tr>
<tr>
<td>Autonomy</td>
<td>4.40</td>
<td>0.71</td>
<td></td>
<td>3.73</td>
<td>0.75</td>
<td></td>
<td>2.49**</td>
</tr>
<tr>
<td>Immersion</td>
<td>4.60</td>
<td>0.54</td>
<td></td>
<td>3.63</td>
<td>1.07</td>
<td></td>
<td>3.10**</td>
</tr>
</tbody>
</table>

Note. *p < .05; **p < .01.

A possible explanation for this result was that various game types between the two learning systems (i.e., management and quiz games) resulted in such differences. More specifically, since the My-Pet-Rush (i.e., quiz
game) asked students to choose a correct answer and then gave the feedback, students’ positive perceptions might be thus enhanced. However, the My-Pet-Shop (i.e., management game) offered students two levels of goals: immediate and long-term goal. The immediate goal was to choose a correct answer for the given scenario, which was similar with what the quiz game provided. The long-term goal was concerning the management of the shop, which involved the status monitoring and effort regulation. The two levels of goal might make students perceive greater intensity of goal clarity, feedback, and autonomy, which, in turn, contributed to enhanced level of immersion.

**Self-regulation**

The mean and SD for the three dimensions of the self-regulation scale in the two groups are presented in Table 6. t-tests were conducted to evaluate the impact of the two learning systems on the three dimensions. The results showed a significant difference in two of the measures – Forethought and Performance – between the two systems ($t = 2.34, p < .05; t = 2.78, p < .05$, respectively). In other words, the findings demonstrated that the My-Pet-Shop system enhanced students’ self-regulation in comparison to My-Pet-Rush in terms of forethought and performance.

A possible explanation was that the finding resulted from the major differences between the two systems: application scenarios and learning regulation, as illustrated in Table 2. More specifically, the My-Pet-Shop offered scenario-based learning, which offered students a global view to think what the requirements were, and what actions they needed to take. The scenario-based learning and the global view might benefit students’ forethought. In addition, the My-Pet-Shop also offered students visualization-based report that could help students obtain more comprehensive understanding and monitoring on their learning status, which, in turn, resulted in better control and performance. This might be the reason why the performance aspect was enhanced in the My-Pet-Shop system. However, regarding the self-reflection aspect, although the means of two groups did not exist a significant difference, the mean of EG (i.e., 4.37) was greater than that of CG (i.e., 4.02), suggesting that students’ self-awareness might be enhanced, but the intensity of self-reflection did not contribute to a significant difference in such a short period of time.

| Table 6. t-test results for the self-regulation scale in terms of three dimensions |
|--------------------------------------|---------|---------|--------|
|                                     | **EG**  | **CG**  |       |
|                                     | Means   | SD      | t      |
| Forethought                         | 4.29    | 0.39    | 2.34*  |
| Performance                         | 4.01    | 0.40    | 2.78*  |
| Self-reflection                     | 4.37    | 0.41    | 1.28   |

*Note.* $p < .05$.

**Behavior**

Table 7 illustrates the transitional probabilities of student behaviors, with the starting behaviors appearing in the rows, and the subsequent behaviors in the columns. A Z-value greater than 2.32 implies that a behavior sequence has reached a level of significance of $p < .01$. The sequential behavior patterns are further illustrated in a transition diagram, as can be seen in Figure 7. The results indicated that (1) Application scenario $\rightarrow$ learning regulation forms an obvious pattern, and so does learning regulation $\rightarrow$ application scenario. Since the patterns involve the opportunities for application, it implies that such application scenarios would drive students to observe their learning status. (2) Subject learning $\rightarrow$ learning regulation forms an obvious pattern, as does learning regulation $\rightarrow$ subject learning. It appears that the reporting table acts as motivation encouraging students’ vocabulary learning.

A possible reason to explain why no behavior pattern occurred between application scenario and subject learning was: learning regulation offered more information to guide them to improve learning. More specifically, on one hand, under the application-driven model, students would be first notified whether they were able to apply what they had learned to related situations. Thus, they naturally would like to comprehensively understand what their learning statuses were because it can help them regulate efforts to improve learning. On the other hand, learning regulation not only provided students a global view to monitor their status (i.e., data visualization), but also a micro view to highlight the vocabularies that need to be further remedial (i.e., color-coded warning). Thus, students preferred to use learning regulation after using the application scenario. This might be the reason why a
behavior pattern occurred between application scenario and learning regulation, instead of that and subject learning.

Table 7. Transitional probabilities for the My-Pet-Shop system

<table>
<thead>
<tr>
<th></th>
<th>Learning regulation</th>
<th>Subject learning</th>
<th>Application scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning regulation</td>
<td>0.34</td>
<td>0.31</td>
<td>0.31</td>
</tr>
<tr>
<td>Subject learning</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Application scenario</td>
<td>0.19</td>
<td>0.78</td>
<td>0.78</td>
</tr>
</tbody>
</table>

Figure 7. Behavior transfer diagram for the experimental group

Discussion

Impact of the application-driven model

Previous studies indicate that management games can help cultivate responsible attitudes in students, and encourage them to think, do, and regulate their learning (Griffiths, 2002; Keys & Wolfe, 1990). In the My-Pet-Shop system, students are asked to play the role of “managers” running a pet-shop in different application scenarios, which encourages them to learn how to be more responsible for what they do, and what they want to do. To be more specific, they need to plan their goals (e.g., to what extent do they want to master the vocabulary items), monitor their progress (e.g., whether they have used the appropriate vocabulary to respond to customers), and evaluate their results (e.g., how satisfied are the customers). They also need to judge the gap between the goal and the outcome, and further regulate their learning direction and effort exerted.

The findings of this study reveal that the application-driven model is helpful to facilitate the student flow experience (in terms of the goal clarity, feedback, autonomy, and immersion aspects), but does not contribute to learning performance. The application-driven model offers a variety of scenarios for students to apply what they have learned. Students can perceive clear goals and receive immediate feedback. Goals and feedback are key game elements (Paras, 2005) which are helpful to facilitating the flow and immersive experience, and also contribute to control and autonomy. All of this enhances the students’ engagement experience.

Role of information visualization

In addition, the findings of this study also reveal that the application-driven model contributes to students’ self-regulation in terms of the forethought and performance aspects. A close look into the analysis of behavior patterns shows that learning regulation is significantly related to both the application scenario and subject learning. In other words, this component (i.e., learning regulation) plays a significant role acting as the “bridge” between two other components. Actually, the learning regulation component provides an information visualization tool (i.e., color-coded reporting table) which enhances student awareness of their own learning. The
results indicate the significance of this component in making students understand their current status which is critical in the process of self-regulation. This might be due to the fact that students need sufficient information to support their planning, decision-making, and strategy selection. When students are more aware of what they have and what they lack, they will have a clearer picture of where their future efforts should be directed—which is closely related to forethought and performance. Thus, harnessing the design of information visualization to promote students’ forethought and performance might be a useful added-value feature for future development.

Moreover, the design of the color-coded reporting table is related to the technique of information visualization for the purpose of allowing students to easily interpret data for self-awareness (Bienkowski, 2012; Verbert, 2012; Duval, 2011; Govaerts, 2012). This is significant because making students be aware of their learning status is critical to improving their learning (Bull & Kay, 2007), as in the open student model (Bull et al., 2009; Velez et al., 2009; Chen et al., 2007) where the data collected by educational systems are opened up to the students themselves. This “open” feature can help students be more aware of their current learning status and progress, so they can further reflect on what they have and have not learned. Thus, collecting and presenting more open data to students might be another future direction for system development.

Conclusion

This paper attempts to answer the two questions mentioned above. In response to the first (i.e., How do we develop a learning system to support young students’ English vocabulary learning?), the My-Pet-Shop system is developed based on the application-driven model to support English vocabulary learning. The second question (i.e., What are the comprehensive influences of such a learning system in terms of performance, flow, self-regulation, and behavior?) is answered using the My-Pet-Shop system as an example. Its influence is evaluated by comparison with a quiz game system without the support of the application-driven model. The results showed that (1) the application-driven model offered students enhanced motivation in terms of the goal, feedback, autonomy, and immersion aspects; (2) the model was also beneficial to students’ self-regulation in terms of the forethought and performance aspects; and (3) two obvious behavior patterns exist, both of which suggest that the learning regulation component plays a significant role.

The contribution of this study covers two aspects: theory and application. In terms of the theory, this study deepens the understanding of the importance of scenarios and visualization in the development of vocabulary learning systems. The findings of this study indicated that the two components could benefit young students’ flow experience and self-regulation in some aspects. In terms of the application, this study proposes an application-driven model that can be practically used in educational settings. The model first assesses students’ applicability (i.e., applying what they have learned to real situations), and then promotes their awareness of learning status (i.e., using visual representation to make them understand easily), and guides them to improve learning status.

However, this study has some limitations that should be further investigated in the future. First, the sample size is small, thus, further investigations with larger sample sizes are required. Second, although the results showed the learning systems to have a positive impact on students, this was merely a short-term study. The long-term effects are still unclear. Third, My-Pet-Shop is used as an example of an application-driven model, but cannot reflect the effects of all such learning system types although it does offer a starting point to investigate their impact. More learning systems and the consistency of the results should be examined in the future.

Acknowledgments

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References


Feedback of Interface Agents on Student Perception: Level, Dialogue, and Emotion

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ABSTRACT

Although feedback from interface agents has recently attracted increasing research attention, most studies emphasize the cognitive influences. Thus, the effect of each feedback type on student perception remains unclear. This study focuses on three types of feedback from interface agents to clarify student perception of single feedback and combinations of feedback types. An empirical study of 45 junior college students was conducted. Results showed that students preferred the emotion feedback and disliked the level feedback when they were asked to choose one feedback type. For combinations, the combined feedback of dialogue and emotion was the most preferred among all combinations. Based on these findings, several implications for the further development of interface agents are discussed.

Keywords

Feedback, Interface agent, Student perception, Animal companion

Introduction

Interface design is regarded as having a crucial influence on the quality of the human-computer interaction (Preece, Rogers, & Sharp, 2002). For learning systems, interface design affects both student participation and the quality of the process, which further influences student learning achievement. Thus, enhancing the interface design of learning systems has become a significant issue. Furthermore, interface design has undergone many changes. First, the human-computer interface has developed from textual to graphical, multimedia, tangible, and gestured forms, where advanced technology has a great impact on the interface design. Second, because people tend to treat computers as social actors (Reeves & Nass, 1996), interface agents have been incorporated into the human-computer interaction (Preece, Rogers, & Sharp, 2002). Interface agents are embodied as virtual characters to play specific educational roles (e.g., tutor, tutee, and learning companions), attracting students’ attention and fostering their participation and communication (Woolf, 2009).

To maximize the impacts of interface agents, these agents are equipped with different appearance, persona, and feedback. First, appearance has been shown to affect students’ perception and participatory willingness when interacting with different visual forms (e.g., realistic or iconic) and visual styles (e.g., ethnicity and gender) of interface agents (Baylor & Kim, 2003; Baylor & Kim, 2005; Gulz & Haake, 2005). Second, the individual persona of interface agents is a key factor in student interaction because the individual persons of interface agents have their own “voice” in the interaction (Hietala & Niemirepo, 1998). For instance, the impact of the personas of “empathy” and “politeness” on student learning has been explored (McQuiggan & Lester, 2007; Wang, Johnson, Mayer, Rizzo, Shaw, & Collins, 2008). Third, the different types of feedback of interface agents have also been investigated. For instance, the feedback of body language (e.g., nodding, gestures, and eye contact) is used to enhance students’ motivation and further facilitate their communication (Johnson, LaBore, & Chiu, 2004; Johnson, Rickel, & Lester, 2000). In addition, different feedback levels of behavioral realism (e.g., high/low realism, and mixed realism) are also investigated. Results show that believable feedback of behavior is a key factor in student perception and participation (Groom, Nass, Chen, Nielsen, & Scarborough, 2009).

Recently, an interface agent named animal companion (Chen, 2012; Chen et al., 2007) has attracted increasing research attention, because its feedback is based on emotional attachment to pets (Beck & Katcher, 1996; Melson, 2001), which further enhances students’ participatory motivation (Chen et al., 2011). Moreover, visual appearance of educational agents could have a major impact on student motivation and affection (Baylor, 2009). Since animal companions own the visual features of simple and cute, they have also attracted college students, especially females (Chen, 2014). In addition, a set of animal companion systems with different types of feedback are explored: level, emotion, and dialogue feedback. For level feedback, animal companions use visual symbols, such as decoration (Liao et al., 2011), and badges (Chen et al., 2013) to represent student learning participation.
Such design is underpinned by the studies in which visual styles (e.g., reality, ethnicity, and gender) have been shown to influence student impressions (Baylor & Kim, 2003; Baylor & Kim, 2005; Gulz & Haake, 2005). For emotion feedback, it has been indicated that emotions will influence learning, and emotional feedback is a powerful educational tool that could enhance student learning (Economides, 2006). Animal companions use various facial emotions to represent student learning status, such as excited, happy, sad, and upset (Chen et al., 2007). This is because facial expressions use deeper emotions to engage students in effective communication (McQuiggan & Lister, 2007; Wang et al., 2008). For dialogue feedback, animal companions use conversations to convey students’ learning status (Chen & Chen, 2013; Chen et al., 2007). Such design is supported by research showing that written or spoken conversation is a significant element of storytelling, a powerful communication or persuading narrative (Alexander, 2011), enabling animal companions to play various social roles (e.g., motivator, sustainer, goal-setter, reflector, and task facilitator) to interact with students (Chen et al., 2007).

However, although the aforementioned studies contribute to our understanding of feedback of interface agents on student learning, current studies lack a systematic evaluation of the feedback. Thus, the impact of each type of feedback remains unclear, although the combination of emotion and dialogue feedback (Chen, 2012; Chen et al., 2011) as well as the combination of level and emotion feedback (Liao et al., 2011) has been revealed to increase student motivation and learning performance. Because of individual differences, not all students have the same preferences for the use of learning systems (Chen, 2014; Yu et al., 2008; 2002). Thus, the design of learning systems should take adaptive feedback into account. However, before providing students with adaptive feedback, the effects of different feedback should be clarified. Hence, it is critical to investigate the influences of the feedback of interface agents on student learning.

In short, three significant feedback of animal companion systems (i.e., level, emotion, and dialogue feedback) are investigated in previous studies (Chen & Chen, 2013; Chen et al., 2013; Chen et al., 2007). Although the impacts of some combinations of the three feedback have been investigated, their influences of each single feedback are not systematically clarified. Thus, this system develops an animal companion as an example of interface agent to systematically examine student preferences across the three types of feedback. More specifically, this study attempts to answer the following two research questions: (1) What are student preferences for interface agent feedback among level, emotion, and dialogue feedback? (2) What are student preferences for combinations of level, emotion, and dialogue feedback?

**Method**

**Settings**

To answer the research questions, this study conducted an evaluation, in which all of participants experienced and assessed feedback of animal companion systems. To this end, two animal companion systems were developed: a single feedback (SF) system, and a combined feedback (CF) system. Both of them had the same subject domains: multimedia programming. During the process, the systems proposed a set of multiple-choice questions to assess students’ concept understanding. Once the students chose one of the items, they would receive the feedback from animal companion systems. In the beginning, the students received one type of feedback each time to experience all types of feedback. Then, they could freely choose the feedback they preferred. In the single feedback (SF) system, the students were offered one of the three types of feedback (i.e., level, emotion, and dialogue). In the combined feedback (CF) system, students were offered a combination of the three feedback types, including level, emotion, dialogue, level & emotion, level & dialogue, emotion & dialogue, and level & emotion & dialogue. After students experienced the systems, they were asked to fill out questionnaires to report their perceptions.

**Participants**

Participants were 45 junior college students (aged an average of 20 years) from the department of information communication in a Taiwanese university. Since they all had similar backgrounds of computer and information skills, bias from different backgrounds of information technology literacy was reduced. In addition, the participations consisted of 25 males and 20 females to reduce gender bias.
Instruments

To clarify students’ perceptions on single and combined feedback, for each system the students were asked to answer a number of multiple-choice questions, where they could freely choose feedback types. In other words, the students could choose one of the three feedback types in the SF system during the process, whereas they could choose among the combinations of the three feedback types in the CF system. Thus, the major difference between the two systems lied in the number of feedback types that students could choose during the learning process. As illustrated in Figure 1, each system consists of three different feedback types (level, dialogue, and emotion), which are described below:

- **Level feedback**: The design of level feedback is based on the concept of mastery learning, in which materials to be learned are divided into short units, and students are evaluated on their progress for each unit of materials (Bloom, 1968; Kulik et al., 1990). In this study, the level feedback of animal companions is divided into nine levels to show students’ mastery levels. Nine different degrees of level feedback are used to illustrate students’ overall learning status according to their accuracy rate. In addition, to enhance students’ confidence in mastery and progressing, the intervals of the first five levels (Level 1~5) are defined as 10%, whereas the last four levels (Level 6~9) are defined as 15%. Through the level feedback, students’ overall learning status can be illustrated directly and clearly.

- **Emotion feedback**: The design of emotion feedback is referred to a previous study of animal companions (Chen et al., 2007), where the emotions of animal companions are classified as a linear model with two dimensions: positive and negative dimensions. More specifically, the positive dimension contains three emotions (i.e., excited, happy, and smile), whereas the negative dimension also contains three emotions (i.e., confused, sad, and crying). The use of this linear model is to highlight students’ current level of performance and the direction for further improvement. In addition, these six emotions are classified as two categories: instant feedback and overall status. The former will present “happy” or “sad” to students when they get a correct/wrong answer. The latter shows the students’ accuracy rate using six different emotions, including excited (85%~100%), happy (70~84%), smile (60%~69%), confused (40%~50%), sad (20%~39%), and crying (1%~20%). These facial emotions are illustrated in Figure 2.

- **Dialogue feedback**: Two categories of facial emotions are used for dialogue feedback. Instant feedback such as “Congratulations! You are right!” or “That’s OK, never give up!” would show whether a student’s
answer is correct. In addition, as with level feedback, overall learning status based on their correct answer percentage is used. For instance, while students’ correct ratio increase to 85%–99%, the agent will say “Excellent! You did that very well.” But if the correct ratio is around 40–59%, it would say “Kept on trying! I know you can do it.” The dialogue feedback can show students’ learning status in the way of conversation.

Data collection

To understand student perceptions of the learning system with different feedback types, two perception questionnaires were developed by the authors of this paper: single-feedback questionnaire and combined-feedback questionnaire. The single-feedback questionnaire contained 15 items evaluating the effect of the three feedback types on student perception. These items are categorized as five aspects according to the educational roles that animal companions might play, such as facilitator, motivator, and reflector (Chen et al., 2007). More specifically, five aspects of learning perception were emphasized, including preferences, performance, motivation, reflection, and pressure. Each item was scored on a 5-point scale ranging from “Strongly Disagreed (S.D., point = 1)”, “Disagreed (D., point = 2)”, “Neutral (N., point = 3)”, “Agreed” (A., point = 4) to “Strongly Agreed” (S.A., point = 5). The combined-feedback questionnaire contained 5 items on student perceptions of the effect of the combined feedback types on preferences, performance, motivation, reflection, and pressure. The collected data was analyzed via one-sample t-test to examine whether students’ choices were significantly different. These analyses were conducted using Statistical Package for the Social Science (SPSS v17).

Procedure

The following procedures were employed in this study: (1) SF system usage: before using the learning systems, the students were given a brief instruction for ten minutes. They then used the SF system for twenty minutes. To help students emphasize the observation of different feedback provided by the system, they were asked to do the practical tasks, in which they need to answer a number of multiple-choice questions about the basic concepts of multimedia programing language. (2) Single-feedback questionnaire: The students were asked to fill out the single-feedback questionnaire for ten minutes. (3) CF system usage: as with the SF system usage, the students were asked to use the CF system for twenty minutes to complete the practical tasks. (4) Combined feedback questionnaire: the students were asked to do the multiple-feedback questionnaire for five minutes. These procedures are illustrated in Figure 3.

![Figure 3. Study procedure](image)

Results

Students’ perception of single feedback

Table 1 presents the means of student preferences on single feedback. The results of the one-sample t-tests revealed that the scores for emotion feedback were significantly higher than the normal distribution ($t = 2.982, p < .01$), which implied that students had significant preference for emotional feedback, but did not have obvious preferences for the other two types of feedback.

<table>
<thead>
<tr>
<th>Feedback Type</th>
<th># of S.D.</th>
<th># of D.</th>
<th># of N.</th>
<th># of A.</th>
<th># of S.A.</th>
<th>Mean</th>
<th>t</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level</td>
<td>2</td>
<td>8</td>
<td>28</td>
<td>7</td>
<td>0</td>
<td>2.88</td>
<td>-1.044</td>
</tr>
<tr>
<td>Emotion</td>
<td>1</td>
<td>2</td>
<td>24</td>
<td>16</td>
<td>1</td>
<td>3.32</td>
<td>2.982**</td>
</tr>
<tr>
<td>Dialogue</td>
<td>1</td>
<td>4</td>
<td>28</td>
<td>12</td>
<td>0</td>
<td>3.13</td>
<td>1.354</td>
</tr>
</tbody>
</table>

*Note. **p < .01.*

Table 2 illustrates the means of student helpfulness scores for single feedback. The results of the one-sample t-tests showed that the score for dialogue feedback was higher than the normal distribution ($t = 2.052, p < .05$), whereas the scores of the other feedback types were not. These results implied that dialogue feedback enhanced helpfulness for students.
Table 2. Helpfulness scores for the three feedback types

<table>
<thead>
<tr>
<th>Feedback Type</th>
<th># of S.D.</th>
<th># of D.</th>
<th># of N.</th>
<th># of A.</th>
<th># of S.A.</th>
<th>Mean</th>
<th>t</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level</td>
<td>3</td>
<td>2</td>
<td>24</td>
<td>16</td>
<td>0</td>
<td>3.18</td>
<td>1.48</td>
</tr>
<tr>
<td>Emotion</td>
<td>3</td>
<td>1</td>
<td>24</td>
<td>16</td>
<td>1</td>
<td>3.24</td>
<td>1.976</td>
</tr>
<tr>
<td>Dialogue</td>
<td>4</td>
<td>2</td>
<td>17</td>
<td>21</td>
<td>1</td>
<td>3.29</td>
<td>2.052*</td>
</tr>
</tbody>
</table>

Note. *p < .05.

For motivation, the results and one-sample t-tests did not demonstrate significant differences for each type of feedback (Table 3). This implies that students did not experience enhanced motivation in using the three types of feedback. Table 4 illustrates the means of reflection for single feedback. The one-sample t-tests demonstrated that level and dialogue feedback had statistically significant differences. These results imply that the two feedback types fostered student reflection.

Table 3. Motivation scores for the three feedback types

<table>
<thead>
<tr>
<th>Feedback Type</th>
<th># of S.D.</th>
<th># of D.</th>
<th># of N.</th>
<th># of A.</th>
<th># of S.A.</th>
<th>Mean</th>
<th>t</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level</td>
<td>3</td>
<td>3</td>
<td>23</td>
<td>15</td>
<td>2</td>
<td>3.18</td>
<td>1.386</td>
</tr>
<tr>
<td>Emotion</td>
<td>4</td>
<td>1</td>
<td>24</td>
<td>14</td>
<td>2</td>
<td>3.20</td>
<td>1.459</td>
</tr>
<tr>
<td>Dialogue</td>
<td>3</td>
<td>4</td>
<td>22</td>
<td>14</td>
<td>2</td>
<td>3.18</td>
<td>1.308</td>
</tr>
</tbody>
</table>

Table 4. Reflection scores for the three feedback types

<table>
<thead>
<tr>
<th>Feedback Type</th>
<th># of S.D.</th>
<th># of D.</th>
<th># of N.</th>
<th># of A.</th>
<th># of S.A.</th>
<th>Mean</th>
<th>t</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level</td>
<td>2</td>
<td>1</td>
<td>15</td>
<td>19</td>
<td>2</td>
<td>3.46</td>
<td>3.376**</td>
</tr>
<tr>
<td>Emotion</td>
<td>3</td>
<td>2</td>
<td>20</td>
<td>14</td>
<td>0</td>
<td>3.15</td>
<td>1.138</td>
</tr>
<tr>
<td>Dialogue</td>
<td>2</td>
<td>0</td>
<td>19</td>
<td>17</td>
<td>1</td>
<td>3.38</td>
<td>3.072**</td>
</tr>
</tbody>
</table>

Note. **p < .01.

In addition, Table 5 shows the means of student pressure for single feedback. The one-sample t-tests showed that the score of level feedback was higher than the normal distribution (t = 2.052, p < .05), whereas the scores of others were not. This result implies that level feedback made the students feel pressure.

Table 5. Pressure scores for the three feedback types

<table>
<thead>
<tr>
<th>Feedback Type</th>
<th># of S.D.</th>
<th># of D.</th>
<th># of N.</th>
<th># of A.</th>
<th># of S.A.</th>
<th>Mean</th>
<th>t</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level</td>
<td>2</td>
<td>3</td>
<td>17</td>
<td>16</td>
<td>1</td>
<td>3.28</td>
<td>2.056*</td>
</tr>
<tr>
<td>Emotion</td>
<td>2</td>
<td>11</td>
<td>18</td>
<td>7</td>
<td>1</td>
<td>2.85</td>
<td>-1.098</td>
</tr>
<tr>
<td>Dialogue</td>
<td>2</td>
<td>6</td>
<td>18</td>
<td>11</td>
<td>2</td>
<td>3.13</td>
<td>0.8676</td>
</tr>
</tbody>
</table>

Note. *p < .05.

Students’ perception of combined feedback

Table 6 illustrates the students’ choices for combined feedback. For helpfulness, motivation, and awareness, the combined feedback of “emotion and dialogue” was the one chosen most by students (34%, 32%, 28%, and 23%, respectively). For pressure, the results show that level (13, 30%) and dialogue (10, 23%) were the models chosen by most students. This suggests that the level and dialogue feedback made students feel more pressure.

Table 6. Student perception of feedback combinations

<table>
<thead>
<tr>
<th></th>
<th>Preference</th>
<th>Helpfulness</th>
<th>Motivation</th>
<th>Awareness</th>
<th>Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level</td>
<td>4 (9%)</td>
<td>7 (16%)</td>
<td>6 (14%)</td>
<td>7 (16%)</td>
<td>13 (30%)</td>
</tr>
<tr>
<td>Emotion</td>
<td>6 (14%)</td>
<td>2 (5%)</td>
<td>4 (9%)</td>
<td>2 (5%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Dialogue</td>
<td>5 (11%)</td>
<td>5 (11%)</td>
<td>5 (12%)</td>
<td>5 (12%)</td>
<td>10 (23%)</td>
</tr>
<tr>
<td>Level and Emotion</td>
<td>6 (14%)</td>
<td>6 (14%)</td>
<td>5 (12%)</td>
<td>6 (14%)</td>
<td>3 (7%)</td>
</tr>
<tr>
<td>Level and Dialogue</td>
<td>4 (9%)</td>
<td>6 (14%)</td>
<td>6 (14%)</td>
<td>8 (19%)</td>
<td>8 (18%)</td>
</tr>
<tr>
<td>Emotion and Dialogue</td>
<td>15 (34%)</td>
<td>14 (32%)</td>
<td>12 (28%)</td>
<td>10 (23%)</td>
<td>9 (20%)</td>
</tr>
<tr>
<td>Level, Emotion and Dialogue</td>
<td>4 (9%)</td>
<td>4 (9%)</td>
<td>5 (12%)</td>
<td>5 (12%)</td>
<td>1 (2%)</td>
</tr>
<tr>
<td>Total</td>
<td>44 (100%)</td>
<td>44 (100%)</td>
<td>43 (100%)</td>
<td>43 (100%)</td>
<td>44 (100%)</td>
</tr>
</tbody>
</table>

In sum, comparing the findings of single feedback with combined feedback shows that: (1) Although level feedback could directly and clearly reveal student status, most students felt this feedback also resulted in more pressure. (2) Because dialogue feedback could describe students’ status in detail, it was regarded as the mode that enhanced helpfulness and reflection. However, dialogue feedback also made students feel more pressure. (3)
Since emotion feedback can show student status in a kindly manner, most students preferred this feedback. In addition, emotion feedback eased the pressure while students learned. (4) Among the combination of multiple feedbacks, the combined feedback of “emotion and dialogue” was the most popular among all of combinations, which implies that “the more, the better” is not always true in the design of interface agent feedback systems.

Discussion

Cognitive and affective impacts

Interface agents are computer-simulated figures that interact with students to enrich their individual learning by acting as social participants (Chou, Chan, & Lin, 2003). From this definition, interface agents are devoted to playing various social roles (e.g., tutor, tutee, companion, motivator, sustainer, goal-setter, reflector, and task facilitator) to interact with students (Chen et al., 2007). Nevertheless, a core part of these social interactions is to communicate and persuade students, which requires student acceptance of agents’ feedback. Such communication is often supported by multimedia technology. For instance, multimedia learning (Mayer, 2009) asserts that optimal learning occurs when visual and verbal information is presented together simultaneously, because students have separate channels to process visual and verbal information. In other words, when visual and verbal forms are linked together, students’ comprehension (Rusanganwa, 2013) can be enhanced, and information can be stored in long-term memory (Kulhavy, Stock, & Kealy, 1993). In addition to the aforementioned cognitive impacts, the development of interface agents should also consider students’ perception from the affective perspective because improving students’ learning performance is insufficient to attract them to use learning systems (Bull & Kay, 2007; Bull & McKay, 2004). Thus, there is a need to provide students with engaging and acceptable learning experiences in interacting with interface agents.

In this study, emotion feedback was the favourite feedback. Students also preferred the combined feedback of emotion and dialogue, rather than the view from the cognitive impacts: “the more, the better.” A possible explanation was that obvious and direct feedback resulted in learning pressure, which affected student preferences. Several previous studies have demonstrated the cognitive impacts of interface agents on student learning (Graesser et al., 2008; Woolf, 2009). This study further clarifies findings from the affective perspective: (1) Although the combination of feedback types has been shown to affect student motivation and performance (Chen, 2012; Chen et al., 2011; Liao et al., 2011), this study examined students’ perceptions for each feedback. The results showed that the emotion feedback was more popular than dialogue and level feedback. (2) Level feedback generated greater learning pressure than the other two feedback types. These findings might be helpful to the further development of interface agents, especially from the affective perspective.

Technological and pedagogical issues

In addition to the development issue of interface agents, it is also important to further interpret the implications of the application of interface agents, especially from the perspectives of advanced technologies and pedagogical strategies. With advanced technologies, the technologies used in constructing interface agents can be quite different. Nevertheless, reviewing the phenomenon of Tamagotchi (Webster, 1998; Pesce, 2000) shows that using which technologies is less important. Instead, whether students can build close relationships with these interface agents is more critical. This is because such close relationships can contribute to human-computer interaction, including enhanced interactivity (Trappi, Petta, & Payr, 2001), social participation (Gulz, 2005), adaption to students’ feelings (Bichmore, 2003; Bichmore & Picard, 2004), and friendship with computers (Stern, 2002). Previous studies have suggested that a set of relations (e.g., tutor-to-tutee, peer-to-peer, mother-to-child, master-to-pet, and gardener-to-plant) can be used to underpin the design of interface agents (Chen & Chen, 2013).

For pedagogical strategies, the results of this study indicated that students preferred emotion feedback, rather than level and dialogue feedback. This conclusion correlates quite well with the central ideas and experience of the System of Emotional-Imaginative Teaching (the EIT-system), which was developed in the 1990s in Russia by Fomichova and Fomichov (Fomichov & Fomichova, 1995; 1997; Fomichova & Fomichov, 1996; 2000) and has been successfully used in practice for at least 25 years (Fomichov & Fomichova, 2012; 2014; Fomichov, 2015). In particular, the practice of using the EIT-system shows that establishing the links between the rules of English grammar and social conventions (such as dress code, etiquette, table manners, behavioral peculiarities) as a part of the world’s conceptual picture of the students makes the process of learning much more personal and, as a result, greatly influences student’s learning achievement and is highly appreciated by the students.
Our study shows that direct and obvious (e.g., level and dialogue) feedback is not welcome, whereas moderate and kind (e.g., emotion) feedback is preferred. Hence, when incorporating pedagogical strategies into interface agents, educational goals should be considered to make good use of different feedback types. The findings of this study further suggest: (1) Although students did not prefer the dialogue feedback, the dialogue feedback can convey information in detail. Thus, the dialogue feedback may be used with emotion feedback to convey information to students. (2) Interface agents can be developed based on the aforementioned relationships, with feedback taking into account the chosen relationships. For instance, animal companions used in this study were developed based on the relationship of master-to-pet. Unlike a strict tutor, animal companions play the role of “companion” in student learning. Thus, the feedback of animal companions should be consistent with the settings of animal companions: moderate in tone, to remind students of their learning status. Other relationships and feedback types should be explored in the future.

Conclusion

This paper answers two research questions. For the first research question (i.e., what are student preferences for interface agent feedback among level, emotion, and dialogue feedback?), the results demonstrated that the emotion feedback was the favourite among the three feedback types, while level feedback resulted in the most pressure among the three feedback types. For the second research question (i.e., what are student preferences for combinations of level, emotion, and dialogue feedback?), the results revealed that the combined feedback of “emotion and dialogue” was the most popular among all combinations of feedback.

The limitations of study suggest areas for further investigation in the future. First, this study is a short-term study on student perceptions of interface agents. The long-term effects remain unclear. Thus, more research is required to examine their consistency. Second, since this study has a small sample size, further investigation with a large sample size is required. Third, this study uses animal companions as an example of interface agents, which cannot reflect the characteristics of other interface agents, although it offers a starting point to investigate their impacts. Thus, a number of different types of interface agents should be examined in future studies. Finally, since students’ preferences will influence their perceived feedback, which could further effect how they acquire knowledge and lead different learning outcomes. Therefore, in the future, students’ learning outcomes should be investigated while they obtain different feedback.

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References


Measuring and Visualizing Group Knowledge Elaboration in Online Collaborative Discussions

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ABSTRACT

Knowledge elaboration plays a critical role in promoting knowledge acquisition and facilitating the retention of target knowledge in online collaborative discussions. Adopting a key-term-based automated analysis approach, we proposed an indicator framework to measure the level of knowledge elaboration in terms of coverage, activation, and equitability. An interactive web-based tool was developed to provide a multidimensional view of students’ knowledge elaboration, allowing teachers to have a real-time, in-depth understanding of students’ mastery of domain knowledge. Using students’ discussion posts as the dataset, a case study was conducted, and the results showed that the proposed methodology was effective in examining group knowledge elaboration in online collaborative discussions.

Keywords

Knowledge elaboration, Collaborative learning, Online collaborative discussions, Visualization

Introduction

In collaborative learning environments, online discussion is an important activity that engages learners in asking questions, articulating their thoughts, explaining and justifying their opinions, and sharing ideas and resources, all of which contribute to meaningful collaborative learning (Li et al., 2009). Knowledge elaboration, as an integral part of online discussion, refers to how learners organize, restructure, interconnect, and integrate knowledge (Reigeluth et al., 1980; Kalyuga, 2009; Gleaves & Walker, 2013), thereby promoting knowledge acquisition and knowledge retention (Anderson, 1983; Denessen et al., 2008; Golanics & Nussbaum, 2008; Stegmann et al., 2012; Zheng et al., 2015).

Researchers have reported that knowledge elaboration has positive effects on group problem-solving (Eryilmaz et al., 2013) and student achievement (Van et al., 2000; Stark et al., 2002; Hwang et al., 2007). However, most previous studies analyzed knowledge elaboration through qualitative manual coding, which involves subjective judgment, and the reliability of dialog analysis schemes also remains a contentious issue (Pilkington, 2001). Because this method is time-intensive and conducted post-event, the information obtained does not offer opportunities for real-time feedback to enhance evaluation, reflection, awareness, and adaptation of collaborative learning (Kumar et al., 2010). Besides, the analysis results are meaningful mainly for researchers; it is difficult for teachers to interpret the data and to provide timely intervention or assistance during students’ collaborative discussions (Xing et al., 2015). Visual representation based on automatic analysis can translate learner-generated data into an accessible visible form that highlights important features, including commonalities and anomalies. Such analysis has been considered as a key to gaining insight into the learning process and providing a basis to better monitor and evaluate students’ learning (Papamitsiou & Economides, 2015). Nevertheless, among the studies on knowledge elaboration, very little research has been conducted on visualization support based on automatic analysis.

Therefore, this study proposes an automatic analysis method to measure the level of groups’ knowledge elaboration in terms of three indicators: coverage, activation, and equitability. Taking the method as a basis, an interactive web-based tool is developed to provide a multidimensional view of students’ knowledge elaboration. The tool allows teachers to have an in-depth understanding of students’ acquisition of the target knowledge in a convenient manner, enabling teachers to monitor student’s discussion process and provide adequate feedback on students’ learning.
Literature review

Knowledge elaboration and measurement

Knowledge elaboration positively affects knowledge acquisition, which is an important determinant of students’ satisfaction and motivation (Draskovic et al., 2004). Many researchers have explored the significant roles of knowledge elaboration in online discussion. For instance, after comparing the elaboration differences in four different instructional approaches in multimedia learning environments, Eysink and de Jong (2012) concluded that elaboration is the key process explaining differences in learning outcomes. As for the factors affecting knowledge elaboration, Stegmann et al. (2012) found that the depth of learners’ cognitive elaboration is positively related to both the domain-specific knowledge acquisition and the formal quality of their own argumentation. Paus et al. (2012) also confirmed that elaborating domain-specific concepts can activate processes conducive to learning and promote individual learning outcomes in online discourse.

To study the nature of online group learning, most researchers have adopted a qualitative approach to measure knowledge elaboration. Through discourse analysis, Daradoumis and Marques (2002) investigated how distribution of cognition is transformed and becomes common to all group members in an online collaborative problem-solving situation. Ding (2009) categorized messages in collaborative learning into three types, namely, off-task, on-task, and elaboration, and then further explored different process patterns of knowledge elaboration. Weinberger and Fischer (2006) measured the epistemic dimension of discourse by calculating the frequency of on-task discourse, which is differentiated into construction of problem space, conceptual space, and the relations between conceptual and problem space. Stegmann et al. (2012) operationalized the depth of knowledge elaboration as the duration of cognitive elaboration per proposition, which was calculated by the number of segments coded as cognitive elaboration. Additionally, Paus et al. (2012) differentiated on-task discourse into questions and explanations. They regarded the number of questions, explanations, and words of on-task discourse were regarded as three indicators of conceptual elaboration activities during online discourse.

Although coding schemes can be used to identify knowledge elaboration from different perspectives, researchers have pointed out that judging which messages exemplify which types of speech act is both ambiguous and subjective (Strijbos et al., 2006). Coding schemes are also blamed for ignoring domain knowledge construction, which runs counter to the definition of knowledge elaboration (Zheng et al., 2015). More importantly, because manual coding is a post-event method and results can only be acquired when students finish their collaborative activity, it cannot provide real-time feedback for teachers to monitor the learning process.

Using semiautomatic or automatic analysis methods, some attempts have been made to overcome the methodological limitations of manual coding. Zheng et al. (2015) adopted a graph theory to construct indicators to quantitatively measure the level of knowledge elaboration. Although the value of proposed indicators can be automatically calculated via their analytical tool, it still takes manual coding to segment information flow generated in collaborative learning processes. Hong and Scardamalia (2014) used key terms automatically extracted from different sets of notes to represent and measure group knowledge, which proved the validity and feasibility of using percentages and frequency of shared key terms to measure community knowledge. However, their study failed to reveal the connections among knowledge concepts proposed by the students.

Previous studies have indicated that the conceptual links that students construct in their discussions can reflect the level of their knowledge elaboration (Weinberger & Fischer 2006). More importantly, the connections among knowledge concepts are recognized as fundamental constituents of knowledge structure, acting as illustrative instruments providing access to the current knowledge and the representational state of a group. Therefore, identifying the conceptual links generated in students’ discussions is a way to gain an in-depth understanding of students’ conceptions about complex knowledge domains (Mcclure et al. 1999).

Visualizing online collaborative discussions

Although online collaborative discussion generates large corpora of discourses for teachers and researchers to observe how students process information, it still poses a challenge concerning how to analyze and make sense of these data (Law et al., 2011). Previous studies have demonstrated that visual representation has potential value in inducing a more direct observation of what is happening inside groups (Calvani et al., 2010), perceiving implicit aspects of raw data, supporting teachers’ awareness of collaboration process (Papamitsiou & Economides, 2015), and leading to flexible instructional interventions (Dönmez et al., 2005).
Various attempts have been made to provide visual tools that offer information for teachers to act upon in real time. Calvani et al. (2010) developed Forum Plus, a module for gathering the interaction data of each group and representing them on a radar graph to obtain an immediate idea of the group’s effectiveness. Similarly, based on activity theory, Xing et al. (2015) designed a web-based visual tool to present the assessment results of groups’ collaborative learning. Although these visual tools have potential value in easing teachers’ burden of understanding the information, they cannot present procedural information on students’ knowledge elaboration.

From a time-series perspective, Goggins et al. (2015) developed a visualization tool to show a process-oriented automatic formative assessment of group learning so that instructors can understand how group collaboration evolves and varies over time. Additionally, Law et al. (2011) identified indicators based a number of Knowledge Forum corpora and provided visualization of the time sequence of the coded discourses in thread structures over time. Juan et al. (2009) developed a tool which facilitates the automatic generation of weekly monitoring reports derived from data contained in server log files. These reports provide online instructors with visual information regarding students’ and groups’ activity, thus allowing more efficient monitoring of students’ and groups’ progress and performance in e-collaborative scenarios. However, most studies focused on students’ superficial behavioral information instead of the quality and level of students’ online discussion. Hong and Scardamalia (2014) constructed a key-term tag cloud to help visually represent the shared key terms in the students’ discussions, yet simple consideration of the frequency of key terms could not convey a complete understanding of students’ discussions. The authors advocated that this key-term tool be further enhanced to visualize collaborative learning processes and promising ideas, after which, they argued, it would be very useful for teachers and learners.

To overcome the aforementioned methodological limitations, this study aims to further explore the automatic approach to measure and visualize students’ knowledge elaboration. This study was guided by the following two research questions:

- Are the proposed multi-dimensional indicators valid in measuring the levels of knowledge elaboration in student groups’ collaborative discussion?
- Can the web-based visual tool provide a useful and easily handled representation of groups’ knowledge elaboration levels so as to assist instructors in detecting potential problems in collaborative discussions?

**Key-term-based automatic measurement of knowledge elaboration**

Knowledge elaboration is a process of expanding and refining new information via organizing, structuring, and connecting the prior knowledge (Ding et al., 2011). In the course of elaborating knowledge, students not only construct a new understanding of their knowledge, but also enrich and expand their knowledge structures. The knowledge structure constructed by students is a representation of how they organize their knowledge concepts and identify the relations between them (Day et al., 2001; Engelmann & Hesse, 2011). It provides a valuable source of information that taps into both the content and organization of students’ knowledge (Mcclure et al., 1999). Further, researchers have pointed out that examining students’ knowledge structures in real time is an important means of measuring their levels of knowledge elaboration (Day et al., 2001; Kalyuga, 2009).

Evaluating students’ knowledge structure in a specific task domain usually entails judgments about the similarity of the structure to the knowledge structure provided by experts. Since experts’ organization and comprehension of domain knowledge closely approximate the true representation of that domain, the similarity to an established expert structure can be considered as an indicator for measuring the level of knowledge elaboration and acquisition (Day et al., 2001; Clariana et al., 2009). This similarity is often operationalized by calculating the ratio of the number of mutually shared concepts between the two structures divided by the total number of concepts (Hong & Scardamalia, 2014; Clariana et al., 2009; Xu et al., 2016; Goldsmith & Davenport, 1990). Higher frequency of the use of concepts concerning domain knowledge shows that students expends more effort in knowledge elaboration (Hong & Scardamalia, 2014).

Besides independent knowledge concepts, the linkages among the different knowledge concepts constructed by students are also critical for measuring their knowledge structures (Goldsmith & Davenport, 1990; Clariana et al., 2009). The number of mutually shared conceptual linkages between students’ knowledge structures and experts’ structures is associated with the level of students’ knowledge elaboration (Zheng et al., 2015). Additionally, equitability has been used as an indicator representing whether all members participate to a similar degree without monopolizing behavior, in collaborative learning (Calvani et al., 2010; Li et al., 2007). Similarly, the equitability of discussion of the target knowledge concepts and linkages between them is also an important factor for examining the balance of groups’ elaboration of the knowledge concerning the specific task domain.
Based on the aforementioned discussion of approaches and indicators to evaluate knowledge elaboration, this study proposes a multidimensional framework to quantify different facets of student groups’ knowledge elaboration. Three main dimensions derived from the properties of knowledge structure were identified, namely, coverage, activation, and equitability.

**Indicators to measure knowledge elaboration**

**Coverage**

Coverage refers to the scope of students’ discussion of the topic-specific knowledge. Higher coverage means that the students have fully elaborated their knowledge during the collaborative discussion process. Herein, coverage is examined by measuring the coverage of key terms (CKT) and the coverage of key terms linkages (CKTL). The two indicators can be calculated by formula (1) and formula (2), respectively.

\[
CKT = \frac{\bigcup_{1 \leq j \leq N} (T_i \cap T_j)}{K}
\]  

(1)

Where \(N\) denotes the total number of members in a group. \(T_i\) denotes the set of key terms mentioned by member \(i\) in all his/her posts, which can be represented as \(T_i = \{\text{term}_1, \text{term}_2, \ldots\}\). \((T_i \cap T_j)\) denotes a set of the shared key terms discussed both by member \(i\) and member \(j\). \(\bigcup_{1 \leq j \leq N} (T_i \cap T_j)\) indicates the set of shared key terms of a group, denoted as \(ST\). \(K\) represents the total number of key terms provided by teachers.

\[
CKTL = \frac{\bigcup_{1 \leq j \leq N} (R_i \cap R_j)}{L}
\]  

(2)

Where \(N\) denotes the number of members in a group. \(R_i\) denotes a set of the key-term linkages involved in all posts of member \(i\), represented as \(R_i = \{<\text{term}_1, \text{term}_2>, <\text{term}_3, \text{term}_4>, \ldots\}\). \((R_i \cap R_j)\) denotes a set of the shared key-term linkages contributed both by member \(i\) and member \(j\). \(\bigcup_{1 \leq j \leq N} (R_i \cap R_j)\) indicates the set of shared key-term linkages of a group, denoted as \(SR\). \(L\) denotes the number of linkages provided by teachers.

**Activation**

Activation represents the intensity of elaboration of target knowledge. Higher activation indicates that students show a deeper understanding of topic-specific knowledge in the process of collaboration. Herein, activation is captured through measuring the activation of key terms (AKT) and the activation of key-term linkages (AKTL). The two indicators can be calculated by formula (3) and formula (4), respectively.

\[
AKT = \sum_{i=1}^{N} \sum_{t=1}^{ST} \frac{FT_{it}}{K}
\]  

(3)

Where \(N\) denotes the total number of members in a group. \(ST\) indicates the set of shared key terms of a group. \(FT_{it}\) denotes the frequency of key term \(t\) mentioned by member \(i\) in all his/her posts. Key term \(t\) belongs to \(ST\). \(K\) denotes the total number of key terms provided by teachers.

\[
AKTL = \sum_{i=1}^{N} \sum_{l=1}^{SR} \frac{FR_{il}}{L}
\]  

(4)

Where \(N\) denotes the total number of members in a group. \(FR_{il}\) denotes the frequency of key-term linkage \(l\) involved in all posts of member \(i\). Key-term linkage \(l\) belongs to \(SR\). \(L\) denotes the number of linkages provided by teachers.
Equitability

Equitability is an indicator to examine whether the target concepts are equally elaborated. It indicates whether or not the content of the student’s discussion evenly covers the target knowledge. Herein, standard deviation is used to depict the degree of knowledge equitability. Lower standard deviation value indicates a more balanced discussion, while higher deviation value means that some target knowledge is processed intensively, but other knowledge may be neglected. In this study, equitability refers to the equitability of key terms (EKT) and the equitability of key-term linkages (EKTL). The two indicators can be calculated by formula (5) and formula (6) respectively.

$$EKT = \frac{AKT}{\sqrt{\frac{1}{K} \sum_{i=1}^{n} (GT_i - AT)^2}}$$  \hspace{1cm} (5)

Where $GT_i$ denotes the frequency of shared key term $i$ mentioned in a group’s discussion. $AT$ denotes the average frequency of all the shared key terms mentioned in a group’s discussion. The denominator is the standard deviation of the frequency of a group’s key terms. In order to make the value of equitability of key terms be a positive value, we divide $AKT$ by the standard deviation value.

$$EKTL = \frac{AKTL}{\sqrt{\frac{1}{L} \sum_{l=1}^{n} (GR_l - AR)^2}}$$  \hspace{1cm} (6)

Where $GR_l$ denotes the frequency of shared key-term linkage $l$ mentioned in a group’s discussion. $AR$ denotes the average frequency of all the shared key-term linkages mentioned in a group’s discussion. The denominator is the standard deviation of the frequency of a group’s key-term linkages. In order to make the value of equitability of key-term linkages be a positive value, we divide $AKTL$ by the standard deviation value.

Method of key-term extraction

Teachers are required to construct a knowledge structure via an authoring tool. The knowledge structure consists of concepts and linkages between concepts, which summarize the key terms expected to be discussed by students during collaborative learning activities. Taking the knowledge structure as a benchmark, students’ discussion posts are processed to extract meaningful key terms and identify the linkages between key terms to examine students’ knowledge elaboration.

Key terms were extracted and compared in the following steps. First, each student’s posts were preprocessed by (a) splitting Chinese words using open-source software ICTCLAS (Zhang et al., 2003) and (b) replacing the similar key terms by referring to a list of synonyms. Second, we extracted the key terms according to the knowledge map provided by the teachers. Meanwhile, we identified the co-occurrence of any two key terms in one sentence. Clariana et al. (2009) reported that the sentence can be regard as a meaningful unit to measure the relationship between key terms, and herein we adopted this method to identify the linkage between key terms. Third, comparison between any two students’ posts was performed to identify shared key terms and linkage between key terms within one group. Following that, the frequency of shared key terms and linkages between key terms was computed and recorded in an adjacent matrix. Based on the adjacent matrix, indicators were computed to determine the knowledge elaboration of a group. Figure 1 shows an illustrative example of the adjacent matrix.

In Figure 1. $GT_i$ ($i=1,2,..n$) denotes the frequency of shared key term $T_i$ in a group. $GR_{ij}$ (0<i<j<n+1) represents the frequency of shared linkage between $T_i$ and $T_j$. If $GR_{ij}$ equals zero, it means that there is no linkage between $T_i$ and $T_j$. 

95
A case study

Participants

Two cohorts of second-year undergraduate students at a comprehensive university in northern China participated in the study. Altogether, there were 157 students, of whom 105 were female and 52 were male. Students’ age ranged from 18 to 20 (M = 19, SD = 0.78). All of the participants majored in educational technology and had a basic knowledge of computer programming. The participants were randomly assigned by the instructor to groups of five or six.

Context

The context of this study was a compulsory course named “Data Structure” and this 18-week course was delivered with a blended learning mode. Each week, instructors and students were scheduled to meet for a two-hour face-to-face lesson in a traditional classroom and a two-hour online learning activity of programming in a computer laboratory. As for the programming activities in the computer laboratory, students were encouraged to communicate online about the given task, although they were able to meet face-to-face. Utilizing the Moodle platform (Cesareni et al., 2015) as a collaborative learning tool, the instructor designed four problem-solving tasks on different topics, namely collection bidding, cipher decoding, tour guiding, and campus planning.

Procedure

In each task, before the collaborative problem solving process, students were required to learn the materials by themselves and collect information related to task. Then, by clicking on a topic link, students could enter the topic page to view the discussion messages and post responses. Group members conducted online discussion within the Moodle forum until they came to a final solution. In order to achieve agreement, members of each group could ask questions, share ideas, and even debate with each other in Moodle. Students were required to post and edit their solutions of each task collaboratively on the wiki tool. The data collected for analysis in this research included information concerning what was said in each post, the time when the message was posted, and who participated in the discussion. Each task lasted two hours, and the number of posts generated in each task ranged from 19 to 167.

It should be noted that, to avoid potential interference, each group had an assigned space which was not accessible to other groups. The instructor provided no intervention except the description of the task and presentation of relevant learning materials.

Results

Indicator validation

Using the key-term extraction method mentioned above, we selected the discussion posts on the first activity as a sample to automatically compute the values of the six indicators. Table 1 shows values of six indicators. In the table, CKT represents coverage of key terms; AKT represents activation of key terms; EKT represents equitability of key terms; CKTL represents coverage of key-term linkages; AKTL represents activation of key-term linkages; and EKTL represents equitability of key-term linkages.
Previous research has conducted model validation by comparing automatic analysis with experts’ rating (e.g., Li et al., 2013; J. Zhang et al., 2007). Likewise, an alternative validation method was adopted in our study. We used human raters to evaluate groups’ online discussion in terms of to what extent their discussion covers the target knowledge and contributes to the problem-solving, and compared this evaluation results with corresponding values of the automated analysis. Two instructors teaching data structures were asked to rate the quality of groups’ online discussion into five levels. The five levels and their descriptions are shown in Table 2.

Table 2. Five levels for evaluating groups’ discussion

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Fully covers the target knowledge; finds the solution to the task</td>
</tr>
<tr>
<td>4</td>
<td>Covers the majority of the target knowledge; finds the task solution but some details are inaccurate</td>
</tr>
<tr>
<td>3</td>
<td>Covers some of the target knowledge; presents task solution with noticeable errors</td>
</tr>
<tr>
<td>2</td>
<td>Covers only a very limited range of the target knowledge; fails to find the task solution</td>
</tr>
<tr>
<td>1</td>
<td>Fails to address the task; answer is completely unrelated to the task</td>
</tr>
</tbody>
</table>

To evaluate the groups’ online discussion, raters must browse all the posts that the groups posted. After each rater submitted his/her scores, we tested the reliability of the raters by looking at their inter-rater reliability. The Spearman’s rho correlation coefficient was 0.755 ($p < .01$), which is sufficiently high.

In Table 3, we report the descriptive statistics for the full sample. QOD represents the quality of groups’ online discussion by the raters. The analysis indicated that CKT ($r = 0.54$, $p = .002$), AKT ($r = 0.63$, $p = .000$), CKTL ($r = 0.48$, $p = .006$), AKTL ($r = 0.64$, $p = .000$) and EKTL ($r = 0.36$, $p = .046$) were positively correlated with QOD. However EKT was not significantly correlated with QOD. This implies that five indicators, namely CKT, AKT, CKTL, AKTL and EKTL, can effectively measure students’ levels of knowledge elaboration in online learning communities.

Table 3. Descriptive statistics and Spearman correlations for the full sample

<table>
<thead>
<tr>
<th></th>
<th>CKT</th>
<th>AKT</th>
<th>EKT</th>
<th>CKTL</th>
<th>AKTL</th>
<th>EKTL</th>
<th>QOD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>0.56</td>
<td>3.05</td>
<td>0.71</td>
<td>0.25</td>
<td>0.20</td>
<td>0.47</td>
<td>3.35</td>
</tr>
<tr>
<td>SD</td>
<td>0.14</td>
<td>1.40</td>
<td>0.18</td>
<td>0.17</td>
<td>0.23</td>
<td>0.25</td>
<td>0.92</td>
</tr>
<tr>
<td>Minimum</td>
<td>0.18</td>
<td>0.55</td>
<td>0.79</td>
<td>0</td>
<td>0.10</td>
<td>0.36</td>
<td>1</td>
</tr>
<tr>
<td>Maximum</td>
<td>0.83</td>
<td>5.57</td>
<td>1.08</td>
<td>0.65</td>
<td>1.08</td>
<td>1.10</td>
<td>4.5</td>
</tr>
</tbody>
</table>

Note. *$p < .05$; **$p < .01$.

Visualization of knowledge elaboration

A visualization tool was developed to assist teachers in interpreting the procedural information regarding students’ knowledge elaboration. Taking activity 1 as an example, Figures 2–5 show the general interface and basic functions of this visualization tool. This web-based tool allows teachers to monitor students’ discussions from anywhere and at any time.

Figure 2 shows the general picture of group knowledge elaboration on the five indicators using radar charts. For each radar chart, the blue layer represents the average value of the five indicators among all groups, and the green layer shows the value of the five indicators of the selected group. The wider the green layer expands, the higher the knowledge elaboration level of the selected group. In addition, using check boxes, teachers are able, not only to observe the level of knowledge elaboration of a particular group, but also to compare the knowledge elaboration of different groups.
Figure 2. Overall views of five indicators

Figure 3 shows the mapping between the knowledge terms elaborated by Group 5 and the target key terms. With the check boxes, teachers can select any groups to see to what extent the target key terms are covered in their discussion. The black node (collection) in the middle of the figure indicates the task topic. The green nodes represent the key terms which have already been discussed by the selected group, whereas the red ones stand for the target key terms that have not been dealt with. Additionally, the key-term linkages that have already been established by the group are shown with a thick line. The thin lines between nodes represent key-term linkages that have not been built by the group.

Figure 3. Visualization of knowledge coverage

Figure 4 shows the knowledge activation of each key term of the selected five groups. On the left side of the figure, there is a list of key terms, which contains all target knowledge terms for the task. Using the check boxes, teachers can choose any key terms to examine to what extent they are activated in the discussion. The selected key terms are listed on the x-axis, and the groups are displayed on the y-axis. The number in each cell indicates the frequency of an individual term elaborated by a certain group. Additionally, the different frequencies are represented by a color gradient, where, the colors represent activation levels (low, average, high).

Figure 5 shows groups’ knowledge elaboration equitability on target key terms. The blue column represents the equitability of key terms. As the figure suggests, compared with other groups, Group 9 has the most balanced elaboration in terms of the target knowledge in their collaborative discussion, and other groups, Group 13 in particular, may neglect some target knowledge necessary for solving the problem.
Furthermore, in order to assist a teacher having a direct observation of how groups’ discussion content changes over time, our tool provides graphs from a time-series perspective. As Figure 6 shows, with the check boxes, the tool allows teachers to select, combine, and sequence different key terms. The x axis shows the discussion time, and the y axis shows the selected key terms. The dots with different colors on the timeline demonstrate the keys terms elaborated over time. More importantly, by selecting key terms that are relevant to a subtask of the whole problem-solving task, teachers can understand a group’s discussion process on that specific subtask. Further, when the teacher hovers over a node, the graph will automatically present more detailed information, such as the name of the student who mentioned the key term, the time this key term appeared, and the full message of the post. In this way, teachers can directly analyze the content of students’ posts without looking through them in the forum.

![Figure 4. Visualization of knowledge activation](image1)

![Figure 5. Visualization of knowledge equitability](image2)
Figure 6. Visualization of time series of group discussion process

Discussion

Content analysis has been frequently employed to examine knowledge elaboration in online discussions. To avoid the subjective and time-consuming disadvantages of manual coding, a few attempts have been made to measure group knowledge through automated analysis of the number and frequency of key terms (Zheng et al., 2015; Xing et al., 2015). Likewise, the present study adopted an automated method to examine knowledge elaboration based on six indicators. According to the results of computational experiments, we found that five of the proposed indicators are significantly effective in measuring the level of knowledge elaboration in online learning discussions. The case study showed that groups with similar numbers of posts differed widely in knowledge coverage, activation, and equitability. For example, although the number of posts of Group 2 was almost equal to that of Group 5, there was a significant difference between them in all the five indicators of knowledge elaboration measured in the task. This provides insights for teachers to have a comprehensive and accurate judgment of the quality of students’ discussions, enabling teachers to offer adequate instruction. More importantly, it also confirmed the importance of including the quality of textual content as an indicator when analyzing collaborative discussions (Häkkinen, 2013).

Following Hong and Scardamalia (2014), who found that an automated key-term analysis method failed to address the connection between individual concepts, the current study takes the relationship between key terms into consideration so that further in-depth measurement can be made to investigate group knowledge elaboration in terms of group knowledge structure and the mapping between group knowledge and domain knowledge. This case study revealed that the relationship between the terms constructed by students’ discussions was not equivalent to the domain knowledge structure in terms of either depth or width, though the knowledge terms discussed by student groups displayed wide coverage and deep activation of the domain knowledge. This may suggest that teachers should offer sufficient scaffolds for students to form meaningful linkages among isolated concepts to develop a more complete knowledge structure. Thus, our results point to the beneficial potential of examining the connection between ideas when measuring knowledge elaboration in group discussions (Weinberger & Fischer, 2006; Van et al., 2000).

Despite the advantages of automated analysis, studies have noted that teachers may find it hard to infer meaning and make sense of the results without a technical or analytical background, especially when the number of students is large (Xing et al., 2015). Visual representations of student-generated trace data during learning activities could help teachers explain them intuitively and understand hidden aspects of these data quickly (Papamitsiou & Economides, 2015). The visual tool employed in this study made it possible for instructors to easily obtain information on students’ knowledge elaboration in online group discussions. As can be observed from the radar graphs, indicator values of Group 2 were notably above those of Group 5, which revealed that Group 2 is superior to Group 5 in knowledge elaboration. Further, the value of activation of key terms of Group 2 was higher than average, indicating that this group conducted an in-depth discussion of the key domain knowledge. In addition, this visual tool offers the freedom for tutors to select key terms that they think are important to identify how well they are elaborated by the students. For instance, as shown in the knowledge
activation graph, selected concepts like “stack” and “queue” are more widely-discussed than “Pushstack” and “Stackfull.” This may imply that, with the help of the visualization tool, teachers can easily conduct more focused monitoring of students’ online discussions and provide better-targeted feedback.

Finally, because there is a fundamental problem with using traditional manual coding to demonstrate the dynamic processes of knowledge elaboration (Strijbos et al., 2006; Zheng et al., 2015), this study took a time-series perspective in the visualization tool that can assist instructors in understanding how group discussions develop and vary over time (Goggins et al., 2015). This visualization tool can capture the processual nature of knowledge elaboration, making it accessible for teachers to observe the change of the terms discussed by a selected group over a given time. For instance, in this case study, the time-series visualization figure compared Group one’s and Group five’s elaborations of the six key terms, which are the knowledge required by the problem solving task. It showed that Group 5 displayed low intensity of elaboration, as the dots were scattered in a more sparse and incoherent way. This means that the discussion of Group 5 was irrelevant to the subtask in that period. In this way, teachers can easily observe the time when students start a subtask-specific discussion and monitor whether a group’s discussion is off-topic or not. The tool also helps to understand how the key terms are collaboratively elaborated over time to form a progressively more coherent idea for addressing a problem (Papamitsiou & Economides, 2015).

Conclusions

This study proposes a process-oriented, automatic method to analyze knowledge elaboration in collaborative online learning discussions. Five indicators employed in this study were found to be effective in measuring student groups’ knowledge elaboration in terms of knowledge coverage, activation, and equitability. Adopting a natural language processing approach, this automated key-term analysis not only revealed students’ elaboration of the concepts of specific themes, but also identified the linkages among different concepts. Compared with traditional content analysis based on manual coding, the automatic method increases the reliability and consistency of the results. The automatic method also shows potential value in improving the effectiveness of online instruction, especially for increased class sizes, because it is able to deal with large datasets produced in online learning. Moreover, a user-friendly, web-based visualization tool was developed for the teachers to monitor and evaluate students’ knowledge elaboration processes, enabling teachers to provide in-time scaffolding and feedback. This will be especially beneficial for teachers who do not have adequate knowledge and skills for processing transcripts of online discussions, or when they are facing a large number of groups in online learning environments.

One limitation of this study is that it does not take into account the weighting of different key terms, which may play different roles in the problem-solving tasks. Another limitation is that the visualization tool is not available for students to self-monitor their knowledge elaboration processes. For future studies, more attempts should examine knowledge elaboration by addressing the weighting of different key terms in solving the target problem so that the key-term-based automatic method can better measure and monitor students' knowledge elaboration in collaborative discussion. From a technological perspective, further studies should also be conducted to explore knowledge elaboration through semantic classification of the discourse data generated from large-scale online collaborative learning environments. It is also advised to refine the visual tool to make it accessible for learners as individuals and as members of a collaborative group to reflect on their own knowledge elaboration processes. Additionally, with the visual information, this tool can be used as a meta-cognitive tool that enhances students’ self-regulated learning in the online learning environment.

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The Virtues of Taiwanese Internet-Using Adolescents: The Development and Validation of the Cyber Virtues Scale

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ABSTRACT

Given the importance of cultivating users’ positive behaviors in cyberspace, this study presents a comprehensive vision of how to address important virtues that might foster Taiwanese adolescents’ positive behaviors in cyberspace. In this study, we constructed an instrument—the Cyber Virtues Scale (CVS)—for measuring the underlying dimensions of Taiwanese adolescents’ virtuous behaviors in online settings. Research data were gathered from 607 elementary and junior high school students in different Taiwan’s geographic areas. The CVS model has been empirically validated via exploratory factor analysis. The final version of the CVS consists of 5 core virtues in cyberspace: interpersonal interaction, knowledge accumulation, social justice, information sharing and self-discipline. These results will also strengthen the digital generation by cultivating their positive behaviors in cyberspace.

Keywords

Cyber ethics, Cyber virtues scale, Scale development, Virtue

Introduction

The necessity of virtues’ implementation in Cybersociety

In recent years, the rapid development of information technology has deeply influenced human lives. At the same time, we have seen continual changes in the moral circumstances of communities and individuals. Cyberspace-based society may change adolescents’ virtues and character development in particular (Chang & Chou, 2015; Dillon, 2010). This change may promote moral judgments and behaviors that, in cyberspace, are much different from those in traditional offline societies.

Indeed, McMahon and Cohen (2009) argued that adolescents’ virtues in cybersociety are in great need of improvement mainly because laws governing behavior in cybersociety are both ineffective and unclear for adolescents. In other words, cybersociety seems to have difficulty in keeping up with the quickly advancing Internet world. Thus, when laws or regulations of cybersociety are lacking, personal virtues tend to become people’s main behavioral guidepost. However, adolescents have likely neither developed a comprehensive set of virtues nor reached an adequate level of moral maturity to handle the complicated moral conditions and dilemmas that arise in online spaces (Qi & Tang, 2004; Voiskounsky, 2004). A related issue is whether adolescents can apply their virtues from offline reality to cybersociety.

Users of cybersociety frequently abuse network technology. More specifically, adolescents have many chances to experience or engage in such problematic or unhealthy cyberspace-based behavioral patterns as Internet addiction (Chou, 2001; Tsai & Lin, 2003), Internet hacking, network rumor-mongering (Hanson, 2000; Stafford, Kline, & Dimnick, 1999), cyberbullying (Huang & Chou, 2010; Huang & Chou, 2013), Internet crimes (Selwyn, 2008; Stephens, Young, & Calabrese, 2007), and digital plagiarism (Butakov & Scherbinin, 2009; Ma, Wan, & Lu, 2008). For example, Suler (2004) stated that the “online disinhibition effect” and such Internet attributes like anonymity, disembodiment, and intimacy might encourage people to take greater risks and to act more unscrupulously in online spaces than in offline spaces. Therefore, adolescents are likely to engage in problematic behaviors on the Internet (Orgad, 2007; Selwyn, 2008; Suler, 2004).

Thus, with such changes in social contexts, namely with the rapid rise of cyberspace, one’s criteria for moral judgments may also change. Such transformation of moral judgment criteria contributes to a situation where people’s behavior in cyberspace differs from that in traditional offline societies, thus raises the issue of how society should guide adolescents’ development of moral judgments and moral behaviors in cyberspace (Voiskounsky, 2004). In other words, the implementation of virtues in Internet society is necessary and important (Voiskounsky, 2004; Stephens et al., 2007; Vallor, 2010; Yang, 2006).
The positive aspects of Cybersociety’s values

Past studies seem to focus more on online students’ negative behaviors and these behaviors’ negative effects (e.g., Huang & Chou, 2010; Selwyn, 2008; Stephens et al., 2007). Rather than address the theme of network-based harm, researchers have emphasized the Internet’s positive social functions (e.g., Amichai-Hamburger & Furnham, 2007; Orgad, 2007; Rouis, Limayem, & Salehi-Sangri, 2011; Yu & Chou, 2009). These studies suggest that it is important not to ignore the possible progress that cyberspace can bring about. Thus, more attention should be turned from exploring the Internet’s negative values to exploring its positive aspects. Researchers interested in this objective should explore, promote, and develop users’ individual virtues, which can strengthen the Internet’s positive value for these users. Given the importance of cultivating users’ positive behaviors in cyberspace, this paper presents a comprehensive vision of how to address important virtues that can foster adolescents’ positive behaviors in cyberspace.

Past research on virtues in Cybersociety

The virtues mentioned in the previous investigations have been conceptualized mainly in reference to real society — that is, the offline world. Since cyberspace is a particular social context, we should consider that the content of virtues should be re-examined in the context of cyberspace. Furthermore, many studies indicated the problem of ethical dilemmas that may take place on the Internet (Chang & Chou, 2015; McMahon & Cohen, 2009), and proposed that the character-based of virtue ethics could be a solution. However, there is no consensus on what kinds of virtues should be fostered.

Gray and Tejay (2014) examined five cardinal virtues, Astuteness, Conviction, Rectitude, and Self-Discipline, which influence the ethical behavior of trusted workers and ultimately Information System security. Willard (1997) identified respect as the most important Internet ethics issue that parents and educators must address. He argued that people in cyberspace must respect each other’s privacy and property. Ang and Goh (2010) examined empathy and cyberbullying among 396 adolescents from Singapore and suggested the need for empathy training in reducing cyberbullying behavior among adolescents. In addition, Rouis et al. (2011) surveyed 239 undergraduate students and indicated that self-regulation strengthened students’ control over their online social behavior. The above-mentioned studies suggest that virtues critical for cyberspace include respect, responsibility, self-restraint, honesty, law-abidance, equality, care, and philanthropy. However, exploring cyberspace virtues as a research field has not yet taken firm hold among scholars. In this regard, we should rigorously examine which virtues are crucial traits for the digital generation by measuring adolescents’ virtuous behaviors in online settings.

The goal of the current study

In recent years, the issue of virtuousness among adolescents has received heightened attention from educators and parents. Character education focuses on learners’ development of virtues (i.e., moral behaviors and attitudes) (Chang & Chou, 2015; Vallor, 2010). The first step in building this theoretical framework is to identify core virtues and develop valid and reliable measurement tools (Park & Peterson, 2006).

However, how can virtues be objectively measured by self-reported online behavior surveys? The relative researches showed that virtues can be objectively measured via self-reported surveys. Steen, Kachorek and Peterson (2003) indicated virtues as individual differences that exist in degrees. The individual differences can be assessed in ways. Aldridge, Ala’i, and Fraser (2016) developed self-reports of ethnic and moral identity in high schools in Western Australia. Cawley III, Martin and Johnson (2000) developed virtues scale by using a sample of 390 participants and the results support a 140-item self-report measure comprising four factors: Empathy, Order, Resourcefulness, and Serenity. Park and Peterson (2006) developed the Values in Action for Youth (VIA-Youth) which features the comprehensive self-report assessment of the 24 virtues among adolescents. These traditional virtues are widely accepted for offline societies. Because cyberspace is a particular social context, the appropriateness of applying these virtues to cyberspace rightfully remains in doubt.

Chang and Chou (2015) indicated Taiwanese social virtues may not be the same as others around the world. Therefore, the current preliminary study targets Taiwanese young adolescents and the goal is to explore important virtues that can improve experiences in cyberspace, where young adolescents can pursue personal values and social charity. In order to do so, the current study uses an instrument—the Cyber Virtues Scale (CVS)—for measuring underlying dimensions of young adolescents’ virtuous behaviors in online settings. The
CVS may clarify young adolescents’ virtues in cyberspace. The results of this study can be instructive to those who design character education programs.

Method

Item development

Because cyberspace virtues as a research field have not yet been the subject of extensive scholarship (Chang & Chou, 2015), we first probed both possible important virtues among cyberspace-based young adolescents and corresponding behaviors. We surveyed 758 parents and 750 teachers who are experts in the physical and psychological development of young adolescents. Parents and teachers have the educational responsibilities and expectations for young adolescents’ correct behavior and virtues in cyberspace.

We distributed a paper-and-pencil survey questionnaire to teachers and parents of elementary and junior high school students asking “In your opinion, what are important virtues for young adolescents in cyberspace?” The total valid sample that involved nationwide stratified sampling was 1,508, split between 750 teachers and 758 parents. Survey respondents regarded law-abidance (86.2%), respect (77.0%), and self-regulation (74.2%) as three of the most important virtues. Other important virtues identified in this questionnaire were service (49.5%), sharing (47.6%), courtesy (43.0%), honesty (42.8%), responsibility (41.5%), lifelong learning (39.7%), care (37.2%), justice (35.3%), and cooperation (34.3%). These 12 virtues all earned more than one-third of the teachers’ and parents’ support and were chosen as important and needed by students in cyberspace. In order to generate the Cyber Virtual Scale (CVS) items based on these 12 virtues, we adapted the items of the Values in Action for Youth (VIA-Youth) which were created from Park and Peterson’s corresponding instrument. The Internet ethics and virtues were created from Gray and Tejay (2014), and Willard (1997). Empathy and cyberbullying were created from Ang and Goh (2010) and self-regulation and online social behavior were created from Rouis et al. (2011). We created draft items of the CVS.

Furthermore, we organized an expert focus group comprising one university faculty member of education, two doctoral students who major in education, and one senior elementary school teacher. All members of the focus group were experts on Internet literacy or moral education. The experts held detailed discussions on the CVS draft items. Finally, we developed a preliminary set of 64 CVS items on the basis of the focus-group experts’ discussions. Using a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree), we then constructed these items in the form of a self-report questionnaire for the student survey.

Research participants

The target participants were all Taiwanese elementary and junior high school students. A total of 635 paper-and-pencil questionnaires were distributed to stratified sampled 5th–9th graders according to Taiwan’s geographic areas (i.e., north, central, south, and remote environments). A total of 607 valid sets of data were obtained (95.59%): 88 (14.50%) from the 5th graders, 226 (37.23%) from the 6th graders, 80 (13.18%) from the 7th graders, 141 (23.23%) from the 8th graders, and 72 (11.86%) from the 9th graders. Of all the students, 308 (50.74%) were male and 299 (49.26%) were female.

Results

In order to check the validity and reliability of the CVS’s structure, we conducted an item analysis and an exploratory factor analysis (EFA). The data were analyzed using SPSS 19.0. Before conducting the EFA, we examined descriptive statistics of 64 items to ensure their appropriateness as measurement items. The descriptive statistical analyses showed that the mean scores of all items ranged from 2.73 to 4.20, on a 5-point Likert scale. The standard deviations ranged from 1.07 to 1.47. There were no items found with extreme means (close to either 1 or 5) in the CVS. For the factor analysis, we examined skewness and kurtosis, finding that the skew and kurtosis indices ranged from -1.23 to 0.28 and -1.33 to 0.83 respectively. Therefore, the data in this study were univariate normal (Kline, 2005). In this study, the critical ratio ranged from 6.57 to 18.31 for 53 items out of a total of the CVS’s 64 items. Because the critical-ratio standards for the remaining 11 items were all below 4, those 11 items were eliminated as inappropriate items (Huck, 2012). As for the test of homogeneity, the results of the corrected item-total correlation were between 0.41 and 0.69.
In our study, the value of Kaiser-Meyer-Olkin (KMO) was 0.92, suggesting that the application of a factor analysis would be appropriate. Bartlett’s Test of Sphericity yielded a Chi-Square value of approximately 4820.847 ($p < .000$), which means that the correlation matrix of data for a factor analysis would be appropriate. The CVS had a five-factor structure accounting for 57.249% of the total variance. Thus, 28 items with loadings less than 0.40 were deleted from the original 53 items, since Stevens (1992) recommended interpreting factor loadings with a value greater than 0.40. The final version of the CVS consisted of 25 items in 5 factors: interpersonal interaction (six items including etiquette, respect and responsibility), knowledge accumulation (four items including learning and cooperation), social justice (six items including service and justice), information sharing (five items including sharing and caring), and self-discipline (four items including self-control and honesty). We defined the factors according to the shared meaning of each collection of gathered items. We categorized these items by virtues. Throughout the process, a co-author of this study acted as an independent researcher, scrutinizing the identified categories to enhance the truthfulness and consistency of the factors’ name. Table 1 shows the CVS’s sub-scales (factors) and each item’s factor loading.

<table>
<thead>
<tr>
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**Interpersonal interaction (Cronbach’s alpha = 0.827)**

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**Social justice (Cronbach’s alpha = 0.802)**

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**Information sharing (Cronbach’s alpha = 0.787)**

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**Knowledge accumulation (Cronbach’s alpha = 0.799)**

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**Self-discipline (Cronbach’s alpha = 0.738)**

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**Percentage of variance**

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*Note.* Overall $\alpha$=0.906. Total variance explained is 57.249%.
The reliability coefficient, Cronbach’s alpha, is an estimate of the internal consistency of a scale’s items, measuring the extent to which item responses obtained at the same time correlate highly with each other. The 25-item instrument had a very high reliability of .906, which exceeds the minimum standard of 0.80 suggested for basic research (Carmines & Zeller, 1979). The reliability of each factor was as follows: interpersonal interaction, .827; knowledge accumulation, .799; social justice, .802; information sharing, .787; and self-discipline, .738.

To determine the relationships of the scale factors, correlation analysis was conducted, and the correlations between the scores of the factors were found to be significant and within the range of .227-.580. Table 2 shows that the lowest correlation was observed between the factors “Self-discipline” and “Information sharing” (r = .227, p < .01), and the highest correlation was observed to be between “Knowledge accumulation” and “Information sharing” (r = .580, p < .01).

<table>
<thead>
<tr>
<th>Factors</th>
<th>Interpersonal interaction</th>
<th>Social justice</th>
<th>Information sharing</th>
<th>Knowledge accumulation</th>
<th>Self-discipline</th>
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<tbody>
<tr>
<td>Interpersonal interaction</td>
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<tr>
<td>Social justice</td>
<td>.435**</td>
<td>.554**</td>
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<tr>
<td>Information sharing</td>
<td>.378**</td>
<td>.490**</td>
<td>.580**</td>
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<tr>
<td>Knowledge accumulation</td>
<td>.474**</td>
<td>.380**</td>
<td>.227**</td>
<td>.443**</td>
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<tr>
<td>Self-discipline</td>
<td>.511**</td>
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*Note. **p < .01.

Discussion

For the current study, we have created a CVS to probe young adolescents’ practice of virtues in cyber contexts. We conducted an exploratory factor analysis to identify possible exemplary-behavior items as distinct factors, to enumerate these factors, and to ensure CVS-construct validity (i.e., the deletion of invalid items). The results of a series of statistical analyses left 25 statements corresponding to a total of five factors. These five dimensions encompass the core virtues of cyberspace in Taiwanese students.

CVS is a pioneering questionnaire that explores the scope of young adolescents’ virtues in cyberspace: young adolescents’ self-reported data about cyberspace indicates that the higher a CVS score, the greater the number of self-reported virtuous behaviors. There are many similar self-reported surveys for measuring virtues (Cawley III et al., 2000; Peterson & Seligman, 2004; Steen et al., 2003). The CVS could objectively measure online behavior by self-reported surveys too.

This study defined five factors as core virtues for cyberspace. The finding is similar to findings in the studies of Willard (1997), Milson and Chu (2002), and Stephens et al. (2007). These studies identified similar civic virtues for netizenship.

Moreover, the studies identified several core virtues that were also important in both cyberspace and positive psychology. For example, the meaning of “love of learning,” as listed by Peterson and Seligman (2004), share the same spirit as in the core concept of “knowledge accumulation” in the CVS. In our study, we propose that interpersonal interaction can promote mercy, and that courage and integrity can make it easier to pursue justice. Finally, the implied meaning of “self-regulation” (Peterson & Seligman, 2004) as well as the “self-discipline” in the current study.

Why should Taiwanese young adolescents have these five core virtues in cyberspace, and what is the significance of these five core virtues for cyberspace? First of all, young adolescents should have the virtues of interpersonal interaction when interacting with others on the Internet, such as etiquette, respect and responsibility. The virtues of interpersonal interaction refer to one’s consideration for others. Internet users should understand that others will treat them with the same attitude, for example, with polite behavior or well-mannered practice.

This study found that knowledge accumulation is one of the core virtues in cyberspace. However, past research indicated that most students have treated the Internet more as a toy for entertainment or merely a tool for information seeking and searching (Chou, Yu, Chen, & Wu, 2009). Young adolescents often seem to ignore the learning advantages attributable to the Internet, which not only has the merits of reduced temporal and spatial
constraints, but also promotes exploration, collaboration, community, sharing, authenticity (Kearsley, 2000). The Internet may become a tool of thinking and knowledge management, and moreover become a place of creation and knowledge sharing.

Milberry (2006) considered that creating a public and democratic space is very important, whether in real society or in cyberspace. The Net generation might bravely challenge the inherent power inequities in cyberspace. As mentioned above, the Internet has the distinguishing feature of de-contextualization, which therefore might lessen the presence of users’ gender, age, race, and social status. The relationships among users should theoretically be on a highly equal basis. Thus, people might more easily promote or practice social justice in cyberspace. Amichai-Hamburger and Furnham (2007), and Bao and Xiang (2006) pointed that justice and care may be more easily achievable in cyberspace. Young adolescents should realize that every Internet user can change cyberspace by caring about others, helping the disadvantaged and taking part in public affairs.

Information sharing is an act of making something available to others. Information and communication technology (ICT) can be used more easily to share knowledge, information and data once the temporal and spatial barriers between Internet users are lowered. Aigrain (2012) stated that the sharing of digital works without direct or indirect monetary transactions is valuable. Therefore, young adolescents should abide by the concept of information sharing when interacting with others in cyberspace. Online users will have rich information to share at little cost. If the digital generation widely accepts the virtue of information sharing, the Internet would become a place where people can contribute their own knowledge to a collective. However, Aigrain (2012) mentioned that information sharing in cyberspace must be recognized as a legitimate activity. Information sharing has often been beyond the reach of copyright law, so people should simultaneously practice self-restraint and empathy when sharing information. Otherwise, online practices might offend people and even violate intellectual-property law. Therefore, the users should appropriately understand the virtues of sharing to avoid adverse effects.

In cyberspace, the virtue of self-discipline is important as well. Indeed, rules and regulations govern Internet society. Although the anonymity of the Internet has allowed online users to express their opinions with greater freedom and with less concern about censorship, individuals on the Internet should ensure that their statements do not violate laws and regulations. Internet users should show self-restraint and refrain from not only harassing other people but also engaging in harmful behavioral patterns like Internet addiction, hacking, and rumor-mongering (Rouis, Limayem, & Salehi-Sangri, 2011). However, not all parents monitor or discipline their children for inappropriate behavior in cyberspace. In addition, addiction to the Internet affects user’s health, academic performance and other inappropriate consequences (Chou, 2001). If the Internet user could show the virtues of self-discipline, they can avoid the harmfulness of the Internet.

Conclusion and recommendations for future research

In this study, we found that the CVS consists of five core virtues in cyberspace: interpersonal interaction, knowledge accumulation, social justice, information sharing and self-discipline. We recommend that educators should focus on these core virtues and guide young adolescents to practice them in cyberspace. The CVS is to measure adolescents’ behaviors on Internet, and the behaviors are not limited to the use of a specific technology device. For example, the incidents of cyberbullying take place using a computer, laptop or other devices are inevitably about virtuous behaviors, involving interpersonal interaction or social justice. Thus, the CVS is applicable to measuring Internet behavior regardless of the technology equipment used.

This study has revealed several limitations that should be addressed in future research. First, this study focused only on the core values of Taiwanese society. These core values may not be applicable to other cultures. Second, all target participants in this study were elementary and junior high school students. In order to investigate more grade-level differences among students’ virtues and related behaviors, future research may consider involving a wider swath of participants encompassing, for example, senior high school students and college students. Third, the CVS is a self-report scale. We should notice the possible influence posed by social desirability and need to do more studies exploring the incremental validity of the CVS. Finally, the present study has used an exploratory factor analysis. Future research may consider a confirmatory factor analysis (CFA), to confirm the existence of five dimensions in the CVS model.

In conclusion, the development of the CVS here should enable teachers and parents to reconsider young adolescents’ conception and practice of Internet virtues and to provide better guidance in these areas. It is our hope that, if educators successfully help cultivate these virtues, (1) student-age children will change their
attitudes and behaviors in cyberspace so that cyberspace as a whole will evolve in a positive direction and (2) young adolescents will have a more positive and meaningful cyber life.

Acknowledgments

This research was supported by the Ministry of Science and Technology of Taiwan (Project No. MOST 102-2511-S-009-002-MY4). The authors would also like to thank the anonymous reviewers for their insightful feedback.

References


Utilizing Learners’ Negative Ratings in Semantic Content-based Recommender System for e-Learning Forum

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*Corresponding author

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ABSTRACT

Nowadays, most of e-learning systems embody online discussion forums as a medium for collaborative learning that supports knowledge sharing and information exchanging between learners. The exponential growth of the available shared information in e-learning online discussion forums has caused a difficulty for learners in discovering interesting information. This paper introduces a novel recommendation architecture that is able to recommend interesting post messages to the learners in an e-learning online discussion forum based on a semantic content-based filtering and learners’ negative ratings. We evaluated the proposed e-learning recommender system against exiting e-learning recommender systems that use similar filtering techniques in terms of recommendation accuracy and learners’ performance. The obtained experimental results show that the proposed e-learning recommender system outperforms other similar e-learning recommender systems that use non-semantic content-based filtering technique (CB), non-semantic content-based filtering technique with learners’ negative ratings (CB-NR), semantic content-based filtering technique (SCB), with respect to system accuracy of about 57%, 28%, and 25%, respectively. Furthermore, the obtained results also show that the learning performance has been increased by at least 9.84% for the learners whom are supported by recommendations based on the proposed technique as compared to other similar recommendation techniques.

Keywords

E-learning recommender system, E-learning discussion forum, Content-based filtering, Learners’ negative ratings, Latent semantic analysis

Introduction

The emergence of web 2.0 has led to a revolution in education industry where interactive e-learning systems show fast and significant growth world-wide. Nowadays, interactive e-learning environments utilize online discussion forums as a medium for collaborative learning that supports knowledge sharing and information exchanging between learners that have different knowledge levels. Shana (2009) asserted that using online discussion forums as an instructional tool improves the students’ learning performance through providing better cognitive and exploratory learning. Furthermore, the idea of utilizing online discussion forums for learning is strongly supported by Social Learning Theory (Bandura, 1977). However, the exponential growth of the available shared information on e-learning discussion forums, as well as the learners’ limited time for studying have caused a difficulty for learners in discovering interesting information that is relevant to their learning context. To overcome this problem, we propose a novel e-learning recommender system that recommends interesting information to the learners, thus save learners’ time and improve their learning performance.

Recommender systems are utilized for personalizing information sources for users by guiding them in a personalized way to interesting items selected from myriad of available options (Lops et al., 2011). Basically, recommender systems are classified into several categories based on the adopted filtering approach (Adomavicius & Tuzhilin, 2005). Content-based, collaborative and hybrid filtering techniques are the most common filtering approaches used in recommender systems. In content-based recommender systems, recommended items are similar to the ones that the user preferred in the past. This approach is effective in filtering items of textual form where each item is represented as a set of keywords that describe it (Lops et al., 2011). Vector space model is considered as one of the widely used algorithms in content-based recommender systems where items in this model are represented as weighted vectors of keywords in the vector space (Turney & Pantel, 2010). The similarity values between items are obtained based on the cosine of the angle between their weighted vectors. In contrast, collaborative recommender systems recommend items based on item’s profile, where the recommended items are similar to the ones that have been preferred by similar users. Nearest neighbor algorithm is one of the most popular methods used in collaborative filtering (Ekstrand et al., 2011). It was first proposed in GroupLens recommender system by Resnick et al. (1994) to filter news articles for users. On the other hand, hybrid recommender systems were emerged to overcome certain limitations in both of content-based and collaborative filtering techniques by combining them using several ways (Adomavicius & Tuzhilin, 2005).
One way to build a hybrid recommender system is by implementing both methods separately and combining their final predictions, while another way can be done by incorporating some characteristics from one filtering approach into another (Burke, 2002).

Unlike recommendations in other domains, recommender systems in e-learning domain should assist learners in constructing their knowledge in a contextualized progressive way rather than acquiring it. Constructivism Learning Theory states that learning is an active and contextualized process of constructing knowledge; thus, it emphasizes the importance of the active involvement of learners in constructing their knowledge in a contextualized progressive way (Fosnot & Perry, 1996). This theory strongly supports the idea of avoiding the information that is relevant to the learner’s previous understandings (i.e., avoiding the negatively rated items), and keeping the recommendations relatively progressive to promote a contextualized and smooth learning process within a given framework or structure. Furthermore, traditional recommender systems usually rely only on users’ positive ratings to suggest recommendations, while in contrast, users’ negative ratings are rarely taken into consideration. Zeng et al. (2011) indicated that negative ratings may play a positive role in recommendation systems especially for very sparse data sets. Their experimental results show that when the user’s positive ratings are insufficient to recommend relevant items, the negative ratings could indicate disfavor or relevance.

The aim of this study is to propose a novel semantic content-based recommender system utilizing learners’ negative ratings in an e-learning discussion forum. The proposed recommender system utilizes learners’ negative ratings to provide active learners with novel recommendations that in turn will increase their learning performance and save their time. Moreover, the proposed recommender system ensures that the recommendations will remain within the current learner’s context. Therefore, we evaluated the proposed e-learning recommender system in terms of recommendation accuracy and learners’ performance. The terms post messages, items, and learning materials are used interchangeably through this research paper.

The remainder of this paper is organized as follows: we first introduce “Related Work” section which discusses the existing works in e-learning recommender systems research. Section “E-learning Recommendation Framework Utilizing Learners’ Negative Ratings” elaborates on a semantic content-based recommendation framework that utilizes learners’ negative ratings in e-learning discussion forum. Next section “Experimentation and Results” presents the data sets used for evaluation, experiments setup, evaluation metrics, and the obtained results. Finally, the last section of this paper introduces the concluding remarks along with suggestions and extensions for future work.

Related work

Recommender systems in e-learning domain are assorted based on the filtering approach and the type of recommended items. A recent survey of recommender systems in e-learning domain has been conducted by Drachsler et al. (2015). It reported that the vast majority of recommender systems in this research field aim to suggest good learning content (i.e., learning materials, discussions, links) where recommender systems that aim to suggest people who can help with a learning activity (i.e., peer learners) are very limited. On the other hand, recent studies in e-learning recommender systems show that knowledge-based recommendation techniques are the most used recommendation techniques by researchers to recommend good learning items in e-learning systems (Wang, 2008; Santos et al., 2014; Capuano et al., 2014; Lu et al., 2015).

Wang (2008) proposed a new method that uses association mining and statistical techniques to contextualize learners’ browsing events based on several contextual factors (i.e., learner’s group relevance, performance relevance, support and confidence). This method was implemented in an e-learning system to recommend learning content based on learner’s browsing history which in turn supports learners in making decisions on what to study next. Capuano et al. (2014) developed a hybrid recommender system prototype and integrated it into a commercial adaptive e-learning system called IWT (Intelligent Web Teacher) to recommend learning goals and generate learning experiences for learners. This hybrid recommendation technique involves three main phases: concept mapping, concept utility estimation and upper level learning goals utility estimation (ULLGs). The ULLGs with the greater utility are recommended to the active learner. Gauth and Abdullah (2011) proposed a recommendation method that uses good learners’ ratings with content-based filtering techniques to recommend good learning materials to learners in a web-based learning system. The learners that scored more than 80% in the post-test were considered as good learners and their ratings were used to rate recommendations to other learners. Dwivedi and Bharadwaj (2013) introduced a trust-aware recommendation framework that recommends trusted learning resources to learners in an e-learning environment. They utilized both the learners’ learning styles and the knowledge levels to elicit trust values among learners and incorporate them with collaborative
filtering techniques to suggest trusted learning resources. Distante et al. (2014) introduced a technique that enhances the navigation of learning content in online forums. They applied information retrieval techniques (i.e., topic models and formal concept analysis) to semi-automatically extract topics and hierarchical relations between them from the learning forum to associate them to posts and discussion threads based on similarity score basis. Abel et al. (2010) proposed a general-purpose semantic web service based recommendation framework that encapsulates generic personalization algorithms. This rule-based recommendation framework can be integrated with discussion forums in e-learning environments to suggest appropriate recommendations to learners by selecting different recommendation techniques in a flexible rule-based manner. Li et al. (2009) proposed an e-learning semantic forum based on domain ontology and text mining technologies to facilitate active collaborative learning in e-learning discussion forums. The semantic forum automatically processes posted messages for structural modeling with semantic association to discover special interest groups for topic-centric social context measurement. The proposed approach achieved several distinctive functionalities in the semantic forum (i.e., semantic search, relational navigation and recommendation). Khribi et al. (2009) proposed an automatic personalization approach that recommends learning resources in e-learning platforms based on learner’s recent navigation history. The proposed approach exploits similarities and dissimilarities among user preferences and the content of learning resources by using a range of filtering strategies that based mainly on content-based filtering and collaborative filtering techniques. Dascalu et al. (2015) developed an educational recommender agent that produces two types of recommendations (i.e., suggestions and shortcuts for learning materials) based on collaborative filtering techniques and integrated learning style finder. They introduced shortcuts for learning materials by computing the similarity values based on current user’s profile, while suggestions are computed based on the similarity values among learning materials and other learners with similar learning style. Muñoz et al. (2015) combined users’ context information and expert knowledge to build a semantic intelligent system that provides recommendation services and user profiling features in learning management systems. They created an ontology model called OntoSakai to represent users’ context information. This ontology model consists of four ontologies that represent several areas of the learning process. Their experimental results show that this combination of users’ context information and expert knowledge is able to recommend learning resources that help learners to improve their experiences as well as their academic results.

This review of related research works in e-learning recommender systems domain aims to provide more understanding of the different aspects posed by e-learning recommender systems research to enhance the learning experience. It is obvious from the reviewed research that utilizing recommender systems for learning is very important nowadays due to its efficacy in assisting learners in reaching to interesting information from a huge amount of available options. However, the vast majority of these research works lack the exploitation of the learners’ negative ratings to predict better recommendations. Hence, we propose an e-learning recommendation framework by utilizing the learners’ negative ratings to recommend relevant learning content and to keep the recommendations in the learner’s current learning context.

E-learning recommendation framework utilizing learners’ negative ratings

In this section, we introduce our e-learning recommendation framework, then we present its phases and the processes involved in each phase. However, this section extends our previous work proposed in (Albatayneh et al., 2014) by exploiting and modeling learners’ negative ratings to optimize the quality of recommendations, and to personalize e-learning discussion forums in a way that supports constructive learning.

The framework of the proposed e-learning recommender system involves four phases, as Figure 1 depicts. The recommendation process starts by automatically retrieving all the post messages along with learners’ ratings from the database. Post messages can hold discussions about different topics, answers, articles, or any useful information of textual form that can be considered as learning material. However, the retrieved data enter preprocessing phase which involves two processes: removing stop-words and word stemming. These two processes are performed to prepare the input data which will reduce the processing time needed in next phases. Then, the processed data enter the semantic indexing phase to capture the latent semantics into post messages as well as to reduce the dimensionality in the vector space by performing three main processes. Subsequently, the system models the latent semantics along with learners’ negative ratings to build learner’s profile in the next phase. The learner profile builder process builds the learner’s profile by integrating the semantic-based and the negative rating-based profiles. The recommendation prediction phase uses the learner profile to compute the recommendations. More thorough discussions on the processes in each phase are given in the next subsections.
Figure 1. The overall framework of the proposed recommendation system

Data pre-processing phase

In this phase, the input data (i.e., post messages, learners’ ratings and other contextual data) is retrieved from the database to prepare it for the next phase. This phase involves removing stop-words and word stemming processes. In order to remove stop-words, each post message is parsed and every stop-word (i.e., the words that do not influence the overall meaning of the text, such as: the, is, at, which, he, and etc.), special characters and numbers are removed from each post message. Next process is performed by converting each word in each post message to its root (e.g., “learner” and “learning” will be converted to their root which is “learn”). Among the most popular word stemming algorithms is the one proposed by Porter (1980). The aim of applying these two processes on the input data is to prepare it for the next phases.

Semantic indexing phase

We use Vector Space Model (Salton et al., 1975) to represent post messages, where each post message is represented as an m-dimensional vector, in which each dimension corresponds to a distinct term and m is the total number of terms occurred in a collection of post messages. As the number of distinct terms increase, the dimensionality of the vector space increases too. Therefore, the representation of the post messages becomes more complicated. Moreover, representing post messages by the terms that occur in them could lead to a shortcoming in identifying similar post messages if they happen to use different sets of keywords. Thus, representing post messages based on the latent semantics would enhance the quality of filtering. In this regard, we exploit the Latent Semantic Analysis (LSA) technique to capture the latent semantic structure into post messages. LSA assumes that terms that have similar meanings occur in similar contexts.

However, this phase begins by creating the occurrence matrix which is a huge rectangular matrix where each column represents the terms frequencies vector of a particular post message. Consider a rectangular matrix $A = \ldots$
with each column vector \( A_i \) represents the terms frequencies vector of post message \( i \). If there is a total of \( m \) terms that occur in \( n \) post messages, then we will have an \( m \times n \) rectangular matrix \( A \), and an \( m \)-dimensional vector space. Matrix \( A \) is a sparse matrix since every term does not normally occur in every post message.

Once the occurrence matrix is constructed, we normalize its elements using Term Frequency/Inverse Document Frequency (TF-IDF) weighting algorithm (Salton & Buckley, 1988), where the terms that rarely occur in the post messages are given high weight to reflect their relative importance as shown in equation (1).

\[
w_{i,j} = \frac{f_{i,j}}{\max_z f_{z,j}} \cdot \log \left( \frac{D}{d_i} \right)
\]

Where \( w_{i,j} \) is the weighted frequency value of term \( i \) that occurs in post message \( j \), \( f_{i,j} \) denotes the frequency value of term \( i \) occurring in post message \( j \), \( \max_z f_{z,j} \) is the maximum frequency among all the \( z \) terms that occur in post message \( j \), \( D \) is the total number of post messages, and \( d_i \) is the number of post messages that term \( i \) occurs in them.

Next step is to find a low-rank approximation to the occurrence matrix \( A \) by using a mathematical technique called Singular Value Decomposition (SVD). Given an \( m \times n \) rectangular matrix \( A \), where without loss of generality \( m \geq n \), matrix \( A \) can be decomposed into a product of three other matrices using SVD as defined in equation (2).

\[
A = U \Sigma V^T
\]

Where \( U \) is an \( m \times n \) column-orthonormal matrix whose columns are called left singular vectors, \( \Sigma \) is an \( n \times n \) diagonal matrix whose diagonal elements (i.e., \( \sigma_1, \sigma_2, \ldots, \sigma_n \)) are non-negative singular values sorted in descending order, and \( V \) is an \( n \times n \) orthonormal matrix whose rows are called right singular vectors.

By applying truncated SVD, that is, keeping only the \( k \) column vectors of \( U \) and \( k \) row vectors of \( V^T \) corresponding to the \( k \) largest singular values in \( \Sigma \), and discarding the rest of the matrices as figure 2 depicts, the number of rows is reduced while preserving the similarity structure among columns in the approximate matrix \( \hat{A} \). Consequently, the terms (i.e., dimensions in the vector space) that occur in similar contexts are merged and treated as one component (i.e., semantic concept) in a low-rank semantic vector space, thus mitigate the problems of synonymy and polysemy which in turn enhances the quality of filtering. On the other hand, the factorization process became quicker and more economical in processing time and memory allocation. Equation (3) defines the truncated SVD.

\[
\hat{A} = U_k \Sigma_k V_k^T
\]

In our proposed system, we set the value of \( k \) to 100, which means reducing the dimensionality of the vector space to 100 dimensions. Thus, the post messages are represented as vectors of semantic concepts in a 100-dimensional semantic space. These semantic vectors are used in the next phases to model the learners’ profiles and then to calculate the similarity values.

Modeling phase

This phase involves modeling the negation in the post messages based on the learners’ negative ratings, and creating the learner’s profile which is a conjunction of the negative rating-based profile and the semantic-based
profile. The semantic-based profile is created by combining the vectors of the post messages that a learner has rated positively. These vectors are obtained from the approximate matrix $\hat{A}$ as defined in equation (3). Meanwhile, the negative rating-based profile is created by combining the vectors of the negated post messages (i.e., the post messages that have been rated negatively by a learner).

We define negation in term of vectors orthogonality in the vector space, where the scalar product of two orthogonal normalized vectors (i.e., the cosine of the angle between two orthogonal normalized vectors) equals to zero as shown in Figure 3. Thus, if the normalized vectors of two post messages are orthogonal in the vector space, then they are entirely dissimilar (i.e., they have no features in common). Equations (4 and 5) define the learner’s semantic-based profile vector and negative rating-based profile vector, respectively.

$$q_{S_{r}} = \sum_{i=1}^{[P^+]} P_i^+$$  \hspace{1cm} (4)

$$q_{N_{r}} = \sum_{i=1}^{[P^-]} P_i^-$$  \hspace{1cm} (5)

Where $q_{S_{r}}$ denotes the semantic-based profile vector for learner $r$, $P^+$ denotes the weighted vectors of the post messages that have been rated positively by learner $r$, $[P^+]$ indicates the total number of the weighted vectors of the post messages that have been rated positively by learner $r$, $q_{N_{r}}$ denotes the negative rating-based profile vector for learner $r$, $P^-$ denotes the weighted vectors of the post messages that have been rated negatively by learner $r$, $[P^-]$ indicates the total number of the weighted vectors of the post messages that have been rated negatively by learner $r$.

Let $V$ be a vector space. $q_{S_{r}}, q_{N_{r}} \in V$. Then, for the negative rating-based profile vector subspace $\langle q_{N_{r}} \rangle \subseteq V$, the orthogonal vector subspace is defined as follows:

$$\langle -q_{N_{r}} \rangle = \langle q_{N_{r}} \rangle^\perp = \{v \in V : \forall q_{N_{r}} \in \langle q_{N_{r}} \rangle \text{, } q_{N_{r}} \cdot v = 0 \}$$  \hspace{1cm} (6)

Consequently, we can integrate the negative rating-based profile vector $q_{N_{r}}$ and the semantic-based profile vector $q_{S_{r}}$ by projecting the semantic-based profile vector onto the orthogonal subspace of the negative rating-based profile vector $\langle q_{N_{r}} \rangle^\perp$ to create a single profile that have those features of the semantic-based profile, in which the features of the negative rating-based profile are irrelevant, as defined in equation (7).

$$q_{r} = q_{S_{r}} - q_{N_{r}}$$  \hspace{1cm} (7)

Where $q_{r}$ is the profile of learner $r$ that integrates the features of $q_{S_{r}}$ in which the features of $q_{N_{r}}$ are irrelevant. This profile is used in the next phase to calculate the similarity values between it and the post messages.

![Figure 3. Orthogonal vectors in 3-dimensional vector space](image)

**Recommendation prediction phase**

The recommendation prediction phase involves calculating the similarity values between the learner’s profile and the post messages using cosine similarity measure, and recommending top-$N$ interesting post messages to the learner. Cosine similarity measures the cosine of the angle between the vector of the learner’s profile and the vector of the post message in the vector space. Similarity values ranges from 0 to 1, where the value of 1
indicates the highest similarity between the features of the learner’s profile and the features of the post message. In contrast, the value of 0 indicates that there are no similarities between the features of the learner’s profile and the features of the post message. Equation (8) defines the cosine similarity measure.

\[
S = \cos(q_r, P_i) = \frac{q_r \cdot P_i}{\|q_r\| \|P_i\|} \quad (8)
\]

Where \( q_r \) indicates the weighted vector of learner’s profile for learner \( r \), \( P_i \) indicates the weighted vector of the post message \( i \), \( \|q_r\| \) and \( \|P_i\| \) are the magnitudes of the vectors \( q_r \) and \( P_i \), respectively.

Once the similarity values between the learner’s profile and all unviewed post messages are obtained using equation (8), top-\( N \) similar post messages will be recommended to the learner.

### Experimentation and results

In order to conduct this experiment, we implemented an online discussion forum and integrated it with an e-learning system to enable the learners of different knowledge levels and backgrounds share their knowledge with other learners by making discussions about several topics. Five groups of a total number of 125 bachelor students who were enrolled in computer science program and undertaking operating systems course had participated in this experiment. Each group consists of 25 students from a different section of operating systems course. The first group (G1) comprises the students that used the e-learning system without recommendations. The second group (G2) comprises the students that used the e-learning system with recommendations based on traditional content-based filtering (CB). The third group (G3) comprises the students that used the e-learning system with recommendations based on content-based filtering with learners’ negative ratings (CB-NR). The fourth group (G4) comprises the students that used the e-learning system with recommendations based on semantic content-based filtering (SCB). The fifth group (G5) comprises the students that used the e-learning system with recommendations based on semantic content-based filtering with learner’s negative ratings (SCB-NR).

In order to evaluate the knowledge level of the students from all groups before they start using the e-learning system, they were required to sit for the same pre-test. Then, all the students from all groups were enabled to use the e-learning system, make discussions over the discussion forum and rate the posted messages for three months. When the operating systems course ended (i.e., after three months of using the e-learning system), the students from all groups were required to sit for the same post-test. In order to obtain as reliable results as possible, all the classes (i.e., groups) were taught by the same professor. Furthermore, each of the pre-test and the post-test was conducted online and simultaneously in five different classrooms under a well-monitored condition to rule out the possibility of collaborating between the students from different groups. Each of the two tests contained a set of 50 instructor-made and objective multiple-choice questions, where each question is accompanied by five possible answers in which only one of these answers is correct. Both the questions and their answers were arranged randomly in each student’s test screen, and a button for submitting the answer must be clicked to enable the student to proceed to the next question. The purpose beyond such procedures is to rule out any possibility of cheating between the students, and to make the correct answers hard to be guessed unless the student truly knows them.

However, the obtained results from pre-test and post-test were used to evaluate the students’ learning performance during the course. The students from all groups have posted a total of 10021 messages under 347 different threads on the discussion forum during the course. A total of 100107 ratings were received on all the messages posted by the students from all groups. Figure 4 shows the user interface of the e-learning discussion forum, where the learners can make discussions. Figure 5 shows a screenshot of the top-N recommendations list.

In our experiments, we benchmarked the accuracy of the proposed e-learning recommender system against other similar systems in terms of rating deviation by using Mean Absolute Error (MAE). MAE can be defined as a quantity used to measure how close the predicted ratings are to the actual ratings given by the user (Shani & Gunawardana, 2011). The small value of MAE denotes that the predicted ratings by the recommender system are close to the actual ratings given by the user, thus the accuracy of the recommender system is considered high. MAE is defined in equation (9):

\[
MAE = \frac{1}{n} \sum_{i=1}^{n} |\hat{r}_i - r_i| \quad (9)
\]
Where $\hat{r}_i$ is the predicted rating for item $i$, $r_i$ is the actual rating for item $i$, and $n$ is the total number of items.

Figure 4. User interface of the e-learning discussion forum

Figure 5. Screenshot of the top-N recommendations list
Figure 6. The values of MAE for all recommender systems

Figure 6 depicts the difference between the MAE value of the proposed e-learning recommender system (SCB-NR) and the MAE values of the other three similar systems. The proposed e-learning recommender system has obviously achieved the highest accuracy in term of rating deviation comparing to the other three similar systems, where it has the smallest MAE value that is about 0.26. In contrast to the proposed recommender system which uses semantic content-based filtering technique with learners’ negative ratings (SCB-NR), the recommender system that uses a traditional content-based filtering technique (CB) has the lowest rating deviation accuracy with the highest MAE value which is about 0.61. On the other hand, the recommender system that uses a semantic content-based filtering technique (SCB) has a MAE value of about 0.35 which is close to the MAE value of the recommender system that uses a traditional content-based filtering technique with learners’ negative ratings (CB-NR) where it is about 0.36.

Furthermore, we have evaluated the proposed e-learning recommender system in term of decision-support accuracy to measure its effectiveness in supporting the learners in the process of selecting interesting items from a huge set of available options. Thus, we used three other metrics for this purpose which are Precision, Recall, and F-measure. Equations 10, 11, and 12 define Precision, Recall, and F-measure, respectively.

\[
\text{Precision} = \frac{|\text{relevant items} \cap \text{retrieved items}|}{|\text{retrieved items}|} \quad (10)
\]

\[
\text{Recall} = \frac{|\text{relevant items} \cap \text{retrieved items}|}{|\text{relevant items}|} \quad (11)
\]

\[
F - \text{measure} = \frac{2 \times \text{Precision} \times \text{Recall}}{\text{Precision} + \text{Recall}} \quad (12)
\]

Where Precision is the fraction of retrieved items that are relevant, Recall is the fraction of relevant items that are retrieved. F-measure is the harmonic mean of Precision and Recall. The values of these three measurements range from 0 to 1, where 0 is the worst value and 1 is the best value.

Figure 7. The values of Precision for all recommender systems
Figures 7, 8, and 9 depict the obtained results of Precision, Recall, and F-measure of the proposed e-learning recommender system as compared with the other three similar recommender systems. The proposed e-learning recommender system (SCB-NR) has evidently achieved the highest precision with the expense of recall. In contrast to the proposed system, the recommender system that uses traditional content-based filtering technique (CB) has the highest recall as a consequence of the lowest precision. Furthermore, the recommender system that uses semantic content-based filtering technique (SCB) has achieved a slightly higher precision and recall than the recommender system that uses traditional content-based filtering with learners’ negative ratings technique (CB-NR). However, the F-measure metric compares the harmonic mean of both Precision and Recall for all similar systems to reveal the best system accuracy in term of decision-support. It is obvious that the proposed e-learning recommender system (SCB-NR) has the highest F-measure value, while in contrast, the recommender system that uses traditional content-based filtering technique (CB) has the lowest F-measure value. On the other hand, the recommender system that uses semantic content-based filtering technique (SCB) still outperforms the other recommender system that uses traditional content-based filtering technique with learners’ negative ratings (CB-NR) in term of F-measure. According to the obtained results, it is obvious that the proposed e-learning recommender system (SCB-NR) has achieved the best decision-support accuracy, while in contrast, the recommender system that uses traditional content-based filtering technique (CB) has the worst decision-support accuracy.

In order to study the impact of using different recommendation methods for learning on the learners’ performance in five independent groups, we conducted a one-way Analysis of Covariance (ANCOVA) to determine whether or not there was a statistically significant difference between using these different recommendation methods for learning on the learners’ achievements in the post-test in five independent groups, controlling for the learners’ marks in the pre-test. In this analysis, the independent variable was the group of learners, while the learners’ marks in the post-test was the dependent variable, and the learners’ marks in the pre-test was the covariate.

We assumed the null hypothesis (H₀) for the post-test is that there is no significant difference between the means of marks for the five groups, while in contrast, we assumed the alternative hypothesis (H₁) is that there are at least two group means that are statistically significantly different from each other. The null hypothesis and the alternative hypothesis are defined as follows:
H₀: μ₁ = μ₂ = μ₃ = μ₄ = μ₅
H₁: There are at least two group means that are statistically significantly different from each other.

Furthermore, we calculated the average percentage of marks increments from the pre-test to the post-test for each group for further justification and understanding of the differences between groups in term of learners’ performance. Figures 10, 11, and 12 depict the difference between the means of marks for the pre-test and the post-test, the standard deviations of the pre-test and the post-test for the five groups, and the average percentage of mark increments from the pre-test to the post-test for each group, respectively. Table 1 summarizes the means of the marks and the standard deviation for all groups.

<table>
<thead>
<tr>
<th>Groups</th>
<th>Pre-test Mean</th>
<th>Pre-test Standard deviation</th>
<th>Post-test Mean</th>
<th>Post-test Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>G1</td>
<td>37.24</td>
<td>11.78</td>
<td>56.64</td>
<td>14.21</td>
</tr>
<tr>
<td>G2</td>
<td>39.12</td>
<td>13.48</td>
<td>59.84</td>
<td>12.85</td>
</tr>
<tr>
<td>G3</td>
<td>38.96</td>
<td>13.88</td>
<td>59.20</td>
<td>12.03</td>
</tr>
<tr>
<td>G4</td>
<td>38.00</td>
<td>12.91</td>
<td>61.36</td>
<td>14.64</td>
</tr>
<tr>
<td>G5</td>
<td>37.52</td>
<td>13.81</td>
<td>72.04</td>
<td>12.80</td>
</tr>
</tbody>
</table>

Table 1. The means of marks and the standard deviations

![Average of Marks](image)

Figure 10. The mean of marks for the pre-test and the post-test

![Standard Deviation](image)

Figure 11. The standard deviation for the pre-test and the post-test

Table 2. One-way ANCOVA test results (Dependent variable: post-test, covariate: pre-test)

<table>
<thead>
<tr>
<th>Source</th>
<th>Type III sum of squares</th>
<th>df</th>
<th>Mean square</th>
<th>F</th>
<th>Sig.</th>
<th>Partial eta squared</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrected Model</td>
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<td>5</td>
<td>2979.499</td>
<td>35.381</td>
<td>.000</td>
<td>.598</td>
</tr>
<tr>
<td>Intercept</td>
<td>14609.526</td>
<td>1</td>
<td>14609.526</td>
<td>173.484</td>
<td>.000</td>
<td>.593</td>
</tr>
<tr>
<td>Pre-test</td>
<td>11340.565</td>
<td>1</td>
<td>11340.565</td>
<td>134.666</td>
<td>.000</td>
<td>.531</td>
</tr>
<tr>
<td>Group</td>
<td>3803.593</td>
<td>4</td>
<td>950.898</td>
<td>11.292</td>
<td>.000</td>
<td>.275</td>
</tr>
<tr>
<td>Error</td>
<td>10021.275</td>
<td>119</td>
<td>84.212</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>502571.000</td>
<td>125</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrected Total</td>
<td>24918.768</td>
<td>124</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. (*) Indicates that R Squared = .598 (Adjusted R Squared = .581).
The results shown in Table 2 reveal that there was a statistically significant difference at \( p < .05 \) between the mean scores of the post-test marks for all groups controlling for pre-test marks as determined by one-way ANCOVA \( (F(4,119) = 11.292, p = .000) \), therefore we rejected the null hypothesis \((H_0)\) for the means of the post-test marks. Table 3 summarizes the results obtained from Bonferroni post hoc test, it obviously reveals that there was a statistically significant difference between the mean scores of the post-test marks between each of G5 and G1 \((p = .000)\), G5 and G2 \((p = .000)\), G5 and G3 \((p = .000)\), G5 and G4 \((p = .000)\). Furthermore, Figure 12 depicts that G5 has achieved a value of 47.91\% as the highest percentage of marks increment from the pre-test to the post-test, while in contrast, G1 and G3 has achieved the lowest percentage of marks increment which is about 34.20\%.

**Table 3.** Pairwise comparisons of the estimated marginal means using Bonferroni post hoc test

<table>
<thead>
<tr>
<th>(I) Group</th>
<th>(J) Group</th>
<th>Mean difference (I-J)</th>
<th>Std. error</th>
<th>( Sig. b )</th>
<th>95% Confidence interval for difference(^b)</th>
</tr>
</thead>
<tbody>
<tr>
<td>( G1 )</td>
<td>( G2 )</td>
<td>-1.815</td>
<td>2.598</td>
<td>1.000</td>
<td>-9.247</td>
</tr>
<tr>
<td>( G3 )</td>
<td>( G2 )</td>
<td>-1.293</td>
<td>2.598</td>
<td>1.000</td>
<td>-8.724</td>
</tr>
<tr>
<td>( G4 )</td>
<td>( G2 )</td>
<td>-4.160</td>
<td>2.596</td>
<td>1.000</td>
<td>-11.586</td>
</tr>
<tr>
<td>( G5 )</td>
<td>( G2 )</td>
<td>-15.194*</td>
<td>2.596</td>
<td>.00</td>
<td>-22.618</td>
</tr>
<tr>
<td>( G1 )</td>
<td>( G3 )</td>
<td>1.815</td>
<td>2.598</td>
<td>1.000</td>
<td>-5.617</td>
</tr>
<tr>
<td>( G3 )</td>
<td>( G3 )</td>
<td>.522</td>
<td>2.596</td>
<td>1.000</td>
<td>-6.902</td>
</tr>
<tr>
<td>( G4 )</td>
<td>( G3 )</td>
<td>-2.345</td>
<td>2.597</td>
<td>1.000</td>
<td>-9.772</td>
</tr>
<tr>
<td>( G5 )</td>
<td>( G3 )</td>
<td>-13.379*</td>
<td>2.598</td>
<td>.00</td>
<td>-20.809</td>
</tr>
<tr>
<td>( G1 )</td>
<td>( G4 )</td>
<td>1.293</td>
<td>2.598</td>
<td>1.000</td>
<td>-6.138</td>
</tr>
<tr>
<td>( G3 )</td>
<td>( G4 )</td>
<td>.522</td>
<td>2.596</td>
<td>1.000</td>
<td>-7.946</td>
</tr>
<tr>
<td>( G4 )</td>
<td>( G4 )</td>
<td>-2.867</td>
<td>2.596</td>
<td>1.000</td>
<td>-10.293</td>
</tr>
<tr>
<td>( G5 )</td>
<td>( G4 )</td>
<td>-13.901*</td>
<td>2.597</td>
<td>.00</td>
<td>-21.330</td>
</tr>
<tr>
<td>( G1 )</td>
<td>( G5 )</td>
<td>4.160</td>
<td>2.596</td>
<td>1.000</td>
<td>-3.265</td>
</tr>
<tr>
<td>( G3 )</td>
<td>( G5 )</td>
<td>2.345</td>
<td>2.597</td>
<td>1.000</td>
<td>-3.082</td>
</tr>
<tr>
<td>( G4 )</td>
<td>( G5 )</td>
<td>2.867</td>
<td>2.596</td>
<td>1.000</td>
<td>-4.559</td>
</tr>
<tr>
<td>( G5 )</td>
<td>( G5 )</td>
<td>-11.034*</td>
<td>2.596</td>
<td>.00</td>
<td>-18.458</td>
</tr>
</tbody>
</table>

\( * \) Indicates that the mean difference is significant at .05 level, and \( b \) indicates that the adjustment for multiple comparisons is done using Bonferroni post hoc test.

**Conclusion and future work**

In this paper, we have proposed a new recommendation framework to achieve learning personalization in e-learning environments based on content-based filtering techniques and learners’ negative ratings. The proposed recommender system exploits learners’ negative ratings to fulfill a crucial step in e-learning recommendation strategies which is ensuring that the recommended items are in the learner’s current learning context, thus increasing the system accuracy and improving the learners’ performance. A comparative study has been
conducted to benchmark the performance of the proposed recommender system against other similar e-learning recommender systems. The obtained experimental results show that the proposed e-learning recommender system (SCB-NR) outperforms other similar e-learning recommender systems that use non-semantic content-based filtering technique (CB), non-semantic content-based filtering technique with learners’ negative ratings (CB-NR), semantic content-based filtering technique (SCB), with respect to system accuracy of about 57%, 28%, and 25%, respectively. On the other hand, the learners’ performance has been increased by 9.84% as a consequence of utilizing learners’ negative ratings in the proposed e-learning recommendation framework. Thus, exploiting learners’ negative ratings into e-learning recommender systems has a positive effect on both improving the recommendations accuracy and increasing the learning performance of the students in e-learning environments.

Despite the obtained results reveal that the proposed recommender system has outperformed other similar systems in terms of system accuracy and learners’ performance, several further works are planned to be done in the future to further justify and extend our work in several directions. Firstly, our proposed e-learning recommendation framework uses semantic content-based filtering technique with learners’ negative ratings to compute recommendations to learners, it would be promising if learner’s contextual information (i.e., time and date, registered subjects in current semester, program enrolled in) are taken into consideration in the filtering process. This will enable the recommender system to recommend more accurate and novel recommendations.

Verbert et al. (2012) conducted a survey on context-aware e-learning recommender systems. They stated that context information play a key factor in personalizing e-learning systems.

Furthermore, we are planning to extend our proposed recommender system in another direction to suggest to the learner a sorted sequence of recommendations based on the difficulty level of the learning content. This extension is expected to assist the learners in evolving from the beginning of learning a particular subject until they finish it successfully.

Lastly, we are planning to evaluate the proposed recommender system over time to ensure that the more the learner interact with the system, the more accurate recommendations will be suggested. For this purpose, we are planning to conduct an experiment on students of a particular class who use an e-learning system with the proposed recommender system for one complete semester. Then, we will evaluate the system accuracy and students’ learning performance every three weeks.

References


An e-Learning System for Extracting Text Comprehension and Learning Style Characteristics

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ABSTRACT

Technology-mediated learning is very actively and widely researched, with numerous e-learning environments designed for different educational purposes developed during the past few decades. Still, their organization and texts are not structured according to any theory of educational comprehension. Modern education is even more flexible and, thus, demanding, requiring the combination of multiple educational theories for effective results. In this paper we present the combination of two educational theories for text comprehension and learning styles, that are in use by the newly developed Student Diagnosis, Assistance, Evaluation System based on Artificial Intelligence (StuDiAsE) an open learning system for unattended student diagnosis, assistance and evaluation based on artificial intelligence. A trial test about the role of learning styles in student profiling for text comprehension in the educational environment StuDiAsE is described. Research was run with participation of students using the environment for prior knowledge test and test activities. The process revealed remarkable results about the role of learning styles in students’ profiles for text comprehension. Three dimensions for learning styles were identified: conceptualization, visualization and progression dimension and were used for profiling. Refinement of profiles incorporates learning styles by decoding student behavior, which reflects student learning styles for text comprehension.

Keywords

E-learning, Learning Methodologies, Educational theories, Student profiles, Learning styles

Introduction

Numerous eLearning systems and open learning environments (OLEs) have been developed, especially after the rapid adoption of ubiquitous internet access with most of the interest coming from higher education foundations for the remote delivery of educational material and advanced courses (McAndrew et al., 2010). Many systems were developed in the same manner as most theoretical educational texts; according to the judgement and writing style of the author and not based on any proven educational theory. In their vast majority, even the systems developed according to known educational theories could only quantitatively assess the educational performance of the learner, usually basing their assessment on just the end numerical result of a test or a series of tests (Restivo et al., 2009). OLEs have been designed more as alternative channels for delivery of educational material rather than an autonomous/active stakeholder in the education environment. Such systems are ineffective for a variety of educational applications and especially for engineering students, where the same end result can be accomplished via several paths. It is understandable that effective learning environments need to be based on known educational theories be adaptive to different learners and capable of providing multivariate feedback and assessment (Ihantola et al., 2010). This is especially true in engineering education, where a one-size-fits-all approach was proven to be highly ineffective, removing the possibilities of adaptation and customization that are critical in engineering education (Hofstein & Lunetta, 2010).

In text comprehension studies, researchers focus on assisting comprehension by improving text coherence (McNamara & Kintsch, 1998), by improving the design of the text form and text activities (Denhiere & Baudet, 1992) or by exploiting a student’s prior knowledge on a subject and giving feedback to improve a student’s skills (Caillies & Denhière, 2012). Students preferentially take in and process text information in different ways: by seeing and hearing, reflecting and acting, reasoning logically and intuitively, analyzing and visualizing, steadily and in fits and starts (Felder & Brent, 2005; Caillies & Denhière, 2012). Teaching methods also vary. Some instructors lecture, others demonstrate or lead students to self-discovery; some focus on principles and others on applications; some emphasize memory and others comprehension. When mismatches exist between learning styles of most students in a class and the teaching style of the professor, the students may become bored and inattentive in class, do poorly on tests, get discouraged about the courses, the curriculum, and themselves, and in some cases change to other curricula or drop out of school. A learning style model classifies students according to where they fit on a number of scales pertaining to the ways they receive and process information (Felder & Brent, 2005). The Index of Learning Styles (ILS) is an on-line instrument used to assess preferences on four
dimensions (active/reflective, sensing/intuitive, visual/verbal, and sequential/global) of a learning style model formulated by Felder and Silverman (1988).

In this paper, we present the StuDiAsE, an advanced OLE developed specifically to cater for the needs of engineering learners. StuDiAsE is based on the text comprehension theory by Denhière and Baudet (1992). This theory, focus on assisting text comprehension by improving the design of the text form and text activities and by exploiting a student’s prior knowledge on a subject (Caillies & Denhière, 2012). StuDiAsE is also based on the dialogue theory of Collins and Beranek (1986), which focus on assisting text comprehension using dialogue activities based on dialogue management, strategies, tactics and plans, which promote personalized feedback in learning. Moreover, it is based on the learning styles theory (Felder & Silverman, 1988; Felder & Brent, 2005), which classifies students in learning style according to where they fit on a number of scales pertaining to the ways they receive and process information. By combining these known educational theories across its modules, the StuDiAsE is capable of monitoring the comprehension on behalf of the learners (Collins & Beranek, 1986; Kilpatrick & Turner, 1994; Safer & Fleischman, 2005), assess their prior knowledge, construct individual educational profiles, provide personalized assistance, and provide multivariate assessment. It can also be adjusted to monitor factors that may indicate the motivation of the learner, allowing the delivery of personalized assistance and feedback.

In the following chapters, we will discuss the basic architecture of the system and present how its modules make use of the known educational theories to provide higher quality education to both new and advanced learners. In StuDiAsE, learning styles reflect upon the profile and result from decoding monitored elements of student navigation and are used for the refinement of the profile. In order to refine the profile we translate the monitored elements which represent the students’ learning styles for text comprehension. A research study, aiming to perform evaluation tests of the system to improve profiles for better educational effectiveness, is presented.

The state of the art

In the state of the art a number of Adaptive Educational Hypermedia (AEH) systems and Open Learner Environments (OLE) utilize learning style as a basis of the text comprehension and the user modelling (Felder & Spurlin, 2005). Existing evaluation studies are summarized by Brown et al. (2009) and include quantitative evaluation for adaptation and navigation techniques. Examples include AES-CS, INSPIRE, ARTHUR, MANIC and EDUCE (see Table 1).

<table>
<thead>
<tr>
<th>Educational environment &amp; author(s)</th>
<th>Learning style model &amp; author(s)</th>
<th>Learner model</th>
<th>Educational theory / approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>ARTHUR, Gilbert &amp; Han (2002)</td>
<td>Witkin &amp; Goodenough, (1997)</td>
<td>Alternative styles of instruction differ in the type of media they use</td>
<td>Mastery learning – dynamically adapts the instructional style according to learner’s performance</td>
</tr>
<tr>
<td>MANIC, Stern &amp; Wolf, (2000)</td>
<td>(Model not specified)</td>
<td>System adapts learner model</td>
<td>Presentation of content objects using stretchtext - allows certain parts of a page to be opened or closed</td>
</tr>
<tr>
<td>EDUCE, Tangney (2006)</td>
<td>Gardner, (1983)</td>
<td>System dynamically models learning characteristics</td>
<td>Multiple Intelligence - Instructional material is matched and mismatched with learning preferences</td>
</tr>
</tbody>
</table>

Researchers (Matera & Costabile, 2002; Brown et al., 2009) provide case studies to model quantitative evaluation of learning-style-adapted e-learning environments for personalized learning. What these systems mentioned in table 1 have in common is that the learning styles are used to form an important part of the learner profile and the learning style preferences are used for adaptation. The weakness of these systems is that there is...
no any theory of text comprehension, which is systematically used, to be combined with the learning style. This combination we implement could strengthen and enrich the system in the construction of a more effective learner profile and personalized learning.

**Adapted educational theories**

Denhière and Baudet (1992) argue that text comprehension implies the understanding of fundamental cognitive categories. When a student attempts to comprehend a text, constructs a symbolic structure in an attempt to understand the world described by the text. The key role in this illustration lies on cognitive categories which are: the person, the situation, events, acts, as well as the temporal, causal relations and hierarchy of part-whole relationships that connect these symbolic structures. The organization and structure of symbolic structure is also examined on micro and macro-levels. The theory of Collins and Beranek (1986) is related to the objectives and dialogue strategies used by teachers for reflection and scientific thinking when students ask questions for learning of a subject matter. The dialogue is used to serve both of these two purposes of learning. The teachers are not trying to teach concepts, but put them within the context of the theory of a subject.

Based on these two theories, the modules of StuDiAsE perform diagnostic and dialogue sections. Diagnosing the cognitive profile of the learner is crucial for the development of adaptive systems, making the monitoring and evaluation of the learners a critical research subject regarding OLEs (Franca et al., 2012). During the diagnostic section, StuDiAsE provides the student with a series of questions meant to assess general prior knowledge (diagnostic tests) in a specific subject. After reading the text and answering the questions, the student enters the interactive part of the education and is asked to engage in dialogue with the system, in an attempt to revise the student's discrepancies or incorrect answers. The student is then guided through the construction of more coherent arguments in text comprehension. It should be noted the students are given the freedom to access or skip any of the educational steps at any point of time; however, should a student wishes not to follow the recommended path, the assessment and feedback capabilities of the system may become heavily limited, or the system may even be unable to provide any personalized feedback and assessment.

For this purpose, the educational material of the system is formatted according to Denhière and Baudet’s (1992) theory of text comprehension, which suggests three versions of each text: S-text, M-text, and T-text with questions accompanied by alternative answers (Sorenson & Macfadyen, 2010; Samarakou et al., 2015). The three versions of text with questions which each module should include are:

- **S-text (Relational)** and S-type questions describe a document with focus on simple descriptions of the hierarchy of part-whole relations of the system described in the document, as well as on descriptions of the processes, event and system status on micro-level.
- **M-text (Transformative)** and M-type questions designate a document with focus on descriptions of the sequence of events and the state to state transitions of the system.
- **T-text (Teleological)** and T-type questions describe a document with focus on detailed descriptions of the objectives and sub-objectives for which the system has been constructed or of the changes within the system from an initial to a final state due to events in order to achieve the objectives on macro-level.

As such, after the student gets involved in the educational process and as diagnostic and interactive parts are being completed, the modules explore the comprehension of the student on each type of text. The monitoring and logging modules store information that is being assessed by the modelling and profiling modules, initially identifying the comprehension of each student over a specific type of educational text. By default, the system is programmed to attempt and increase the comprehension of the student on relational texts, which is considered to be the easiest type. Once the system asserts that the comprehension of the student on relational texts is sufficient, it proceeds to improve comprehension on transformative texts. Similarly, when the comprehension of transformative texts appears to be sufficient, the system proceeds to teleological texts.

The question that we will try to answer in this Section is whether the involvement of the students in the e-learning scenario can provide some indication towards their categorization according to Felder criteria (Felder & Silverman, 1988). In particular we investigate whether the attributes related to the way students are processing the material, the challenges they take and the results of their efforts can lead us to estimations related to their learning styles. In general such an endeavor should be based only upon the data related to the overall performance of the student as well as the selections and results in individual questions; i.e., the typical data that come from a testing activity. In the case of StuDiAsE, we begin from the fact that the researchers have administrative access to the e-learning platform and we can enrich this activity with various data coming from the overall student activity.
In terms of the conceptualization, we have considered two sets of questions oriented at intuitive and at sensing students. The former set includes questions mostly theoretical related to concepts, usage scenarios of system and interaction. The latter are related to the formulation of concrete facts and definition of procedures as well as identification of logical gaps in workflows. In terms of off-channel data, the sequential attempts of a student towards the successful completion of a question and the gradual approach of the result indicate a sensing approach. The capability of generalization and extension of results to situations different from those examined in the syllabus material indicate intuitive potential.

The evaluation of the visualization potential has also been initially performed through the creation of different types of situations. One set based on syllabus presented using figures and visual representation and the other based ondense text and verbal procedure descriptions and explanations. Visual learners perform better in the former set, while verbal learners prefer the latter. Regarding the off-channel data, we have been evaluating the way the students are navigating in the application (a) either leveraging the individual visual artifacts and pages, handling efficiently the graphical user interface, (b) or based upon the instructions and frequently consulting the written documentation related to the functionality and operations supported of the application.

To determine the collaboration dimension we consider the interaction among the students. For certain time periods, a collaboration tool among the students is enabled and it is upon the student whether they can use it in order to collaborate with the other students. Their behaviour both from the active point of view (whether they initiate communications attempts) and the passive point of view (how they react to inbound communications attempts) can discriminate them to active learners who typically work with others to the reflective learners who learn by themselves in an individualized manner. In terms of off-channel data the exchange of results (when applicable and allowed) as well as the similarity of the responses can provide indication towards collaborative and active attitude. It is not infrequent that student who study together, when evaluated provide similar results in their tests.

The progression dimension discriminates the students into the sequential learners who typically progress in small incremental steps to the global learners who are holistic, systems thinkers and learn in large leaps. This is evaluated by the way the students split larger tasks and attempt (or not) to decompose the tasks in smaller more manageable one or delve into the overall task at once. This dimension can also be related to the approach of the student, either an iterative (and more global) approach where “easy” or acquainted questions are preferred or the waterfall approach where the full set of questions is approached. This information is extracted when we ask the student to divide the available time into specific tasks.

The complete profiling, modelling and evaluation of the learners is being performed through the use of artificial intelligence and, specifically, fuzzy logic (Caillies et al., 2002). The artificial engine decides on real time the current comprehension of each student on a specific educational text type, as well as actively works to classify the user according to Felder’s theory. This is done in order to provide useful, practical and effective educational feedback, maximizing educational performance. Finally, at the completion of the educational process, the student is presented with both the initial and final educational profiles, with clear indications on the improvements and weaknesses. The process of building a cognitive profile of a student is based on several characteristics, such as the student’s prior knowledge on the particular subject, knowledge gaps, contradictory answers and actions, even from the student’s attitude during the exercise and his/her willingness to participate. As such, it also is a requirement of the monitoring module to attempt and motivate the students, ideally by adapting to their educational profile, and particularly into engaging in the diagnostic process, which will be providing both the current educational status of the student before the procedure and the final cognitive profile (Grossman, 2009).

**Architecture**

StuDiAsE is capable of monitoring a student’s text comprehension, assess their prior knowledge, build an individual student profile, provide personalized assistance feedback and evaluate a student’s performance both quantitatively and qualitatively through artificial intelligence mechanisms (Nicol & McFarlane-Dick, 2006; Bull & Kay, 2010; França et al., 2012). Cognitive profile represents student’s text comprehension style over a thematic topic. The initial profile represents a student’s prior knowledge concerning the thematic topic. Student’s special features, identified in the prior knowledge test involve his inactive concepts, misconceptions, conflicts, knowledge gap or contradictions in his arguments. Moreover, other features such as his motivation for participation in activities and his learning style are identified and monitored, option which is utilized for offering the most appropriate text activities for the personal preferences of each student. The text activity, which is given to the student as personalized feedback acts as a motivational factor for further involvement in text.
comprehension activity. Such feedback can be given in the form of help, advice, suggestion and guidance and may drive students to the process of reflecting to their thoughts. After this activity the system infers the final profile of each student which represents the revised profile after reflection. The student profiling process takes into account the initial and the final profile, as well as the changes which happen with student’s active participation through reflective thinking. StuDiAsE is divided into three modules: the monitoring, the logging, the profiling, the modeling and the evaluation module.

The monitoring module

This module observes and monitors the student’s answers to questions while the student participates in: (a) in prior knowledge test, and (b) in text activities. For each of its subjects StuDiAsE provides a prior knowledge diagnostic test in order to identify and recognize a student’s prior knowledge concerning the subject. Prior knowledge test consist of a number of general or specific questions with alternative answers about the subject (Tsaganou & Grigoriadou, 2011). By monitoring the student’s answers to questions regarding a specific subject, the system takes note of the student’s educational needs. Moreover, monitoring facilitates analysis, editing and codification of a student’s arguments process, which contribute in the formulation of student’s initial cognitive profile. For each subject StuDiAsE provides appropriate text activities: text with questions accompanied by alternative answers. Activities help the student build, during the comprehension process, symbolic representations of the information contained in the text. According to the different educational needs of each student, the system provides the appropriate text activity which stands as individualized feedback to promote reflection and scientific thinking. The module for monitoring the student’s answers to questions within the educational environment is designed so as to satisfy specifications in order to record: (a) the student’s name (for registered students), (b) the thematic subject code (c) the thematic prior knowledge test code, (d) the total number of questions included in the prior knowledge test, (e) the total number of alternative answers to each question of the test, (f) the kind of questions: multiple choice, position & justification, question-pairs with alternative answers, categorizing entities, classifying events or operations, completion of event or operations missing in a sequence, (g) the type of each question, (h) the number of questions for each type and (i) the level of difficulty of each question.

The logging module

The logging module monitors student’s movements during activities, which reflect their behavior (Samarakou et al., 2013b). Students have agreed to be monitored but they do not have control over this process. The type of inputs available for monitoring students depends upon the educational settings. The input monitored refers (a) to the responses of the user to the structured questions and (b) complementary information including help invocations, movements within the text etc. Student movements include the selection of answers to questions of different types and seeking assistance using the on-line help. The system monitors the number of hits per page, pages visited and order of steps taken by the student. As a result the monitoring system keeps a complete history of the time each student spent on each subject content page, as well as the time intervals between activities. The system monitors how many times a question has been visited and how many times the answer has been changed. Moreover, the system monitors the student’s logical mistakes-errors or unnecessary steps. Finally, the system also monitors the activities the student chooses to partake, the number of times he makes a mistake of the same or different type, as well as any other information connected to student behaviour during interfacing with the environment.

The profiling module

The initial profile represents a student’s prior knowledge concerning a thematic subject (França et al., 2012; Samarakou et al., 2013a). To specify a student’s special features, the diagnostic module exploits, as a starting point, the results recorded in the prior knowledge test which embodies appropriate questions with alternative answers about a particular thematic subject. Student’s special features to be identified in the text activity involve his misconceptions, conflicts, inactive concepts, knowledge gap or contradictions in his arguments. This option is utilized for offering the most appropriate text activities for the individual needs of each student. The text activity which is given to the student as individualized feedback acts as a motivational factor for further involvement in text comprehension activity. Such motivation may drive students to the process of internally reflecting to their thoughts. Moreover, feedback can be given in the form of help, advice, suggestion and
guidance, or even in the form of solved problems-examples, which can engage student in the reflective process. After the activity, the system assesses the student’s final cognitive profile.

The modelling module

The student diagnostic module in StuDiAsE deduces the cognitive profile of a student. A student’s model represents his or her cognitive profile for text comprehension over a thematic subject and his learning style. The process of student profiling takes into account the initial cognitive profile and the final cognitive profile, as well as the changes which happen with student’s active participation through reflective thinking (Figure 1).

Specifications for composing a student’s model are: (a) description of the rules applied for deducing a student’s initial cognitive profile, (b) artificial intelligence techniques used for the diagnostic process such as case based reasoning, fuzzy logic or neural networks, (c) description of the layout of the student features such as descriptive characterization (high, medium or low level profile) or numeral (33%, 66% or 100% performance), (d) decision making techniques for supplying each student with the appropriate text activity after the diagnostic process, (e) preferences on three dimensions of a learning style model and (f) description of the structure and the content of the cognitive profile and the student model.

![Figure 1. The modelling module](image)

The evaluation module

The involvement of students throughout the entire process depends on individual decisions, from answers and movements, the willingness to participate, from the compliance with instructions and encouragement offered by the system in various phases. If the student insists on wrong or flawed responses, the artificial intelligence system should be designed to achieve the minimization of conflicts and focus on trying to change the reasoning of the student. The minimization will be possible when the learner alone removes the contradiction and thus becomes able to construct a more coherent argument (reflection) (Samarakou et al., 2009). The evaluation module has as its core the student model. By using artificial intelligence techniques, it is possible to evaluate the details of the initial and final cognitive profile. While the output of the system is the cognitive profile of the student, as inputs were used the following items:

- Recorded data of student involvement during modeling: Elements indicating the engagement of the student in the diagnostic process (informing the student for initial cognitive profile), in the process of creating a cognitive profile and model (the number of times that the cognitive profile characterization has changed), the student’s decision to reconsider contradictory answers to questions / errors, etc., indicating the engagement of the student in the improvement of his cognitive model (steps leading to a change in thinking and changes in the model),
- Recorded data of system navigation elements.

Trial test

The trial test aimed to perform test of the system for possible improvement of learning profiles, to monitor student movements which reflect students’ learning styles and to make students participate in the refinement of
their learning profile. The objective was twofold: to test educational effectiveness and consistency. This test was conducted with participation of 28 students studying Informatics (Informatics Sector) in the 2nd EPAL Amarousiou, (Vocational Lyceum). The knowledge domain was that of telecommunication networks, a thematic subject included in StuDiAsE system. Participants were 16 students from the third grade and 12 students from the second grade Informatics course. Students of the third grade had prior knowledge about main concepts acquired during a relevant course they attended the previous year. The students of the second class had prior knowledge only about very basic concepts.

The students worked on the thematic subject of “Local Networks” in StuDiAsE environment following the instructions of their teachers. The process was consisted of three phases:

- At the beginning each student answered the initial diagnostic test D1 consisted of questions with alternative answers from which the student’s initial profile was estimated.

- Then in the interactive part, depending on the diagnosis, the student followed the suggestions of the system to deal with the appropriate for him activity (text with questions) S-type, M-type or T-type.
  - S-type activity includes text which describes units that constitute a system (local network) represented by the text, part to whole relations connecting system units (network nodes) and static states of the units (transmission state in the network).
  - M-type activity includes text which describes events and event sequences taking place in the units of the system the text refers to (sending a packet of bits) and which provoke state to state transitions of the system and causal and temporal relations among events and the changes they bring to the state of the system (change the network from “conflict state” to “transmission state” due to repetition of broadcast the right time).
  - T-type activity includes text which describes a tree of goals and sub-goals and how the technical system described by the text changes from an initial to a final state due to events in order to achieve the goals and sub-goals (the technique to overcome conflicts in sending a packet of bits and achieve transmission).

- At the end, student answered the final diagnostic test D2 from which the final profile was estimated.

During this process, students were monitored. Monitoring included student movements, between others: the selection of answers to questions of different types, the use of the on-line help, the number of hits per page, pages visited and order of steps taken by the student, the time each student spent on each subject content page, as well as the time intervals between activities. The system monitored how many times a question has been visited and how many times the answer has been changed. Moreover, the system monitored the student’s logical mistakes/errors or unnecessary steps. Finally, the system also monitored the activities student chooses to partake, the number of times he makes a mistake of the same or different type, as well as any other information connected to student behavior.

The relation between monitored results of student behavior is expected to reflect on their learning styles and is analyzed into three out of four dimensions of Felder and Silverman:

- Conceptualization dimension which includes: (a) intuitive students who like abstract information, have in mind the goals of a technical system and don’t like courses that require memorization, and (b) sensing students who like solving problems and enjoy courses that have more descriptive texts with connections to the real world.

- Visualization dimension which includes: (a) visual students who rarely used the help mechanism of the system and also spent a little time in doing the text comprehension activity, and (b) verbal students who used the help mechanism and get most out of written explanations.

- Progression dimension which includes: (a) sequential students who gained understanding in small steps and showed minor changes in their profile, and (b) global students who learn in large jumps and showed mayor changes in their profile.

**Results and discussion**

The trial test aimed to test if the presented system StuDiAsE works effectively. In order to assess the system’s effectiveness and consistency we examine both technical and educational point of view. From a technical point of view, the purpose of the test was to study if the monitoring process is made according to the rules and provides the appropriate elements for student profiling and for decoding learning styles. Moreover, the purpose is to test if there are any monitoring mistakes and if the system delivers the appropriate feedback. Moreover, testing the behavior of the system while multiple users have been working simultaneously revealed some technical glitches, such as conflicts in storing data, which have been dealt with. From an educational point of
view, the purpose of the test was to study the refinement of profiles to incorporate learning styles by decoding monitored profile features and student behavior for better educational effectiveness. The results which the trial test revealed about the possible connection between text comprehension styles and Felder theory’s learning styles were used for initial classification. Table 2 summarizes the results.

- According to conceptualization dimension, students who achieved high level in T-type questions in D1 or D2 tests (T-students), who possibly prefer abstract texts, seem to behave as intuitive students. Students who achieved high level in M-type questions in D1 or D2 tests (M-students), who prefer descriptive texts, seem to behave as sensing students. Students who achieved high level in S-type questions in D1 or D2 tests (S-students), who prefer very descriptive texts, seem to behave as strongly sensing. Adopting this initial classification, the trial test results were on average: 57.14% sensing, 17.85% strongly sensing and 25% intuitive.

- As for visualization dimension, students who used help text of the system frequently, while they are trying out the initial diagnostic test D1 or D2, (usually spend a lot of time to finish the test) seem to behave as verbal. On the other hand, students who rarely used help text in D1 or D2 (spend a little time to finish the test) seem to behave as visual. Students who frequently used help in both the initial D1 and the final diagnostic test D2, seem to behave as strongly verbal. Similarly, if rarely used help in both D1 & D2 seem to behave as strongly visual. Following this classification, the trial test results were on average: 53% strongly verbal and 17% strongly visual.

- According to progression dimension, for the degree of performance improvement in the profile, two categories of students were identified: those who showed one change in their performance and those who showed two or more changes. Students which achieved one change between profiles D1 and D2 seem to behave as sequential. This small step means small improvement in performance. Students which achieve two or three changes between profiles D1 and D2 seem to behave as global, whereas more than three changes as strongly global. More than one step means great improvement in performance. The trial test results were on average: sequential (42.85%) and global (28.57%).

| Table 2. Total learner profile is structured by text comprehension and learning styles |
|---------------------------------|-----------------|---------------------------------|-----------------------------------|
| **Dimension**                   | **Learning styles** | **Identified elements in diagnosis tests:** | **Prevalent text comprehension styles** |
| Conceptualization              | Intuitive        | High level in t-type questions in D1 or D2 | T-students (prefer abstract texts) |
|                                 | Sensing          | High level in M-type questions in D1 or D2 | M-students (prefer descriptive texts) |
|                                 | Strongly intuitive | High level in T-type questions in D1 and D2 | T-students (strongly prefer abstract texts) |
|                                 | Strongly sensing | High level in S-type questions in D1 and D2 | S-students (strongly prefer descriptive texts) |
| Visualization                   | Visual           | Rare use of help (a little time spent) | T-students (fast in using the system) |
|                                 | Verbal           | Frequent use of help (a lot of time spent) | M-students (slow in using the system) |
|                                 | Strongly visual  | Very rare or no use of help (a little time spent) | T-students (very fast in using the system) |
|                                 | Strongly verbal  | Very frequent use of help (a lot of time spent) | S-students (very slow in using the system) |
| Progression                     | Sequential       | One change/step in the profile | S-students |
|                                 | Global           | Two or three changes/steps in the profile | M-students |
|                                 | Strongly sequential | No change in the profile | S-students |
|                                 | Strongly global  | More than three changes/steps in the profile | T-students |

A large number of students, who scored “high level” in T-type activities, were also classified as intuitive and visual. This means that those who preferred abstract texts rarely used the help mechanism and also spent a little time in doing the text comprehension activity. Moreover, they showed important improvement in their profile (two or three steps) as most of them were classified as global.
Another remarkable result was the combination of sensing, sequential and visual styles for a significant number of students. This is translated as the case of students who scored “high level” in M-type activities, used the help elements and showed not remarkable improvement in their profile. Based on the above results, discussion has been made regarding the fact that we have an opportunity to personalize instruction not only in terms of content, but also in terms of student learning style. Text comprehension S, M and T types within the StuDiAsE system reflect not only different educational needs but different learning styles. Based on Table 2 results, Table 3 depicts an indicative learner profile of Alice, an M-student.

<table>
<thead>
<tr>
<th>Table 3. Indicative learner profile</th>
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</thead>
<tbody>
<tr>
<td>Student name</td>
</tr>
<tr>
<td>Initial profile D1</td>
</tr>
<tr>
<td>Average value (AvD1)</td>
</tr>
<tr>
<td>Final profile D2</td>
</tr>
<tr>
<td>Average value (AvD2)</td>
</tr>
<tr>
<td>Change: AvD2-AvD1</td>
</tr>
<tr>
<td>Number of changes</td>
</tr>
<tr>
<td>Learning style</td>
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<tr>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

**Conclusion**

The monitoring module of StuDiAsE, can observe the sequence of a student’s actions and provide a wealth of information to the educator that can be used to improve instruction and learning within the lines of a course. Educators may adjust their teaching techniques and customize the instruction to match the needs of the student by delivering personalized educational material based on their text comprehension styles and learning styles.

In order to make improvements in the learning environment of StuDiAsE, we have decided the set of monitorable indicators and the types of data which require monitoring. Moreover, we have organized information gathered from monitoring. All available sources of information have been used for a refined and more accurate estimation of the student profile. We explored several queries, which have been discussed, have found their answers and others are going to be the object of future research. A large scale evaluation study may verify the results.

Discussion so far provides clear justification as to why a comprehensive learner profiling system should be set up as an integral part of an e-learning framework.

**Acknowledgments**

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**References**


Comparing Digital Badges-and-Points with Classroom Token Systems: Effects on Elementary School ESL Students’ Classroom Behavior and English Learning

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ABSTRACT

This paper reports the findings of a field experiment that gamified the classroom experience of elementary school ESL students by implementing digital badges-and-points which students could earn by achieving specific behavioral and learning goals. Altogether, 120 children in eight different classes participated in this study. Four of the classes (experimental group) used the digital badges-and-points available in ClassDojo, a free online classroom management system, while the other four classes (control group) employed a non-digital conventional school token point system. The results showed that digital badges-and-points afforded by ClassDojo significantly improved student learning in two classes (Grades 3 and 4) but not in Grades 1 and 2 classes. Overall, students reported enjoying using digital badges-and-points in the classrooms. Teacher observational data indicated that the digital badges-and-points group displayed more positive and on-task behaviors than the non-digital classroom token point system group.

Keywords

English as second language, Gamification, Engagement, Class token system, Digital badges-and-points, Speaking, Reading

Introduction

Gamification is a term usually used to denote the application of digital game mechanics, such as digital points, or badges in a non-game context to motivate behavior (Deterding et al., 2011). Points refer to tokens that can be collected by users, which can be used as progression indicators, and positive reinforcement (Richter et al., 2015). Badges refer to tokens that appear as icons or logos that signify accomplishments of a particular activity (Bunchball, 2010). Badges fulfill a person’s need for acknowledgement and work as virtual status symbol (Sailer et al., 2013). Collectively, badges and points stimulate self-efficacy by measuring progression and providing feedback on an individual’s own performance (Gnaauk et al., 2012), as well as how one’s performance compared with others. Although people prefer to assess themselves using nonsocial and objective standards, if these standards are not available, individuals will evaluate their abilities by comparing themselves with other people (Festinger, 1954).

Already firmly established in the commercial world, digital badges-and-points are widely viewed as a powerful strategy for building brand loyalty, and crowd-sourcing initiatives (Educause, 2011; Caponetto et al., 2014). However, the potential of digital badges-and-points in motivating people goes far beyond that of promoting business success (Caponetto et al., 2014; Lee & Hammer 2011). The use of digital badges-and-points might help improve ESL student classroom engagement and learning of English.

Traditionally, teachers in elementary or special education schools have widely used the classroom point system, a form of token economy, which consists of expectations for desired student behavior and learning, rules that govern how points are earned, and criteria for earning prizes such as stationary upon receiving a certain number of points (Donaldson et al., 2014). Although the use of such token economy has been reported to be effective in increasing appropriate behavior (Kazdin, 1982) and learning, schools today still face major problems around student engagement (Lee & Hammer, 2011). To address these problems, some educators have attempted other means to engage students. Digital badges-and-points may foster better student engagement because it makes the coursework look more like a game-like challenge rather than a chore (Educause, 2011).

Hitherto, a majority of previous studies focused on higher education, and can be characterized as qualitative case studies design in which practitioners describe their implementation of digital badges and points and report primarily user perceptions (Denny, 2013). For example, Chang and Wei (2016) investigated what digital game mechanics were perceived as engaging by MOOC learners. Analysis of 4,891 online survey responses revealed that digital badges were among the top five most engaging game mechanics. Although qualitative case studies are informative, they cannot offer causal explanation because they are seldom compared with a control.
There is a dearth of experimental studies examining the impact of digital badges-and-points on student learning and classroom behavior particularly at the elementary school context. For example, in a literature review of over 120 papers, Caponetto et al. (2014), found that only 3% of studies targeted the elementary school population.

According to Falkner and Falkner (2014), context is important in the system we gamify and the users who participate in it. Some of the questions that we wish to explore in this study include: Would young elementary school students of ages find digital badges-and-points engaging? Would the use of digital badges-and-points motivate them to exhibit certain desired classroom learning behaviors and promote learning? This paper makes a novel contribution by investigating the potential of digital badges-and-points on improving students’ classroom behavioral engagement and learning of English among Hong Kong ESL elementary school children. Behavioral engagement refers to students participating in a classroom such as answering questions, and completing set work (Fredricks et al., 2004).

Research questions

The main purpose of this study was to compare the use of digital badges-and-points afforded by ClassDojo versus a non-digital conventional classroom token system on elementary school students’ classroom behavior and English learning. The following questions were addressed in this study:

- To what extent does the use of digital badges-and-points afforded by ClassDojo have an impact on student learning when compared to a non-digital conventional classroom token system?
- To what extent does the use of digital badges-and-points influence student behavior when compared to a non-digital conventional classroom token system?
- How did the students perceive the use of digital badges-and-points afforded by ClassDojo?
- How did the teacher perceive the use of digital badges-and-points afforded by ClassDojo?

Method

Participants

The research was conducted during the English lessons at an elementary school in Hong Kong. Two classes from Grades 1, 2, 3 and 4 took part in the study that lasted about 16 weeks (Table 1).

<table>
<thead>
<tr>
<th>Level</th>
<th>Experiment</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade One (P1) Reading</td>
<td>P1B (n = 18, 10 boys, 8 girls)</td>
<td>P1C (n = 14, 8 boys, 6 girls)</td>
</tr>
<tr>
<td>Grade Two (P2) Reading</td>
<td>P2B (n = 16, 9 boys, 7 girls)</td>
<td>P2C (n = 16, 9 boys, 7 girls)</td>
</tr>
<tr>
<td>Grade Three (P3) Speaking</td>
<td>P3B (n = 16, 10 boys, 6 girls)</td>
<td>P3A (n = 13, 7 boys, 6 girls)</td>
</tr>
<tr>
<td>Grade Four (P4) Speaking</td>
<td>P4B (n = 13, 9 boys, 4 girls)</td>
<td>P4A (n = 14, 9 boys, 5 girls)</td>
</tr>
</tbody>
</table>

The ages of the students ranged from 6 years old in P1 to 11 years old in P4. The eight classes were chosen because the same English teacher taught them throughout the entire research period. Of the two classes at each level, one class was randomly as the experiment class, and the other as the control class. All 63 experimental and 57 control students had Chinese as their mother tongue, while English was learned as a second-language.

Background of the English lessons

The English teacher taught reading in double-period lessons each week to the P1 and P2 classes involved in this research. The aim of these lessons was to develop students reading skills. The lessons emphasized shared and guided reading by focusing on a number of big books. The lesson began with students sitting on the reading mat at the front of the classroom. First they sang some songs, followed by phonics practice, high frequency words, and big book shared reading. The students would then move to their group tables for either guided reading or an activity based on the big book’s language structure. Students were expected to read and answer comprehension questions, and complete any set work.

The English teacher taught speaking in a single lesson each week to the P3 and P4 classes. The aim of these lessons was to provide students with the necessary skills to do well in the Hong Kong Territory-wide System Assessments (TSA), a nationwide examination. These lessons used questions from past examination papers to
practice and develop students’ presentation and speaking skills, as well as improve their speaking confidence. Sitting on their usual chairs in their usual groups, the lessons began with students discussing the past week or any special events with the teacher. Next, either student presentations or sharing from the previous week’s work would be undertaken, or a new question from a past examination paper would be examined in preparation for sharing and presentations for the following week. Students were expected to answer questions, share opinions, complete any set work, and present their work either as part of a group or individually.

Experimental lessons

This research utilized the flexibility of the ClassDojo platform to apply digital badges-and-points into the learning of the experimental classes. The participants were familiar with ClassDojo because they had been using it for about four months prior to this study. This makes the ClassDojo environment an unlikely novel experience for the participants. Using P3B’s class home page as an example, Figure 1 (best seen in color) shows what the students saw during the lessons. The points were in green next to the students’ name. The points were recorded on the students’ profiles and could be viewed throughout the lesson via the class display page, or at home by the students or their parents using their assigned log in account.

![Figure 1. An example of a class home page](image)

During these lessons, ClassDojo was used to award points to students for achieving certain targeted behavior or learning objectives, which were tailored to each year level (see Figure 2). These points were recorded on the class’s homepage on ClassDojo during the lessons and accumulated throughout the duration of the research. For the sake of consistency, all experimental and control reading classes (P1 and P2), as well as the speaking classes (P3 and P4) had the same categories of points.

![Figure 2. Allocation of points](image)
Using ClassDojo’s customizable avatar option, a selection of digital badges was designed to be awarded to students who accumulated a certain amount of specified points (see Figure 3). All participants knew exactly how many points each badge worth. Once a student accomplished the targeted amount of points, the teacher awarded them with a badge in the form of a new avatar on their class page of ClassDojo. This can be seen in Figure 1, which shows the variety of badges that students achieved in a class. Upon achieving the highest amount of points, students received a physical prize, such as stationary.

![Figure 3. Reward chart](image)

Before the experiment began, the English teacher first opened a new ClassDojo account and set up a new class page for the reading classes (P1 and P2), and the speaking classes (P3 and P4). This involved entering student names and selecting an avatar for each student in each of the experiment classes. At the beginning of each lesson, the teacher used the overhead projector to display the class home page (Figure 1) on the whiteboard for all students to observe. The teacher then reminded the class how to earn points by referring to the reward chart in the classroom (Figure 2).

The teacher awarded points to individual students or groups of students if they achieved the behavior or learning targets outlined in Figure 2 via his cell phone. For example - if only seven students read a book, then these seven would be awarded a point each; or if only one student elaborated the answers while speaking, only he or she would be awarded a point; or if the whole class read well during shared reading, then everyone would win a point. Having the mobile application at hand allowed the teacher to award points instantaneously. This also allowed the teacher to award points when walking around the classroom observing the students. The teacher also deducted points from individuals who displayed the negative behavior outlined in Figure 2. A loud sound was played by the computer whenever a point awarded (high pitch) or deducted (low pitch), so therefore whether the class home page was on display or not, the students were always aware of their behavior and learning levels. Any points, added or deducted, were automatically recorded to the relevant students’ profile on the class home page.

**Control lessons**

The same teacher used the same lesson plans, teaching approach and materials as the experimental classes at each grade level. In other words, the control classes were planned to be exactly the same as the experimental classes except for the exclusion of ClassDojo. Instead, the teacher continued to use the non-digital conventional school points system that was used in all classes in the school (see Figure 4).

This worked by first dividing each control class into four groups of between 4 to 6 students each. The teacher used this group setting to implement the school award system (see Figure 4). The school based award charts were drawn and displayed on the class boards at all times. Points were won by individuals within the group or the group as a whole, and were awarded for the same number of reasons as in the experimental group (see Figure 2). For example - if two students in a group elaborated the answers while speaking, then the particular group would be awarded a point; or if the whole group read well during shared reading, then the particular group would win a point. The group with the highest points at the end of the week received a prize (e.g., a box of chocolates).
The teacher utilized the chart in a similar way to ClassDojo – referring to the number of points each group had at regular intervals throughout the lesson, highlighting and reinforcing how to win points, and deducting points for negative behavior.

![Figure 4. School token point system chart](image)

**Measures**

**Pre and post tests**

Both the experimental and control groups took exactly the same pre and post-test at each year level. The purpose of conducting the pre-tests was to establish group equivalence in terms of the students’ prior ability. The pre-tests took place the week before the research started, between January 26th and the 30th. The post-tests took place after the research had been completed, between May 25th and 29th. The specific pre and post-test questions at each level were different from each other to eliminate any carryover learning effects, but were similar in terms of scope and difficulty to maintain test fairness.

For the P1 and P2 classes, a pre and post reading test was designed using the content of one of the big books they had read that school year. The book content was condensed and printed out on a piece of A4 paper for the students to read. The pre-test and post-test had a similar word count. During the test, the teacher did not offer any help and would allow five seconds before moving the student on if they got stuck on a word. Students were graded between 1 and 15 marks on their clarity, fluency, pronunciation and ability to read. The test took 2 to 4 minutes per student to complete.

For the P3 classes, a pre and post-speaking tests were designed using questions from one of the TSA past examination papers for each year level. Both P3 tests were picture descriptions in which the students were shown four sequenced pictures and then asked five questions to describe what was happening. Students were graded between 1 and 15 marks on their ability to convey information clearly, fluently, and intelligibly with good pronunciation. Students who elaborated their answers and used imagination gained higher marks. The test took 2 to 4 minutes per student to complete. For the P4 pre and post tests, the students had to present their opinions on a set topic, such as eating habits, which was presented to students in the form of a mind map with hints on an A4 sheet of paper. Students had one minute to prepare and one minute to talk. Students were graded between 1 and 15 marks on the content, presentation language, grammar and pronunciation. Students who elaborated and used imagination gained higher marks.

**Teacher observations**

A behavior chart was used to record the teacher’s observations of the student’s behavior during the lessons of the experimental and the control classes (Table 2).

The inclusion of the specific behavioral indicators was informed by relevant literature, as well as the teacher’s own expectations of the students during the lessons. For example, Tulley and Chiu (1995) found that disruption (e.g., talking out of turn) and inattention (not listening to teacher, being off-task) to be the most frequent
behavior problems. Therefore, in our present study, we developed specific indicators to observe these behaviors (e.g., whether students listen to teacher or other students, complete set work).

<table>
<thead>
<tr>
<th>Behaviour</th>
<th>Nearly all of the students</th>
<th>Most of the students</th>
<th>Some of the students</th>
<th>Only a few students</th>
<th>One or two students</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Listening to teacher or other students</td>
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<tr>
<td>Reading</td>
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<tr>
<td>Answering Questions in class</td>
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<tr>
<td>Following instructions</td>
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<tr>
<td>Sitting still</td>
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<tr>
<td>Waiting for their turn to speak in class</td>
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<tr>
<td>Staying on task</td>
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<tr>
<td>Completing set work</td>
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</tbody>
</table>

Six rating categories - Nearly all of the Students (except 1 or 2), Most of the Students (except 3 or 4), Some of the Students (6-10 students), Only a few Students (4 or 5 students), One or Two Students, and Not Applicable – were used to quantify the behavior by the whole class during lessons (class size from 13 to 18 students). The same chart was used for all the classes. The observations began from the initial implementation of the experiment and continued in every lesson until the end.

The teacher completed the charts by putting a tick or cross in the appropriate box. If a behavior was deemed not applicable to the lesson, the teacher ticked the N/A box. For reliability purposes, other teachers observed six lessons (P1B, P1C, P2B, P2C, P3B, and P4A) and completed a behavior chart in order to cross check and thus ensure that the one undertaken by the teacher was consistent. The overall inter-observer agreement was 80%.

Student surveys

In order to help gauge students’ perceptions of the use of game mechanics in the lessons and also explore any differences in attitude and motivation towards the lessons, two student surveys were designed, one for all the experimental class students and one for all control class students. The students completed the surveys during the final lesson of the research.

The survey for the experimental classes consisted of four questions. The first question asked if they felt interested in the English lessons. The remaining three questions focused on the use of ClassDojo (e.g., whether students liked it and if it helped them participate more).

The survey for the control classes consisted of three questions. The first question asked if they felt interested in the English lessons. The remaining two questions focused on whether they participated in the lessons and how motivated they felt to do so.

Teacher reflection

In order to ascertain a teacher’s perception on the use of game mechanics, he was asked to provide a written reflection on his experience. The reflection would focus on the teacher's experiences and opinions, both positive and negative, of using ClassDojo in the lessons, what actually happened during the lessons and the impacts it had on motivation and behavior of the students during the lessons.

Data analysis

Once collected and recorded, the test scores, behavior charts and student surveys were subjected to descriptive statistics and independent t-test analyses for each pair of experiment-control group in different grade level. To determine effect sizes, we calculated Cohen’s (1988) $d$ statistic. Once the teacher reflection data had been
collected, they were analysed and interpreted using an analytic strategy involving data reduction, pattern-matching, explanation-building, and conclusion drawing (Miles & Huberman, 1984).

Results

To what extent does the use of digital badges-and-points afforded by ClassDojo have an impact on student learning when compared to a non-digital conventional classroom token system?

Table 3 summarizes student performance on the pre- and post-tests. To test for initial group equivalence, we conducted t tests.

<table>
<thead>
<tr>
<th>Grade</th>
<th>Pre-test</th>
<th>Post-test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Reading</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grade 1</td>
<td>8.94</td>
<td>3.56</td>
</tr>
<tr>
<td>Grade 1</td>
<td>9.43</td>
<td>2.74</td>
</tr>
<tr>
<td>Grade 2</td>
<td>8.69</td>
<td>3.81</td>
</tr>
<tr>
<td>Grade 2</td>
<td>10.81</td>
<td>2.51</td>
</tr>
<tr>
<td>Speaking</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grade 3</td>
<td>9.00</td>
<td>2.56</td>
</tr>
<tr>
<td>Grade 3</td>
<td>8.46</td>
<td>2.99</td>
</tr>
<tr>
<td>Grade 4</td>
<td>10.15</td>
<td>2.64</td>
</tr>
<tr>
<td>Grade 4</td>
<td>8.36</td>
<td>3.71</td>
</tr>
</tbody>
</table>

Note. p < .05.

Comparing students’ pre-test performance: Reading

The results of the independent sample t test (for pre-tests) indicated that there was no significant difference in the students’ prior knowledge or ability in the experimental and control groups for the reading levels (Grade 1: M(SD)experiment = 8.94(3.56), M(SD)control = 9.43(2.74), t(30) = -0.421, p = .677; Grade 2: M(SD)experiment = 8.69(3.81), M(SD)control = 10.81(2.51), t(30) = -1.864, p = .072. Therefore, all Grades 1 and 2 classes were considered equivalent in terms of their prior reading knowledge or ability.

Comparing students’ pre-test performance: Speaking

There was also no significant difference in the students’ prior knowledge or ability in the experimental and control groups for the speaking levels (Grade 3: M(SD)experiment = 9.00(2.56), M(SD)control = 8.46(2.99), t(27) = 0.523, p = .605; Grade 4: M(SD)experiment = 10.15(2.64), M(SD)control = 8.36(3.71), t(25) = 1.438, p = .163). Hence, all Grades 3 and 4 classes were considered comparable in terms of their prior speaking knowledge or ability.

Comparing students’ post-test performance: Reading

The results of an independent sample t test (for post-tests) indicated no between-subject difference in post-test scores for the reading groups – Grades 1 and 2 students (Grade 1: M(SD)experiment = 11.00(3.68), M(SD)control = 11.14(1.61), t(30) = -0.135, p = .893; Grade 2: M(SD)experiment = 11.13(3.38), M(SD)control = 11.25(2.65), t(30) = -0.116, p = .908).

Comparing students’ post-test performance: Speaking

The results of an independent sample t test (for post-tests) revealed that the post-test scores for Grade 3 students in the experimental group, M(SD)experiment = 12.69(2.09), was significantly higher than for students in the control group, M(SD)control = 10.08(3.17), t(27) = 2.661, p = .013, d = 0.972 at the 0.05 level of significance with a large effect size (Cohen, 1988). Similarly, Grade 4 students in the experimental group, M(SD)experiment = 12.00(2.77)
also scored significantly higher with a large effect size than the students in the control group, $M(\text{SD})_{\text{control}} = 9.14(4.04)$, $t(25) = 2.128$, $p = .043$, $d = 0.83$.

The box plots of post-test scores for all groups are shown in Figure 5. The box plot is a useful technique to present a visual summary of the distribution of a dataset. Specifically, the box plots in Figure 5 showed the spread of all the post-test data points for the reading (P1 and P2), and speaking (P3 and P4) classes. For example, comparing the P4 control and experimental classes, the following observations can be made: (a) the post-test scores of the P4 experimental class ranged from 9 to 15, excluding one outlier (id number 6), while those in the control class ranged from 0 to 14; and (b) the median post-test score of the P4 experimental class was 13 compared to 10 of the control class. These observations suggest that overall students in the P4 experimental class did better in their speaking test than those in the control class.

![Box plots of post-test scores](image)

**Figure 5.** Box plots of post-test scores

To what extent does the use of digital badges-and-points influence student behavior when compared to a non-digital conventional classroom token system?

**Reading (P1 and P2 classes)**

The reading experimental group (P1 and P2 classes) had a total of 16 lessons observed, while the control group had 17. In the tables, each particular behavior types has two figures under each of the six measurements. For example, the behavior *Staying on task* in Table 4 (experimental group) displays 10 and 62.5% under the measurement *Most of the students*. The first figure shows the number of lessons that the experimental classes achieved that measurement, while the second number is this number of lessons expressed as a percentage of the total number of lessons (16). So in about 63% of the classes, *Most of the students* in the experimental group stayed on task during the English reading lessons.

Table 4 shows that the majority of students in the experimental classes behaved considerably well in all behavior categories. The experimental groups achieve a score of over 80% in six categories (A, B, D, E, G, H). For example, in 81% of the lessons most or nearly all of the students read and stayed on task, in about 88% of the lessons most or nearly all of the students sat and completed the set work, and in 93% of the lessons most or nearly all of the students successfully followed the teacher’s instructions.
the highest percentage being about 6%. When combining the measurements achieved by dividing this figure by the total number of lessons (count). For example, the mean score of 4.7 for experimental of lessons each behavior measurement was recorded in a particular behavior by the assigned points (sum), and the more positive the behavior of the class. The weighted mean score was calculated by multiplying the number of students obtained for each of the behavior types. To do this, each of the six measurements were assigned points – 5 points - Nearly all of the Students, 4 points - Most of the Students, 3 points - Some of the Students, 2 points - Only a few Students, 1 point - One or Two Students, and 0 points for Not Applicable. The higher the weighted mean score, the more positive the behavior of the class. The weighted mean score was calculated by multiplying the number of lessons each behavior measurement was recorded in a particular behavior by the assigned points (sum), and dividing this figure by the total number of lessons (count). For example, the mean score of 4.7 for experimental

\[ \text{Weighted Mean Score} = \frac{\sum \text{Assigned Points} \times \text{Number of Lessons}}{\text{Total Number of Lessons}} \]

\begin{table}[h]
\centering
\caption{Behavioral chart data for the experimental reading classes (n = 16 lesson observations)}
\begin{tabular}{lcccccc}
\hline
Code & Assigned points & 5 & 4 & 3 & 2 & 1 & 0 \\
\hline
Behaviour & Nearly all of the students & Most of the students & Some of the students & Only a few students & One or two students & N/A \\
\hline
A & Listening to teacher or other students & 4 & 10 & 2 & 0 & 0 & 0 \\
B & Reading & 8 & 5 & 2 & 0 & 0 & 1 \\
C & Answering questions in class & 2 & 10 & 4 & 0 & 0 & 0 \\
D & Following instructions & 6 & 9 & 1 & 0 & 0 & 0 \\
E & Sitting still & 1 & 13 & 2 & 0 & 0 & 0 \\
F & Waiting for their turn to speak in class & 1 & 8 & 6 & 1 & 0 & 0 \\
G & Staying on task & 3 & 10 & 3 & 0 & 0 & 0 \\
H & Completing set work & 7 & 7 & 0 & 0 & 0 & 2 \\
\hline
\end{tabular}
\end{table}

\[ \text{Nearly all} \times 2 \quad \text{Most of} \times 1 \quad \text{Some of} \times 0 \quad \text{Only a few} \times 0 \quad \text{One or two} \times 0 \quad \text{N/A} \]

\begin{table}[h]
\centering
\caption{Behavioral chart data for the control reading classes (n = 17 lesson observations)}
\begin{tabular}{lcccccc}
\hline
Code & Assigned points & 5 & 4 & 3 & 2 & 1 & 0 \\
\hline
Behaviour & Nearly all of the students & Most of the students & Some of the students & Only a few students & One or two students & N/A \\
\hline
A & Listening to teacher or other students & 1 & 6 & 9 & 1 & 0 & 0 \\
B & Reading & 1 & 7 & 9 & 0 & 0 & 0 \\
C & Answering questions in class & 0 & 4 & 8 & 5 & 0 & 0 \\
D & Following instructions & 0 & 7 & 6 & 4 & 0 & 0 \\
E & Sitting still & 0 & 2 & 9 & 3 & 3 & 0 \\
F & Waiting for their turn to speak in class & 0 & 2 & 8 & 5 & 2 & 0 \\
G & Staying on task & 0 & 4 & 10 & 2 & 1 & 0 \\
H & Completing set work & 1 & 11 & 4 & 1 & 0 & 0 \\
\hline
\end{tabular}
\end{table}

It can be seen that students in the control classes behaved less well in almost all behavior categories (see Table 5). The percentage of lessons in which nearly all the students achieved the behavioral targets A to H was less than the experimental group, with the highest percentage being about 6%. When combining the measurements Nearly all of the students and Most of the students together, it can be seen that only one of the targeted behavioral goals (Completing set work) were achieved in more than 50% of the lessons by most of the students or more. Instead, the majority of the targeted behavioral goals in the control group were achieved by Some of the students and Only a few students.

\[ \text{Nearl all} \times 2 \quad \text{Most of} \times 1 \quad \text{Some of} \times 0 \quad \text{Only a few} \times 0 \quad \text{One or two} \times 0 \quad \text{N/A} \]

In order to better illustrate the differences in behavior between the two groups, a weighted mean score was obtained for each of the behavior types. To do this, each of the six measurements were assigned points – 5 points - Nearly all of the Students, 4 points - Most of the Students, 3 points - Some of the Students, 2 points - Only a few Students, 1 point - One or Two Students, and 0 points for Not Applicable. The higher the weighted mean score, the more positive the behavior of the class. The weighted mean score was calculated by multiplying the number of lessons each behavior measurement was recorded in a particular behavior by the assigned points (sum), and dividing this figure by the total number of lessons (count). For example, the mean score of 4.7 for experimental
group in the behavior *Listening to Teacher or Other Students* is calculated by \( (4 \times 5 + 10 \times 4 + 2 \times 3 + 0 \times 2 + 0 \times 1 + 0 \times 0) / 16 = 4.1 \).

Figure 6 illustrates the differences in behavior between the experimental and controlled groups. Overall, the experimental group behaved better in all behaviors than the controlled group. It scored a weighted mean score of 4 or more (equivalent to most of students showing a particular behavior in class) in four behaviors, compared to the controlled group that failed to score a mean of 4 or more in any of the behaviors.

![Figure 6. Weighted mean scores for the reading group](image)

**Speaking (P3 and P4 classes)**

The experimental speaking group (P3 and P4 classes) had a total of 20 lessons observed. The experimental groups achieve a score of 85% or more in all eight categories (Table 6). For example, in 95% of the lessons most or nearly all of the students stayed on task, and completed the set work.

**Table 6. Behaviour chart data for experimental speaking classes (n = 20 lesson observations)**

<table>
<thead>
<tr>
<th>Code</th>
<th>Assigned points</th>
<th>Behaviour</th>
<th>Nearly all of the students</th>
<th>Most of the students</th>
<th>Some of the students</th>
<th>Only a few students</th>
<th>One or two students</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>15</td>
<td>Listening to teacher or other students</td>
<td>75%</td>
<td>20%</td>
<td>5%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>B</td>
<td>10</td>
<td>Reading</td>
<td>50%</td>
<td>35%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>15%</td>
</tr>
<tr>
<td>C</td>
<td>16</td>
<td>Answering questions in class</td>
<td>55%</td>
<td>45%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>D</td>
<td>15</td>
<td>Following instructions</td>
<td>80%</td>
<td>20%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>E</td>
<td>14</td>
<td>Sitting still</td>
<td>75%</td>
<td>20%</td>
<td>5%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>F</td>
<td>16</td>
<td>Waiting for their turn to speak in class</td>
<td>55%</td>
<td>35%</td>
<td>10%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>G</td>
<td>14</td>
<td>Staying on task</td>
<td>70%</td>
<td>25%</td>
<td>5%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>H</td>
<td>16</td>
<td>Completing set work</td>
<td>80%</td>
<td>15%</td>
<td>5%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
</tbody>
</table>

Table 7 shows the behavioral chart of the control speaking group. The control group had also the same number of lessons observed. The percentage of lessons in which nearly all the students achieved the behavioral targets A to H was less than the experimental group, with the highest percentage being 20%. When combining the
measurements Nearly all of the students and Most of the students together, it can be seen that only two of the targeted behavioral goals (listening to teacher or other students and sitting still) were achieved in at least 85% of the lessons by most of the students or more. Instead, the majority of the targeted behavioral goals in the control group were achieved by Some of the students and Only a few students.

Table 7. Behavioral chart data for control speaking classes (n = 20 lesson observations)

<table>
<thead>
<tr>
<th>Code</th>
<th>Assigned points</th>
<th>Behaviour</th>
<th>Nearly all of the students</th>
<th>Most of the students</th>
<th>Some of the students</th>
<th>Only a few students</th>
<th>One or two students</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>3</td>
<td>Listening to teacher or other students</td>
<td>15%</td>
<td>75%</td>
<td>5%</td>
<td>5%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>B</td>
<td>0</td>
<td>Reading</td>
<td>0%</td>
<td>50%</td>
<td>35%</td>
<td>0%</td>
<td>0%</td>
<td>15%</td>
</tr>
<tr>
<td>C</td>
<td>0</td>
<td>Answering questions in class</td>
<td>0%</td>
<td>0%</td>
<td>60%</td>
<td>40%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>D</td>
<td>0</td>
<td>Following instructions</td>
<td>0%</td>
<td>30%</td>
<td>60%</td>
<td>10%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>E</td>
<td>4</td>
<td>Sitting still</td>
<td>20%</td>
<td>65%</td>
<td>15%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>F</td>
<td>1</td>
<td>Waiting for their turn to speak in class</td>
<td>5%</td>
<td>45%</td>
<td>40%</td>
<td>10%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>G</td>
<td>0</td>
<td>Staying on task</td>
<td>0%</td>
<td>30%</td>
<td>45%</td>
<td>25%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>H</td>
<td>1</td>
<td>Completing set work</td>
<td>5%</td>
<td>20%</td>
<td>55%</td>
<td>15%</td>
<td>0%</td>
<td>5%</td>
</tr>
</tbody>
</table>

In order to better illustrate the differences in behavior between the two groups, a weighted mean score was also obtained for each of the behavior types (Figure 7). Overall, the experimental group behaved better in all of the behaviors than the controlled group. It scored a weighted mean score of 4 or more (equivalent to most of students showing a particular behavior in class) in seven categories of behaviors, compared to the controlled group that scored a mean of 4 or more in only two of the behaviors.

How did the students perceive the use of digital badges-and-points afforded by ClassDojo?

Reading (P1 and P2 classes)

More than 88% of students felt interested in English lessons (agree + strongly agree) (Table 8). 85% of students liked using ClassDojo in lessons and the same percentage agreed that ClassDojo made them participate more. Finally, about 74% of students agreed that ClassDojo helped them work harder in the lessons. It can be seen that the student’s responses in the experimental reading group were generally very positive. The results suggest that
students not only enjoyed using the digital badges and points in the classrooms, but also perceived the digital badges and points enhanced their motivation and participation towards learning reading.

Table 8. Survey results of the experimental reading classes

<table>
<thead>
<tr>
<th>Experiment classes</th>
<th>Total - 34 students</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Strongly Disagree</td>
</tr>
<tr>
<td>I feel interested in the English Lessons</td>
<td>0.0%</td>
</tr>
<tr>
<td>ClassDojo makes me participate more in the lessons</td>
<td>2.9%</td>
</tr>
<tr>
<td>ClassDojo helps me work harder in the lessons</td>
<td>0.0%</td>
</tr>
<tr>
<td>I like using ClassDojo</td>
<td>0.0%</td>
</tr>
</tbody>
</table>

With regard to the control group, Table 9 shows that 83% of students felt interested in the teacher’s English lessons. However, a lesser figure of 50% of students answered that they participated in the lessons with only 60% agreeing that they felt eager to participate in the lessons. These results suggest that although students enjoyed the teacher’s lessons, many did not feel motivated enough to participate in the learning. Overall, it can be seen that the student’s responses in the control group were generally not as positive as those in the experimental group.

Table 9. Survey results of control reading classes

<table>
<thead>
<tr>
<th>Control classes</th>
<th>Total - 30 Students</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Strongly Disagree</td>
</tr>
<tr>
<td>I feel interested in the English Lessons</td>
<td>3.3%</td>
</tr>
<tr>
<td>I participated /joined in the lessons</td>
<td>10.0%</td>
</tr>
<tr>
<td>I am eager to participate in the lessons</td>
<td>10.0%</td>
</tr>
</tbody>
</table>

Speaking (P3 and P4 classes)

About 93% of students felt interested in the English speaking lessons (agree + strongly agree) (Table 10). 86% of students liked using ClassDojo in lessons and the same percentage agreed that ClassDojo made them participate more. The results suggest that students not only enjoyed using the digital badges and points in the classrooms, but also perceived the digital badges and point enhanced their motivation and participation towards learning and practicing speaking.

Table 10. Survey results of the experimental speaking classes

<table>
<thead>
<tr>
<th>Experiment classes</th>
<th>Total - 29 students</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Strongly Disagree</td>
</tr>
<tr>
<td>I feel interested in the English Lessons</td>
<td>3.4%</td>
</tr>
<tr>
<td>ClassDojo makes me participate more in the lessons</td>
<td>6.9%</td>
</tr>
<tr>
<td>ClassDojo helps me work harder in the lessons</td>
<td>10.3%</td>
</tr>
<tr>
<td>I like using ClassDojo</td>
<td>6.9%</td>
</tr>
</tbody>
</table>

Table 11. Survey results of the control speaking classes

<table>
<thead>
<tr>
<th>Control classes</th>
<th>Total - 27 Students</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Strongly Disagree</td>
</tr>
<tr>
<td>I feel interested in the English Lessons</td>
<td>7.4%</td>
</tr>
<tr>
<td>I participated /joined in the lessons</td>
<td>3.7%</td>
</tr>
<tr>
<td>I am eager to participate in the lessons</td>
<td>3.7%</td>
</tr>
</tbody>
</table>

In contrast, only 59% of students in the control classes felt interested (agree + strongly agree) in the teacher’s English lessons (Table 11). Just slightly half (59%) of students answered that they participated in the lessons
with only 37% agreeing that they felt eager to participate in the lessons. Overall, it can be seen that the student’s responses in the control group were generally less positive than in the experimental group.

**How did the teacher perceive the use of digital badges-and-points afforded by ClassDojo?**

The teacher suggested that ClassDojo was very effective as a behavioral and classroom management system. Not only were students rewarded for basic good behavior, they were given points if they read well or elaborated on their answers, therefore helping to constantly reinforce and focus the students on achieving the targeted learning objectives, and thus, in a sense, developing valuable reflective learning skills.

According to the teacher, the experimental classes were far better behaved than the control classes, and much easier to manage at all year levels. Seeing their points increase and upgrading to a new badge really gripped the students’ attention. On the whole, they were more willing to participate. Whereas five hands might go up to answer a question in the control classes, almost all the hands went up in the experimental classes. When classes got off task, the teacher rarely needed to raise his voice, and instead just displayed the point boards and then awarded points for the required behavior. Those who did not behave were soon brought back on task by their peers with the threat of whole class (implicating every student) point deductions by the teacher.

It took much more effort to achieve and maintain similar behavior in the control classes. Even though the behavior was not unsatisfactory, it did not match the experimental classes in terms of consistency in paying attention, following instructions, and sitting still. Furthermore, in the control classes only the more academically competent students would try to tackle reading difficult words, or elaborate when speaking. On the other hand, the majority of the students in the experimental classes were attempting to do so. The teacher was pleasantly surprised to see students who might usually sit back and observe now not only participating, but also pushing themselves further.

Not all students were so enthusiastic about winning badges or about ClassDojo, but the general feeling was extremely positive. In most classes, there were a majority of students who were engaged in the project and eager to gain points. This influence brought an element of peer pressure to classes with students working harder to keep up and achieve what their friends or the majority of the rest of the class had.

**Discussion**

The aim of this study was to explore if the behavior and learning of ESL students at an elementary school was influenced by introducing digital badges-and-points afforded by ClassDojo into the lessons. A total of 120 children in eight different classes participated in this study. Four of the classes (experimental group) utilized the digital badges-and-points, while the other four classes (control group) employed a non-digital conventional school point system. The participants in the experimental classes were familiar with ClassDojo because they had been using it for about four months prior to this study. This makes the use of digital badges and points an unlikely novel experience for the participants.

The use of digital badges-and-points afforded by ClassDojo significantly improved the oral post-test scores of Grades 3 and 4 students compared to their counterparts who utilized the non-digital conventional school point system. One explanation of the better performance of the experimental group students was that they were more engaged such as answering questions in class, staying on task, and completing set work.

However, we found no significant difference in reading post-test scores between the experimental and control groups for Grades 1 and 2. The reason for is currently not clear. It is possible that a combination of young age and circumstances of these classes had a part to play. As noticed by the teacher, students in the four P1 and 2 classes were still consumed with other happenings in the classroom, such as who they were sitting next to, in addition to the excitement of going to different classrooms. Moreover, the nature of the P1 and P2 English reading curriculum focused mainly on reviewing and reinforcing what they were expected to know at this level, rather than enforcing new skill or knowledge; this may have influenced the lack of significant differences in test scores. The curriculum probably was easy enough to follow without the need for additional motivational tools (e.g., digital badges), hence progression in both groups being similar and relatively good.

Our results indicated that the majority of students in the experimental classes behaved considerably better than their counterparts in the control classes who used the non-digital conventional token system. The qualitative
results also showed that both the teacher and the students perceived the use of gamification in lessons as having a generally positive impact on behavior and motivation.

We offer three plausible explanations for the generally favorable results concerning classroom management in the experimental group. First, the use of different badges (see Figure 3) gives students a sense of progression. According to the self-determination theory of motivation (Ryan & Deci, 2000), users seek competency. The element of progression shows users where they are in their learning and how far they are from reaching the goals; it motivates users to move toward completion and feelings of competence. Reaching a checkpoint or milestone, and earning new badges stimulates endorphin release in learners in a similar way that exercise, excitement, or love does (Wroten, 2014). This helps promote a feeling of well-being, and thus motivates learners to do try harder. This element of progression was not evident in the conventional school token point system.

Second, the use of the online ClassDojo helped create a sense of pervasiveness in the learning environment. Students can view the class home page which shows each student’s achievements inside as well as outside class. The school token point system that was implemented in the control group can only be viewed in-class. Third, the online ClassDojo group tended to focus on individual-based achievement, as opposed to the group-based achievement practiced in the conventional school token point system. It is possible that the use of individual-based achievement gave each learner a more personal responsibility for managing their own learning and behavior.

We would like to highlight a certain point of interest. Some skeptics may argue that digital badges and points mainly act as extrinsic rewards which could undermine a user’s intrinsic motivation (e.g., Nicholson, 2012). Such criticisms, however, remain questionable and speculative. First, it is not conclusive that extrinsic rewards will always interfere with intrinsic motivation. Several recent studies, for example, found that extrinsic rewards did not negatively affect the participants’ intrinsic motivation needs (Ledford et al., 2013; Mekler et al., 2013). Second, focusing only on intrinsic motivation is not a practical strategy for schools. As Deci and Ryan (2000, p. 55) stated, “Frankly speaking, because many of the tasks that educators want their students to perform are not inherently interesting or enjoyable, knowing how to promote more active forms of extrinsic motivation becomes an essential strategy for successful teaching.”

Conclusion

In addressing the limitations of past research, the overall aim of this paper was to explore the impact of digital badges-and-points afforded by ClassDojo on behavior and learning of students’ at the elementary school level. We acknowledge that digital badges-and-points are not a universal solution to all motivational shortcomings; however this study suggests that they had a positive impact on students and teacher, considerably improving learning in some of the classes involved in the research, and positively stimulating many of the behaviors expected of student’s during lessons in all of the classes involved in the research. No adverse effect on student learning or behavior was found.

For further research, a larger study in which students are exposed to digital badges-and-points for longer periods would be beneficial in assessing the longevity of their impact on learning and behavior. Further studies should also focus on the impacts of digital badges-and-points in a number of subject areas and not just English. Classroom dynamics change depending on the subject and it would be interesting to see the impact digital badges-and-points may have. We also suggest that a similar research project takes place in other schools that have a more diverse mix of students such as students in an international elementary school setting.

References


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ABSTRACT

There are still disparities in technology-access despite economic pressures and widespread promises to overcome them. The induced digital gap defines the degree of digital citizenship for which, unified policies have yet to be drawn at various educational levels to reduce that gap. The quest for a broad participation to develop digital citizenship competencies needs further investigations into innovative educational approaches, pedagogical methods, and routine practices that foster digital literacy, and narrows the digital divide. This special issue accumulates original theoretical and empirical research contributions across contemporary digital citizenship perspectives. The final selection of the papers explores digital citizenship concepts such as ethics, digital literacy and participation, in various contexts to develop opportunities for a wider engagement in social actions. The international perspectives of contributing authors shed lights on digital citizenship prospects across unique contexts among different nations.

Keywords

Digital citizenship, Digital literacy, Ethics, Education, Pedagogy

Introduction

There is a lack of research defining digital citizenship despite the wide proliferation of Internet, and citizens’ engagement in online communities. These technological spaces develop digital footprints as citizens explore online applications that foster civic awareness or influence social and political norms. These collective digital interactions are nurtured by an increasing immersion into cyberspace which entails knowledge and behavioural competencies. The resulting aptitudes cultivate digital literacy as well as ethical use of technology and social inclusion brought by an active participation and a further engagement into society actions (Parry, 2008). These defining dimensions of digital citizenship have been further analyzed to establish some basis for supplementary studies (Choi, 2016). Previous analysis suggested salient digital citizenship concepts, which can be used to gauge relevant knowledge and behavioural scales. These concepts include: Ethics, information literacy and participation/engagement of digital citizens into Internet-mediated societal actions (Choi, 2016). This special issue builds on these existing categories of digital citizenship concepts, with an educational-perspective at various levels, to promote best practices that cultivate these digital citizenship concepts. The proposed contributions could align efforts to support the digital transformation of school-children and advocate the corresponding educational changes (Sancho, 2010). Such educational practices are poised to develop a range of competences and shape new behaviours, which harness the benefits and opportunities of virtual spaces, while ensuring protection against potential harms.

Digital citizenship and ethics

The ethics dimension of digital citizenship denotes suitable and accountable conducts in cyberspace (Gereluk, 2017). Citizens inherit rights and associated responsibilities as members of online communities, whereby individuals manage their behaviour within the community context. However, there are some educational disparities in best practices which frame ethics as a salient feature of digital citizenship. This special issue discusses some of these disparities across various contexts, to reshape the role that education could play in enabling digital citizens who thrive online responsibly in a democratic society.

Information literacy

The scale of digital citizenship profile is levelled by information literacy as it provides access means to build the required knowledge. This includes conceptacles to evaluate information sources. Instructional practices could support the dissemination of credible information through integrating relevant practices across the curriculum and authentic tasks. Educational settings and hybrid educational models are discussed in this special issue where authors evaluate their contributions to elevate digital citizenship levels.
Participation and engagement

Participation and engagement are new digital citizenship norms in support of collective actions. Several approaches to mobilize citizens to get involved into politics have been advocated. Social networks had particularly played influential role in civic engagement through participation into political discussions (Parry, 2008; Vromen, 2017). The role of social media in engaging citizens across different participatory domains, including education, civic and political domains are discussed in this special issue. The proposed contributions highlight and evaluate the rising role and proper use of social media to engage in meaningful societal actions.

Special issue structure and brief overview of contributions

This special issue is categorized into three tracks that include investigations to rise digital citizenship scales, namely: information literacy, ethics and participation/engagement. This categorization designates a repertoire for meaningful and responsible participation in society. As technology permeates educational, business and civic sectors, digital literacy develops the required skills to navigate through the information pathways. Additionally, citizens need to develop the ethical attitude to consolidate a responsible internet-enabled engagement within society and government agenda.

Minjeong Kim and Dongyeon Choi’s contribution falls within the information literacy category of digital citizenship, as they argue on the need for a comprehensive knowledge, as well as technological accessibility to digital spaces. For that endeavour, they highlight the transformational role of educators to lead digital citizens into develop relevant competencies. On the other hand, the broad range of digital citizenship scales reveal some challenges to identify competency gaps. Hence, the authors propose a study which identifies digital citizenship scales within an educational context. A five-factor digital citizenship model is revealed, to characterize the scale values that profile citizens in digital environment. Alex Young Pedersen et al.’s contribution fosters a hybrid education approach to develop patterns for inclusion in digital society. The authors of this paper describe a process on identifying and describing educational patterns as part of a hybrid education model that are mapped to digital citizenship components. The paper includes a scenario of actual participants intervening in the proposed hybrid educational model to evaluate its contribution to digital citizenship.

The participation and engagement dimension of digital citizenship has been investigated in Benjamin Gleason and Sam von Gillern paper where they explore social media use in secondary education contexts. The article proposes a conceptual analysis of civic engagement and examines digital media applications support to citizenship education in middle- and high-school levels. Their empirical study demonstrates the development of digital citizenship through the proposed integration of social media into education practices. Further, Nuri Kara develops a study in another contribution to this special issue to investigate university students’ perception and practices about digital citizenship. Barriers for political engagement are explored among a population of students through online activities. Along the same lines, Damien M. Sánchez reports upon a case study of community participation in learning exchanges, within a blog on civic engagement. President Trump’s election is used as a forum of discourse whereby people diagnose policies that impact their everyday lives. Similarly, Stefanie Panke et al also leverage blogs and other social media spaces to encourage a reflective and critical discourse about civic engagement that promote genuine learning exchanges.

The ethical factor of digital citizenship is first addressed by Xianhui Wang and Wanli Xing through a contribution to this special issue where parental involvement is solicited to instil the norms of appropriate and responsible behaviour with regard to technology use. This involvement is shown to reinforce ethical online conduct and dissuade risky behaviours. The authors proposed a research–based path model is proposed to explain causal relationships between the effects of parental involvement and teens’ digital citizenship. Secondly, inappropriate use of social media can be detrimental to digital citizenship in K-12 schools, which is emphasized in Florence Martin et al.’s contribution to this special issue. An empirical study in this paper reveals a substantial population of middle-school students involved in the study who lack parental monitoring in their social media use. Subsequently, the authors justify the need for cyber-security education to prevent inappropriate postings, hacking incidents, or privacy infringements. The study increases educators’ and parents’ awareness on social media use by students to reduce cyber-bullying incidents and protect their digital identity in cyberspace.
References


Development of Youth Digital Citizenship Scale and Implication for Educational Setting

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ABSTRACT

Digital citizens need comprehensive knowledge and technological accessibility to the internet and digital world and teachers have a responsibility to lead them to become digital citizens. However, existing Digital Citizenship Scales contain too broad ranges and do not precisely focus on the target students, so teachers do not have clear criteria for facilitating young people to have digital citizenship, which leads to problems in the direction and goals of digital citizenship education. This study aims to clearly identify the Digital Citizenship Scale for adolescents perceived by teachers who are responsible for their students' digital citizenship education and to present the needs and direction of school-based education to satisfy the identified Digital Citizenship Scales. A five-factor Digital Citizenship Scale called S.A.F.E model, meaning leading character of Self-identity in digital environment, Activity in online(Reasonable Activity and Social/cultural engagement), Fluency for the Digital tools, and Ethics for digital environment, was derived through Exploratory Factor Analysis (EFA) and further cross-validated through Confirmatory Factor Analysis (CFA) with 200 pre-service teachers and in-service teachers. The S.A.F.E model, derived by teachers, shows high reliability and construct validity to be used as a digital citizenship scale for students through concept analysis, EFA, and CFA verification. Based on the theoretically rigorously derived SAFE model, the educational requirements and direction to become active and critical citizens in the online community were discussed.

Keywords

Adolescent digital citizenship scale, Adolescent digital citizenship education, Factor analysis, Teachers’ perspective on digital citizenship scale

Introduction

In the digital age, where the boundaries between online and offline are blurred due to the rapid development of information and communication technologies, the conceptual scope of citizenship should no longer be limited to that of traditional one. While the traditional approaches for citizenship which emphasize rights and responsibilities as citizens are valid, additional efforts to review and redefine what are the appropriate concepts of citizenship matching to the 21st internet age have been made continuously (Bennett, Wells, & Rank, 2009; Hermes, 2006). Although, in this context, the concept of digital citizenship emerged, the definition and use of term for the digital citizenship vary from scholar to scholar. In addition to digital citizenship, the names cyber citizenship, online and network citizenship, or internet citizenship are used interchangeably, but the definition of digital citizenship varies slightly depending on what emphasis is placed (Bennett & Fessenden, 2006; Ribble, Bailey, & Ross, 2004). Based on existing studies that have defined digital citizens as people who use technology effectively and properly (Isman & Gungoren, 2014; Ribble, 2011), digital citizenship can be defined as the qualities required for citizens to use digital tools and behave in various digital environment (Searson, Hancock, Soheil, & Shepherd, 2015).

In harmony with the emergence and emphasis of digital citizenship, the changes in the school classroom environment into the use of digital devices, the internet and digital textbooks, implication of smart education, and activation of online classes have become a global trend (Cristol et al., 2015). Regardless of students’ acceptance of cyberspace, information and digital world have already become and will be a big stream for future society. In this ongoing cyber space, therefore, adolescents in the process of maturing self-identity need to establish their value and identity for digital citizenship more clearly (Lee, Aiken, & Hung, 2012; ISTE, 2016; Ribble, 2011) in online environment. Beyond the level of past safety online education to prevent potential dangers faced by youth, it has become important to foster actively participatory citizens with self-identity and expand the capabilities for the future digital and networked society comprehensively (Jones & Mitchell, 2016). In this sense, as pointed out by Jones and Mitchell (2016), the direction of digital citizen education for youth should be differentiated from simple digital literacy education and cyberbullying prevention; attention for (1) putting into practice proper use of internet resources for respect and tolerance for others in online and (2) utilizing internet resources to increase reasonable participation in online should be paid. In addition, the
establishment of identity in the internet space that meets the development stage of the youth should be treated as an important aspect.

In order to educate young people to develop appropriate citizenship in the digital world, it is necessary for teachers to establish clear criteria for determining the degree and extent of education. Digital citizenship education is not simply about teaching the use of digital tools. It is the process of preparing students for life in a world full of abundant skills. In the digital age, teachers no longer serve as mere communicators of knowledge, but as guides, mentors, role models, facilitators and counselors of information activities (Jones, Mitchell, & Walsh, 2014; Lee, 2017; Ribble, 2015). In other words, in a global digital age, teachers play a very important role in innovative classroom activities related to the elements of active and positive digital citizenship. Teachers have the most direct responsibility to educate and guide students in digital citizenship. Consequently, in order to achieve the successful digital citizenship education for youth, a criterion for the digital citizen education that the teacher recognizes must be prepared. On the basis of this, a valid and reliable Digital Citizen Scale derived from the teacher’s perspective is required. In accordance with this requirement, A five-factor Digital Citizenship Scale called S.A.F.E model, meaning leading character of Self-identity in digital environment, Activity in online, Fluency for the Digital tools, and Ethics for digital environment, was derived through Exploratory Factor Analysis (EFA) and further cross-validated through Confirmatory Factor Analysis (CFA). This study made efforts to develop a valid and reliable digital citizenship scale from the teacher's point of view. A road map should be provided for programs that are more closely aligned with the direction of youth digital citizenship education and are interested in improving positive behavior in online.

Defining digital citizenship

Perspective of digital citizenship approach

As interest in digital citizenship began to emerge, researches regarding the scope and definition of digital citizenship have continued. Traditionally, under the name of digital, researches on the ethical aspect called netiquette and the ability to access and utilize digital technology have begun. As a consequence, according to the previous literature, the greatest part of the category of digital citizens is the emphasis on ethical aspect, which means responsible behavior in the online environment (Farmer, 2011; ISTE, 2016; Lenhart et al., 2011; Ribble, Bailey, & Ross, 2004; Ribble, 2011). The concept of ethics or etiquette varies from acknowledging the rights of others and taking responsibility for their actions to enhancing respect for others, protecting intellectual property rights, and not cyberbullying in the online environment. In addition, there is a strong tendency to emphasize the ability to utilize digital media and interact with others successfully (Dede, 2009; Mossberger, 2009) through online communication. Media and information literacy as a digital citizenship have been focused on by many scholars as well (Simsek & Simsek, 2013). This capability is viewed as a comprehensive concept such as accessibility to digital media and activities through a variety of methods, keeping up with changing technologies using digital tools and managing issues involving computer problems or security.

As a matter of fact, the perspective of digital citizenship emphasizes on various participation and activities in online beyond the above-mentioned level (Mossberger, Tolbert, & McNeal, 2007). One representative example is the tendency to emphasize political, cultural, and economic involvement and involvement through online (Simsek & Simsek, 2013). These activities can be regarded as extending the range of citizenship required in real life to that of digital life through appropriate communication and decision making process. In the same context, the establishment of critical consciousness and the manifestation of resistance (Bennett, Wells, & Rank, 2009) through the internet are also confirmed as the category of highly emphasized digital citizenship. This ability reflects the belief and ability to achieve social justice through the internet. Finally, some researchers approach digital citizenship in terms of internet-specific abilities and self-efficacy. This aspect has also been seen as specialized ability to participate in online activities and communicate his or her opinions clearly as a citizen (De Marco, Robles, & Antino, 2014). The results of these studies reveal that the ability to collaborate and communicate with others, the main competence of digital citizenship, is directly related to internet self-efficacy and information literacy (Livingstone & Helsper, 2009).

Literature review: Framework for digital citizenship scale

The followings are the various discussions about the components of digital citizenship that are fundamental to the development of digital citizenship scale. The components of digital citizenship are largely presented as cognitive factor (e.g., communication ability, autonomous judgment ability, rational decision making ability, and
Based on the aforementioned digital citizenship components, attempts to develop digital citizenship scale have been made (Choi, Glassman, & Cristol, 2017; Isman & Gungoren, 2014; Jones & Mitchell, 2016). In the most recent study on digital citizenship scale, Choi, Glassman, and Cristol (2017) developed a digital citizenship scale for adults by studying graduate students and university students. In this study, the digital citizenship scale is composed of five elements (e.g., Internet Political Activism, Technical Skills, Local/Global Awareness, Critical Perspective, and Networking Agency), and the scope of the applying range is limited to the level of participation of young adults in the internet-centric community life. Meanwhile, in a study that developed digital citizenship scale focusing on respect, patience, and civic engagement in on-line, two factors (e.g., online respect and online civic engagement) were suggested as the scale for identifying the most essential digital citizenship (Jones & Mitchell, 2016). To mention one more representative study, Isman and Gungoren (2014), with the goal of completing the digital citizenship for the 21st century, developed digital citizenship scale based on the three elements suggested by Ribble, Bailey, and Ross (2004), such as respect (etiquette, access, law), educate (communication, literacy, commerce) and protect (rights and responsibility, safety / security, health and welfare).

The previous studies mentioned above have some limitations in that the concept of traditional citizenship is transformed to the category of on-line, or the psychological and social elements required for digital citizens are not applied in a comprehensive manner. In addition, the majority of studies also focused on general digital citizenship scale for the adult citizen. Even if there is digital citizenship scale for students, digital citizenship scale for students was centered on adult college students. For this reason, it does not include the comprehensive digital citizenship scale that juvenile youth who are in the process of self-identity formation should have. Table 1 summarizes the content and limitations of the main DC framework and scale mentioned so far.

<table>
<thead>
<tr>
<th>Researcher / Institution</th>
<th>Contents and factors</th>
<th>Main target subjects</th>
<th>Limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ribble (2011)</td>
<td>9 factors</td>
<td>Mainly technology leaders and teachers</td>
<td>Some elements are beyond the scope of individual student responsibilities (i.e., rights, communication, education, and access).</td>
</tr>
<tr>
<td>ISTE</td>
<td>9 factors</td>
<td>Teachers and students (All Grades)</td>
<td>It presents the digital citizenship competencies required of the students, but mainly focuses on skills and attitudes and lacks of knowledge.</td>
</tr>
<tr>
<td>Brichacek (2014)</td>
<td></td>
<td></td>
<td>It focuses on skills and attitudes, and lacks identity factors.</td>
</tr>
<tr>
<td>iKeepshape (<a href="http://www.ikeepsafe.org/">http://www.ikeepsafe.org/</a>)</td>
<td>6 factors</td>
<td>Students (All Grades)</td>
<td>It is limited to the participation of adults in the Internet-centric community.</td>
</tr>
<tr>
<td>Choi, Glassman, &amp; Cristol (2017)</td>
<td>5 factors</td>
<td>Adult (over college students)</td>
<td>It includes digital citizenship scale for adolescents, but is limited to ethics and participation in online.</td>
</tr>
<tr>
<td>Jones &amp; Mitchell (2015)</td>
<td>2 factors</td>
<td>Students(11-17)</td>
<td>It merely confirms Ribble’s research from the viewpoint of college students.</td>
</tr>
<tr>
<td>Isman &amp; Gungoren (2014)</td>
<td>9 factors</td>
<td>College students</td>
<td></td>
</tr>
</tbody>
</table>
Youth identity and digital citizenship education

Adolescents' identity and digital environment

Adolescence, described as “storm and stress” (Harold, Colarossi, & Mercier, 2007), is an inevitable stage of development in which the relationship of parent and friend changes (Huang et al., 2014), and the confusion of identity and role coexist (Erikson, 1968). During these developments, biological changes related to puberty, a new psychosocial desire for relationships, the development of identities and social roles keeping abreast of the change of the environment, and changes in perceptions related to sophisticated thinking skills take place (Adams & Marshall, 1996; Berzonsky, 2003; Erikson, 1968; Giddens, 1991). In addition, as adolescents enter higher education and broaden their range of activities, new rights and obligations are legitimately given. Therefore, adolescence is a time when adolescents face the task of autonomy, the importance of identity issues, and the desire to establish self-consciousness in a dynamic ecological environment (Barth, 2014; Harold et al., 2007). In summary, adolescents define themselves as members of a group in the context of the environment and articulate their identity in the context of dialogue and relationships with others.

Erikson (1968) emphasized that the development of personally validated identities is the most important part of the main developmental challenges of adolescence. He asserted that if adolescent successfully perceived his or her various roles in an expanded social contexts and relationships, he or she could construct self-identity effectively through “self-sameness and inner continuity” (Erikson, 1968, p. 87). Adolescents consider their role and contribution as they expand the boundaries of familiar relationships and environments. In the process of forming and establishing this identity, interpersonal relations and social context play a very important role (Adams & Marshall, 1996; Erikson, 1968). However, the social context of youth today is significantly different from that of previous generations. In particular, digital media technology creates a new environment for adolescents to express and explore their identity, by way of mobile phones, social networking sites, instant messaging platforms and blogs, virtual worlds and video sharing sites (Davis, 2012). Although there are studies that show an optimistic view of the relationship between digital use and adolescent identity (Lee, Aiken, & Hung, 2012), many studies have shown negative results highlighting potential hazards (Israelashvili, Kim, & Bukobza, 2012; Miles, 2011).

Given the scalability and ubiquity of these digital technologies, it is necessary to raise questions about how youth form and experience their identities in the digital environment. Today's young people were born in the internet age, so they can hardly imagine the absence of computers in relationship and information acquisition. Moreover, they have grown in the digital environment and led their life as a digital native (Prensky, 2001). Consequently, it is meaningful to explore the effects of the digital age on formation for self-identity of adolescents.

Integration digital citizenship with education

The most important part of digital citizenship education is teaching digital literacy, which is computer and internet-based technical skills (Koltay, 2011). Another big axis is the promotion of ethical consciousness represented by the prohibition of cyber-bullying, etiquette, and sense of responsibility that respects the rights of others as well as those of on their own in the digital age (Jones, Mitchell, & Walsh, 2014; Nation et al., 2003). However, as suggested by Jones and Mitchell (2016), it is necessary to discuss digital citizenship education beyond the horizon of digital literacy education and ethics education. Now, digital citizenship education should become a new identity card for the citizens of digital era who are demonstrating their capabilities such as appropriate responsibilities and codes of conduct relating to the use of technology through a reasonable approach (Miles, 2011) to interactive online activities (Ribble, 2015), ability to be productive with a sense of responsibility and criticism about technology (Farmer, 2011), capabilities to use technologies that extend from theoretical context to the social context (Nosko & Wood, 2011), and competence for young citizens to make reasonable and wise choices in a variety of online environments and situations in a comprehensive way (Farmer, 2011; Kassam, 2013; Miles, 2011, Ribble, 2015). Nosko and Wood (2011) emphasized the necessity for effective cooperation between educators, students, and the entire education system in order to develop citizenship awareness in the digital age and to provide effective education and to facilitate culturally appropriate behavior online.

The digital and internet-based activities can positively develop the cognitive and emotional skills needed for adolescents and, moreover, positively reinforce citizen participation in online and offline (Kahne and Sporte, 2008; Sherrod, Flanagan, & Youniss, 2002). It is also directly related to cultivating citizenship to act with their own identity and values (Westheimer and Kahne, 2004; Youniss et al., 2002). In this regard, it is necessary to shift the center axis of digital citizenship education to the point of establishing the viewpoints and self-image of
the youth in and out of on-line activities based on tolerance and respect (Jones & Mitchell; 2016; Lenzi et al., 2012). This perspective is reflected as the key category of digital citizenship highlighted in the most recent technical standards for students presented by the International Society for Technology in Education (ISTE). Under this category, the factors are: (1) to cultivate and manage their digital identity and reputation; (2) to engage in positive, safe, legal and ethical behavior when using technology, including social interactions online; (3) to demonstrate an understanding of and respect for the rights and obligations; and (4) to manage their personal data to maintain digital privacy and security (ISTE, 2016). Given the increasing emphasis on the importance of new online identities in ISTE’s 2016 standard for students, the inclusion of youth identity in digital citizenship education cannot be too overemphasized.

Necessity of new framework for adolescents’ digital citizenship

The importance of digital citizenship education for establishing the identity of the adolescents in the digital environment and performing its goal is summarized as follows. The most fundamental proviso to the study of digital citizenship for adolescents begins with an understanding of the changing digital environment and characteristics of youth at developmental stage (Israelashvili, Kim, & Bukobza, 2012; Valkenburg & Peter, 2011). The harmony of digital technology environment and the establishment of identity and self-consciousness, which are psychosocial desires for various human relations, which youth experience, should be integrated into digital citizenship (Davis, 2012; Lee, Aiken, & Hung, 2012). The fact that adolescents live in a digital environment cannot be confirmed to have achieved digital citizenship. In other words, integrated education needed as a digital citizen should be provided. The framework of education for digital citizenship should include various activities for the formation of human relations and social context based on digital literacy and ethical dimension in the digital environment (Jones & Mitchell, 2015; Nosko & Wood, 2011; Ribble, 2014). Standards for students for digital citizenship presented by ISTE (2016), is one of the major important efforts to highlight this perspective. As a result, it is now necessary to elaborate and provide a more specific common language that can include a change from traditional society to the digital age, the formation of youth societies, cultural human relationships underlined in its social context, and identity of adolescents.

New framework for adolescent digital citizenship scale

As mentioned before, there have been various studies to construct components and frameworks of digital citizenship (Brichacek, 2014; Ribble, 2011; Searson et al., 2015). There have been various ways to classify the elements of digital citizenship according to the purpose of research and researchers. For example, Ribble (2011) divided the components of digital citizenship into nine items and classified them into three categories; respect, education, and protect. This study aimed to develop a digital citizenship scale for adolescents perceived by teachers. The digital citizenship of this study is a target for adolescents, so it is necessary to set up the identity, which is the emotional and positive domain in the development stage of adolescents, as a factor (Adams & Marshall, 1996; Berzonsky, 2003; Erikson, 1968; Giddens, 1991). Although there were items that corresponded to the concept of self-identity by several researchers, but there were no studies that separated the self-identity of adolescents as an independent factor for digital citizenship. Therefore, for the purpose of this study, new SAFE framework with four categories (Self-identity, Activity in online, Fluency for Digital environment, and Ethics for Digital environment) for the digital citizen was developed with reference to ISTE’s standards for students (ISTE, 2016). Table 2 shows the classification for Framework of Digital Citizenship Scale, which is presented in the previous section, and classifies the items according to the SAFE framework. The conceptual definition of each of the four categories for classification is as follows.

- **Self-identity**: Building personal values and beliefs in the digital environment and to protect themselves from potential risks
- **Activity in online**: Engaging in positive and reasonable activity and interact with others through rational decision-making
- **Fluency for digital environment**: Using software and hardware to achieve a variety of goals and keep up with changing digital environment
- **Ethics for digital environment**: Demonstrating an understanding of and respect for the rights and obligations of others in digital environment
Table 2. Classification for framework of digital citizenship scale for youth

<table>
<thead>
<tr>
<th>The Nine Elements of Digital Citizenship (Ribble, 2011)</th>
<th>S</th>
<th>A</th>
<th>F</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digital Literacy: teaching and learning about technology and its use.</td>
<td></td>
<td></td>
<td>●</td>
<td></td>
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<tr>
<td>Digital Etiquette: electronic standards of conduct or procedure.</td>
<td></td>
<td></td>
<td></td>
<td>●</td>
</tr>
<tr>
<td>Digital Law: electronic responsibility for actions and deeds</td>
<td></td>
<td></td>
<td></td>
<td>●</td>
</tr>
<tr>
<td>Digital Rights &amp; Responsibilities: freedoms extended to everyone in a digital world.</td>
<td></td>
<td>●</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Digital Health &amp; Wellness: physical and psychological well-being in a digital world.</td>
<td>●</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Model by the International Society for Technology in Education (ISTE)</td>
<td>●</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equal digital rights and access for all.</td>
<td>●</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treating others with respect in online environments, no cyber-bullying.</td>
<td></td>
<td>●</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No stealing or damaging others’ digital work, identity or property.</td>
<td></td>
<td>●</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Appropriate decisions when communicating through digital channels.</td>
<td></td>
<td></td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>Using and Keeping up with digital tools to advance learning</td>
<td></td>
<td>●</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Responsible online purchasing decisions while protecting payment information.</td>
<td>●</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Upholding basic digital rights in digital forums.</td>
<td></td>
<td></td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>Protecting personal information from forces that might cause harm.</td>
<td></td>
<td></td>
<td></td>
<td>●</td>
</tr>
<tr>
<td>Limiting physical and psychological health risks of technology</td>
<td></td>
<td></td>
<td></td>
<td>●</td>
</tr>
<tr>
<td>The iKeepSafe Six pillar model (<a href="http://www.ikeepsafe.org/be-a-pro/info/">http://www.ikeepsafe.org/be-a-pro/info/</a>)</td>
<td>●</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Balance: Balancing Digital Usage</td>
<td>●</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ethics: Practicing Ethical Digital Usage</td>
<td></td>
<td>●</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Privacy: Protecting Personal Information</td>
<td></td>
<td></td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>Relationships: Maintaining Healthy &amp; Safe Relationships</td>
<td></td>
<td></td>
<td></td>
<td>●</td>
</tr>
<tr>
<td>Reputation: Building a Positive Reputation</td>
<td></td>
<td></td>
<td></td>
<td>●</td>
</tr>
<tr>
<td>Online Security: Achieving Digital Security</td>
<td></td>
<td></td>
<td></td>
<td>●</td>
</tr>
<tr>
<td>The digital citizenship scale factors (Choi, Glassman, &amp; Cristol, 2017)</td>
<td>●</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Internet Political Activism (IPA)</td>
<td>●</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technical Skills (TS)</td>
<td>●</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Local/Global Awareness (LGA)</td>
<td>●</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Critical Perspective (CP)</td>
<td>●</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Networking Agency (NA)</td>
<td>●</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


Present study

As mentioned so far, existing Digital Citizenship scales have applied the concept of traditional citizenship for general adults to the online setting, which leads to contain too broad ranges and do not precisely focus on the target students. In addition, there is a limitation in that they do not explicitly include psychological factors such as adolescents’ self-identity. For these reasons, teachers do not have clear criteria for facilitating young people to have digital citizenship, which leads to problems in the direction and goals of Digital Citizenship education. This study aims to clearly identify the Digital Citizenship Scale for adolescents perceived by teachers who are responsible for their students’ digital citizenship education and to present the needs and direction of school-based education to satisfy the identified Digital Citizenship Scales. The research questions for this study are addressed below: (1) What are the categories and factors of Digital Citizen Scale for adolescents from the teacher’s perspective? (2) What are the guidelines for proper digital citizenship education for adolescents?

The limitations of this study are as follows. In this study, convenience sampling method was used. Therefore, due to the nature of convenience sampling, the background information of the sample is unevenly distributed, particularly gender and nationality. First, the subjects of this study were pre and in service teachers in Korea. Considering the appropriate number of samples for the structural equation model (150-400) (Hair et al., 1998), the number of subjects in this study is an appropriate sample. However, since the proportion of women is higher than that of men, it is not possible to exclude differences in recognition of Digital Citizenship Scale by gender. Second, although Korea has the highest score in the ICT development index in the world, as data are collected in one country, a little attention needs to be paid to the generalization of this study. Third, in order to derive the
overall Digital Citizenship Scale framework, we conducted a study through concept analysis based on the research presented in English in. For this reason, there may be some studies that are missing. Given that there are some limitations in terms of methodology, we have tried to maintain maximum objectivity and universality using the ISTE Standard for the overall analysis process.

**Method**

**Participants**

There were 200 participants consisting of 97 pre-service teachers (48.5%) who are currently enrolled in Teachers’ College and 103 in-service teachers (51.5%) in Korea as of 2017 for this study. These participants were recruited through convenience sampling. A total of 200 questionnaires were analyzed. The mean age was 29.93 (SD = 11.50), and female (138, 69%) was more than male (62, 31%). The average Internet usage time per day of participants was 2.96 hours (SD = 2.06), including the time to access the Internet through a mobile phone. In the case of current teachers, the average year of career experience was 13.37 years (SD = 9.77), while the pre-service teachers had the highest percentage of students in 2nd grade (n = 34, 35.1%) overall. The demographic characteristics of the samples used in this study are presented in Table 3.

<table>
<thead>
<tr>
<th>Respondents characteristics</th>
<th>% (N)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gender</strong></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>31% (62)</td>
</tr>
<tr>
<td>Female</td>
<td>69% (138)</td>
</tr>
<tr>
<td><strong>Age</strong></td>
<td></td>
</tr>
<tr>
<td>19-20 years old</td>
<td>21% (42)</td>
</tr>
<tr>
<td>21-25 years old</td>
<td>35% (70)</td>
</tr>
<tr>
<td>26-30 years old</td>
<td>5.5% (11)</td>
</tr>
<tr>
<td>Over 30 years</td>
<td>38.5% (77)</td>
</tr>
<tr>
<td><strong>Average Internet usage time per day</strong></td>
<td></td>
</tr>
<tr>
<td>Less than 1 hour</td>
<td>21.5% (43)</td>
</tr>
<tr>
<td>2-3 hours</td>
<td>54% (108)</td>
</tr>
<tr>
<td>4-5 hours</td>
<td>14.5% (29)</td>
</tr>
<tr>
<td>More than 6 hours</td>
<td>10% (20)</td>
</tr>
<tr>
<td><strong>Years of teaching experience</strong></td>
<td></td>
</tr>
<tr>
<td>Less than 5 years</td>
<td>31.1% (32)</td>
</tr>
<tr>
<td>6-10 years</td>
<td>9.7% (10)</td>
</tr>
<tr>
<td>11-15 years</td>
<td>13.6% (14)</td>
</tr>
<tr>
<td>More than 16 years</td>
<td>45.6% (47)</td>
</tr>
<tr>
<td><strong>Grade (pre-service teacher)</strong></td>
<td></td>
</tr>
<tr>
<td>Freshman</td>
<td>15.5% (15)</td>
</tr>
<tr>
<td>Sophomore</td>
<td>35.1% (34)</td>
</tr>
<tr>
<td>Junior</td>
<td>21.6% (21)</td>
</tr>
<tr>
<td>Senior</td>
<td>27.8% (27)</td>
</tr>
</tbody>
</table>

When it comes to participants in this study, Korea is one of the leading countries in the ICT sector. Particularly, in the ICT Development Index, which is evaluated annually by the Information Technology Union (ITU), Korea has been ranked first place for 9 consecutive years since 2008. The digital age connected in various ways is a period of learning and collaborating with other nations and at the same time a period of accountability. In this context, ISTE elaborates and provides the skills teachers need to integrate for learning and teaching. ISTE standards are being adopted by ICT frameworks in their school environment in various countries, mainly in the United States (ISTE, 2016). Korea also adopts the ISTE standard as the standard of school learning and education for the digital age (Heider & Jalongo, 2014). Standards or competencies provide a common language for skills, goals, and anticipated outcomes. In this context, the Digital Citizenship Scale derived from Korean teachers is consisted with the ISTE standard and will have universal impact on various countries.
Procedure

We tried to use the procedures as useful and valid as we could in developing items for digital citizenship scale for Adolescents. The elements for digital citizenship scale presented in this study were derived from concept analysis using the term digital citizenship. As Meyer, Becker, and Vandenbergh (2004) pointed out, conceptual analysis provides a plausibility to develop measurement tools by classifying, clarifying, comparing, and redefining meaning. Based on the researches on the components of digital citizenship that have already been published and released, we derived the categories that constitute digital citizenship concept for adolescents. This study was conducted in four steps to create a reliable and valid tool for measuring the digital citizenship for adolescents perceived by teachers. For the procedure of this study, the most recently composed digital citizenship scale study (Choi, Glassman, & Cristol, 2017) was referenced to and revised.

Step one: Concept analysis for item generation

A preliminary part of the study to create a digital citizenship scale for adolescents began with deriving an understanding of the relevant items. In order to check what items have been set up in previous researches and to identify the meaning, characteristics, and attributes of abstract components, conceptual analysis was conducted through three online databases (i.e., Google Scholar, ERIC, and EBSCO) and 16 related studies were confirmed. The researchers identified items for digital citizenship scale commonly used in these studies. At the same time, the emotional aspect of adolescents, which was an important research subject of this study, was added and confirmed. Through this step one, we identified the categories that make up digital citizenship for adolescents, and have classified them into four categories (Self-identity, Activity in online, Fluency for Digital environment, and Ethics for Digital environment) using ISTE’s standards for students for digital citizenship (Figure 1).

![Figure 1. SAFE framework for digital citizenship scale of youth](image)

Step two: Generating scale items and expert review for revision

Based on the four categories derived from step one, scale items appropriate for each category were constructed. At this stage, the scale items used in the previous research were constructed as much as possible, rather than being constructed arbitrarily by the researchers. After creating the scale items, cross-checked and double-check were conducted to determine if the generated scale items for digital citizenship scale was appropriate by both survey composition specialist and education specialist. The objective of this was to minimize the ambiguity, misunderstanding or other nonconformity of the items constituted by the researchers. The key questions used at this stage were: (1) Are the questions proper for adolescents’ digital citizenship? (2) Are there questions that are not related to digital citizenship? (3) Are there any parts that are difficult to interpret or interpreted in a poly-semantic way? (4) Are there any questions that need to be repeated or added? Through this process, we finally made corrections, inclusion and elimination of digital citizenship scale for adolescents.
Step three: Executing EFA and CFA

For conducting Exploratory Factor Analysis (EFA) for the digital citizenship scale questionnaire which was composed and revised clearly through two stages, the convenience sample of current serving teachers and pre-service teachers was used. The survey was conducted anonymously, and the questionnaire was briefly described before putting into survey. In the case of the preliminary teacher, the permission was obtained from the school and all participants volunteered to participate in the survey as well. After that, for the purpose of verifying a proposed factor structure derived from EFA, Confirmatory Factor Analysis (CFA) was performed.

Step four: Measuring concurrent validity for final scale

Through the process of Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA), the final digital citizenship scale for adolescent was derived. Researchers confirmed the validity of final digital citizenship scale for adolescent through correlation with internet self-efficacy scale.

Measures

Internet self-efficacy scale

We measured the Internet efficacy for the concurrent validity of this study based on the precedent studies (De Marco et al., 2014) that the internet efficacy has a positive correlation with digital citizenship. Kim and Glassman (2013) defines the internet efficacy as an individual’s competence and beliefs related to internet use and developed a self-report scale to measure it. In order to measure the internet efficacy, we used self-report scale of Kim and Glassman (2013) which defined internet use with individual competence and belief. Originally, the Internet Efficacy Scale developed by them, is composed of 17 items including information search, communication, differentiation, and information organization. Researchers used 15 questions for this study after eliminating the ambiguous questions considering the content validity. The Cronbach’s alpha of the Internet efficacy used in this study was 9.16. A 5-point Likert type of scale ranging from 1 (strongly disagree) to 5 (strongly agree) was used.

Data analyses

In order to examine the sub-factor structure of DCS consisting of 42 items, we conducted Exploratory Factor Analysis (EFA) using the total sample (n = 200). Factor analysis does not presuppose linear independence between factors and it is desirable to conduct the principal axis factoring in examining the structure between factors (Reinard, 2006), so maximum likelihood factoring was used for this study to produce more accurate results. As for a rotation method, the direct Oblimin method is more accurate than the Varimax rotation in social science assuming a correlation between factors (Osborne & Costello, 2009), so direct Oblimin method was applied. Next, to verify the reliability of the digital citizenship scale, the Cronbach's alpha coefficient was calculated to evaluate the internal consistency of the total and sub-categories of the digital citizen scale. Also, to test the scale’s construct validity, correlation between digital citizenship and Internet self-efficacy was analyzed. Finally, Confirmatory Factor Analysis (CFA) was performed using AMOS 23.0 to verify a proposed factor structure derived from EFA.

Result

The demographic characteristics of the entire sample used in exploratory factor analysis and confirmatory factor analysis are presented in the table 2. Results of exploratory factor analysis using maximum likelihood factoring and direct Oblimin method, reliability and validity of scale, and confirmatory factor analysis using structural equation modeling are presented below.

Exploratory factor analysis

To determine whether exploratory factor analysis was adequate for the samples, KMO (Keiser-Meyer-Olkin) measures, Bartlett’s test, and correlation matrix table were confirmed. The KMO measure of this measurement
was 0.79 and the Bartlett’s test score was 4389.636 ($df = 496$, $p = .00$), which indicated that the sample was acceptable. If the correlation between the items is high ($r > 0.80$), those items should be removed from the scale due to the problem of multi-collinearity (Field, 2013). After we analyzing the correlation matrix table of scale items for this study, the items (1, 4, 13, 16, 17, 28, 29, 33, 38, 42) that high correlation between inter-correlation between variables were removed from scale items, to prevent the problem of multi-collinearity.

As a result of exploratory factor analysis for 32 items by way of maximum likelihood analysis and direct Oblimin method, factor rotation was converged by 15 iterations. Considering the point where eigenvalue greater than one and elbow of the curve in scree test (accepting factors above it and rejecting those below it), seven factors were found initially. However, the five items (23, 5, 7, 25, 27, and 37) with factor loadings less than 0.40 and five items (22, 35, 30, 37, 40, 41, and 26), which were not consistent with the results of the conceptual analysis of digital citizenship, were eliminated in later analysis. So, 18 out of the 32 items were used for reliability analysis. The factors including individual items retained in the final scale and their factor loadings are provided in Table 4.

Finally, an 18-item measure with five-factors was found from EFA (Table 3). The first factor consists of 3 items (24, 8, and 20) and was associated with the demonstration and respect for rights, responsibilities, obligations, and etiquette in online. The second factor was composed of 3 items (3, 15, and 11) and mainly dealt with knowledge and literacy skills of digital environment. When it comes to the third factor (items 6, 2, 14) and the fifth factor (items 39, 31, 18, 36, 19, 10), both factors were related to the positive and safe behavioral aspect in the digital environment. Regarding the fourth factor (21, 34, 9), it mainly related to the establishment and management of adolescents’ digital identity and reputation. Descriptive statistics for the five factors are also presented in Table 4. The first factor had the highest mean ($M = 4.42$, $SD = .79$) while the fifth factor had the lowest means ($M = 3.13$, $SD = .68$).

Reliabilities of digital citizenship scale

The Cronbach’s alpha coefficient for entire 18 items on the Digital Citizenship Scale was 0.75. In detail, the Cronbach’s alpha coefficients for verifying the internal consistency of each sub-factor extracted from the exploratory factor analysis were 0.92 for the first factor, 0.74 for second factor, 0.83 for the third factor, 0.91 for the fourth factor, and 0.76 for the fifth factor. In summary, the homogeneity between the items constituting each sub-factor of digital citizenship was good between 0.74 and 0.92.

Table 4. The digital citizenship scale for adolescent items and the respective factor loadings

<table>
<thead>
<tr>
<th>Items</th>
<th>F1</th>
<th>F2</th>
<th>F3</th>
<th>F4</th>
<th>F5</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Factor 1</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24. Students should respect other people in the online environment and not engage in bullying behavior.</td>
<td>0.959</td>
<td>0.038</td>
<td>0.075</td>
<td>-0.013</td>
<td>-0.035</td>
</tr>
<tr>
<td>8. Students should be responsible for their own online activities.</td>
<td>0.819</td>
<td>0.04</td>
<td>0.027</td>
<td>-0.037</td>
<td>0.029</td>
</tr>
<tr>
<td>20. Students should be aware of the order of others in the online digital environment and should obey the order.</td>
<td>0.752</td>
<td>-0.102</td>
<td>-0.122</td>
<td>0.211</td>
<td>0.01</td>
</tr>
<tr>
<td><strong>Factor 2</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Students should use digital technology to achieve various goals.</td>
<td>-0.002</td>
<td>0.935</td>
<td>0.068</td>
<td>0.061</td>
<td>-0.105</td>
</tr>
<tr>
<td>15. Students should immediately manage unnecessary files and programs on their computers.</td>
<td>-0.01</td>
<td>0.697</td>
<td>-0.016</td>
<td>0.1</td>
<td>0.035</td>
</tr>
<tr>
<td>11. Students should use the Internet to access more information about domestic and international issues.</td>
<td>-0.088</td>
<td>0.512</td>
<td>-0.182</td>
<td>0.016</td>
<td>0.059</td>
</tr>
<tr>
<td><strong>Factor 3</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Students should express their emotions reasonably through communication when problems or inconveniences arise in the online digital environment.</td>
<td>0.047</td>
<td>-0.061</td>
<td>0.909</td>
<td>0.049</td>
<td>-0.08</td>
</tr>
<tr>
<td>2. Students should express their opinions online and learn and share their expertise.</td>
<td>0.051</td>
<td>0.013</td>
<td>0.754</td>
<td>-0.02</td>
<td>-0.059</td>
</tr>
<tr>
<td>14. Students should purchase legitimate goods during e-commerce activities.</td>
<td>0.045</td>
<td>-0.029</td>
<td>0.662</td>
<td>-0.008</td>
<td>0.059</td>
</tr>
<tr>
<td><strong>Factor 4</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21. Students should be aware of their own health problems</td>
<td>0.147</td>
<td>0.15</td>
<td>0.026</td>
<td>0.881</td>
<td></td>
</tr>
</tbody>
</table>
caused by the abuse of digital devices, such as addiction and stress.

34. Students should establish their own beliefs and values about the digital environment.

9. Students should immediately delete emails from suspicious senders.

**Factor 5**

39. Students should present their feelings, thoughts and opinions while posting text, photos, music, or videos online.

31. Students should belong to an online community related to social or political issues.

18. Students should always check the price on the Internet when purchasing goods.

36. Students should work with others online to solve regional or school problems.

19. Students should take care of the computer immediately if something goes wrong.

10. Students should be active in SNS such as KakaoTalk and Facebook.

<table>
<thead>
<tr>
<th>Factor</th>
<th>N</th>
<th>Mean(SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factor 1</td>
<td>3</td>
<td>4.42(0.79)</td>
</tr>
<tr>
<td>Factor 2</td>
<td>3</td>
<td>3.82(0.59)</td>
</tr>
<tr>
<td>Factor 3</td>
<td>3</td>
<td>4.00(0.66)</td>
</tr>
<tr>
<td>Factor 4</td>
<td>3</td>
<td>4.40(0.69)</td>
</tr>
<tr>
<td>Factor 5</td>
<td>6</td>
<td>3.13(0.68)</td>
</tr>
</tbody>
</table>

**Confirmatory factor analysis**

Based on the five-factor structure with 18 items extracted by Exploratory Factor Analysis, Confirmatory factor analysis was performed on the five-factor model. The path model used for CFA is shown in the following Figure 2, and the model fit index obtained from the verification is presented in Table 6. Model fit indexes such as GFI (Goodness of Fit Index), CFI (Comparative Fit Index), TLI (Tucker-Lewis Index), and RMSEA (Root Mean Square Error of Approximation), which were sensitive to the size of the sample and reflected the model's interrelation (Lomax & Schumacker, 2012), were taken into account as to evaluate how well the model matched the actual data. Since the initial model did not meet the criteria, researchers detected covariance paths between the error of items 31 and 10, 18 and 19, 11 and 12 using modification indices and then the model was rerun. The results of the five-factor structural model fit obtained in this study were GFI = .876, CFI = .924, TLI = .915, and RMSEA = .076. Considering that GFI, CFI, and TLI are moderate when close to 1, and RMSEA is between .05 and .08, the final 5 factor model assumed in this study considered to be moderate to good fit (Table 6).

<table>
<thead>
<tr>
<th>X²</th>
<th>df</th>
<th>GFI</th>
<th>CFI</th>
<th>TLI</th>
<th>RMSEA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Original model</td>
<td>318.900</td>
<td>125</td>
<td>.859</td>
<td>.898</td>
<td>.875</td>
</tr>
<tr>
<td>Second model</td>
<td>306.249</td>
<td>124</td>
<td>.864</td>
<td>.904</td>
<td>.881</td>
</tr>
<tr>
<td>Final model</td>
<td>265.516</td>
<td>122</td>
<td>.876</td>
<td>.924</td>
<td>.915</td>
</tr>
</tbody>
</table>

The first factor was named Ethics for Digital environment because it was associated with the demonstration and respect for rights, responsibilities, obligations, and etiquette in online. The second factor was called Fluency for Digital environment because it mainly dealt with knowledge and literacy skills of digital environment. Both the third factor and the fifth factor were related to the positive and safe behavioural aspect of the concept analysis for developing the scale of this study, so we decided to classify them into so called Activity in Online in large (together). The former was named Reasonable activity and the latter was Social/cultural engagement. When it comes to the fourth factor, we decided to name it Self-identity in digital world.

Traditionally, citizenship has been divided into “duty-based citizenship” which focused on formal duties, responsibilities, and management and “engaged citizenship” which emphasized on moral and empathic roles (Dalton, 2013). The results of this study showed that the digital citizen scale for adolescents was not only a
mandatory citizen as a passive participant but also an active personality that can be cultivated by interactive and horizontal network communication such as internet and social media at the same time. In addition, the issues of autonomy, importance of identity issues, and desire to establish self-consciousness, which represent the characteristics of adolescents at the developmental stage (Barth, 2015; Harold et al., 2007) were reflected in the digital citizen scale. The characteristics of digital citizenship scale for adolescent derived from this study are as follows.

First, the factors related to the ethics and literacy in the digital environment, which have been frequently emphasized in digital citizenship, were found to be the most important factors in this study as well. Above all, the items emphasized in digital ethics were interpreted as showing the duality of duty-based citizenship and engaged citizenship. Specifically, the teacher recognizes that youth should be equipped with respecting other people in the online environment and not engage in bullying behaviour, being responsible for their own online activities, and knowing of the order of others in the online digital environment and should obey the order. These results are consistent with the discussion of netiquette or etiquette that has traditionally been emphasized under the name digital citizenship (Farmer, 2011; ISTE, 2016; Ribble, 2011; Ribble, 2015; Ribble, Bailey, & Ross, 2004). In addition, the competence related to digital literacy is derived as the second factor in this study. In detail, using digital technology to achieve various goals, managing unnecessary files and programs on their computers, and using the internet to access more information about domestic and international issues are presented as important items. These results have shown that beyond the simple technical skills (Dede, 2009;

Figure 2. CFA model of the Digital Citizenship Scale
Mossberger, 2009; Simsek & Simsek, 2013), setting goals for their own, cultivating problem solving abilities, and demanding digital literacy or fluency are emphasized as comprehensive capabilities for digital environment. The most important aspect of the digital citizenship scale for adolescents perceived by teachers can be understood as significantly as the traditional perceptions.

Second, the active and participatory media use and activities were emphasized rather than the passive approach to media in the digital environment. The recognition of social issues in terms of the types and characteristics of digital environment to realize oneself leads to differentiation of participation in digital world (Besley, 2006), which can be interpreted that the debate about digital activities has been deepened. The third factor and the fifth factor, which were the category of activity in online derived from this study, were aspects of this active digital citizenship. The third factor emphasized active activity through rational and critical decisions (e.g., expressing their emotions reasonably through communication when problems or inconveniences arise in the online digital environment, delivering their opinions online and learn and share their expertise, purchasing legitimate goods during e-commerce activities based on rational decisions). The reason for reconsidering this critical and rational judgment is that the advent of diverse social media, including the internet, can be interpreted as creating more complex and multi-layered problem situations and conflicts than ever before (Bennett, Wells, & Rank, 2009).

In other words, students who are able to participate in various activities by presenting their opinions clearly through reasonable decision-making are considered desirable as a digital citizen (Livingstone & Helsper, 2009). In the theoretical analysis of digital citizenship for adolescents, another factor that is classified as activity in online is the fifth element (social and cultural engagement). The items included in this factor were presenting feelings, thoughts and opinions while posting various materials in online, belonging to an online community, checking the price on the internet in purchasing goods, collaboration with others online to solve regional or school problems, and being active in SNS. As social media become more common, the relationship between society, digital media, and culture is becoming more complex and dynamic. People who are both members of the society and who use the media are more actively transforming and sharing the media in various forms and seeking information than in the past. And it can be interpreted that online participatory culture can be formed around the interaction based on the convergence (Jenkins, 2006).

Third, the digital citizenship of adolescents, based on their understanding of social media, was competency to present their opinions on social issues for the public goals in digital environment, to act in consideration of the position of others, and to make faith on their own in online. These items (e.g., being aware of their own health problems caused by the abuse of digital devices, establishing his or her own beliefs and values about the digital environment, and protecting themselves from suspicious third party in digital environment) are the fourth element of this study. Although many items for the factor of self-identity in the digital world have not been derived, these items can be interpreted as protecting themselves through sophisticated thinking in a dynamic digital world and capturing the psychological desire for new relationships (Berzonsky, 2003; Erikson, 1968; Giddens, 1991).

Prensky (2001) named the generation that is born and growing with the transition to the digital society as “digital native.” They are innovative generation that can learn, play, communicate, work, and create communities in a different way from the older generation that was born and grown in the industrial world. The factor related to the self-identity presented in this study can be interpreted as the valuable attempt of digital citizenship scale which reflects characteristics of adolescents who are more free and sincere than other generations and who are characterized by pursuing entertainment with an emphasis on collaboration and speed.

**Concurrent validity of digital citizenship scale**

In order to verify Construct validity of Digital Citizenship Scale, the correlation between the total scores of Digital Citizenship Scale and Internet Efficacy Scale was tested. As a result of the correlation analysis, the total score correlation of the digital citizenship scale showed positive correlations with internet efficacy scale ($r = .21, p < .01$). This result indicated that the validity of the digital citizenship scale was statistically significant as mentioned in previous study (De Marco et al., 2014).

**Discussion**

The five-factor(Ethics for Digital environment, Fluency for Digital environment, Reasonable Activity, Self-identity in digital world, and Social/cultural engagement) digital citizenship scale for adolescents perceived by the teacher was extracted from exploratory factor analysis and reliability and validity of the scale were found to
be statistically significant. In addition, confirmatory factor analysis revealed that the construct validity of the five-factor structure model of the digital citizenship scale was also appropriate. Based on the results of this study, we can make a tentative conclusion that the digital citizenship scale consists of homogeneous items by factors and is valid and reliable for measuring the sense of digital citizenship of adolescents.

**Direction of digital citizenship education for digital age**

Many researchers have argued that the concept of digital citizenship should be redefined in the current digital environment and that the direction of digital citizenship education should be newly established (Bennett & Fessenden, 2006). In fact, the concept of citizenship in school education emphasizes its role as active participant (Bennett, Wells, & Rank, 2009; Dalton, 2013). In addition, since digital networks as well as traditional educational institutions such as schools and homes have a strong connection to the citizenship development of youth generation called “digital native,” the need for a new citizenship education for them is suggested. The followings are a discussion of the direction and implication of the digital citizenship scale perceived by the teachers to the digital citizenship education.

First, as can be seen from the five-factor structure of the digital citizenship scale for adolescents perceived by the teacher, it can be inferred that the concept of digital citizenship consists of multidimensional rather than single dimension. This implies that various factors such as knowledge, attitude, and behaviour should be considered together when understanding digital citizenship. This provides important implications for exploring the direction of citizenship education in the digital age of the 21st century. The education of citizenship in the digital age should be done from a comprehensive point of view, moving away from existing citizenship education which emphasized only one factor such as digital literacy education or participation education (Jones & Mitchell, 2016). Therefore, it is important to cast doubt once again about the possibility of educating democratic digital citizens automatically through the use of internet-based instruction or software education.

Second, although the new features of internet development are attached to the concept of digital citizenship, the whole concept of digital citizenship education should be understood in a continuous line network of traditional citizenship concepts. This is because the concept of digital citizenship also includes various characteristics of traditional citizenship concepts such as social ethics, literacy ability, and participation through rational judgment (Choi, Glassman, & Cristol, 2017). In other words, it can be said that the concept of digital citizenship education exists not only in the linear developmental relationship of the existing concept of citizenship education, but also in the non-linear and indirect relationship rather than the opposite concept of the traditional concept of citizenship. Therefore, rather than replacing existing education contents with new ones for the purpose of digital citizenship education, if we emphasize the knowledge, ability, and behaviour related to development of digital world within existing citizenship education, it will help to foster sense of digital citizen without major changes in curriculum or textbook content.

Third, this study shows that there is a limit to growth as a digital citizen who actively expresses and acts in the digital age simply by technically using the internet without problems and by knowing information about politics, economy, society and culture of local, national and global society (Bennett, Wells, & Rank, 2009; Mossberger, Tolbert, & McNeal, 2007). Therefore, the direction of digital citizenship education should be set so that students can grow into a citizen who actively participates in active interaction with other citizens with various interests in the online community to solve various community and global problems.

Fourth, the participation of adolescents in the digital environment has raised educational interest to emphasize the importance of establishing self-identity in the concept of citizenship education (Bennett, Wells, & Rank, 2009). The concept of digital citizenship education has emerged from the foundation of more self-fulfilling, interactive, and network digital media environment, and it can be said that digital education is connected to diverse digital related experiences and activities of youth who grew up in this digital environment. Therefore, digital citizen education should be extended to the level of exercise of right to establish self-identity and belief, protect oneself, and maintain healthy digital use, beyond the dimension of duty and responsibility to others in online activities. More multi-layered and multi-faceted digital education for the identity of students who are influenced by the digital environment needs to be considered.
Conclusion

The digital citizenship scale derived from this study measures the digital citizenship that the youth should have in terms of ethics for digital environment, fluency for digital environment, rational and active activities and establishing self-identity in digital world. In particular, this scale was derived from the teacher's perspective, so that it will provide implications for educating students to become active digital citizens. These implications are education from a comprehensive viewpoint, in harmony with traditional citizenship, with interaction from various perspectives, and for exercising rights to establish their own identity and beliefs. In a digital age, teachers play a very important role in innovative classroom activities related to the elements of digital citizenship. That is, in this digital age where abundant technology and traditional culture coexist, the role of teachers must go beyond the limit of being a mere knowledge propagator. Teachers should act as guides, counsellors, mentors and role models for various information activities. Above all, for this purpose, teachers need to understand the benefits and risks imposed by technology on students and the diverse cultures and knowledge of the current digital age. Based on these roles, teachers not only should hold a crucial role as a moral and ethical role model for safety and success in the students' offline and offline environment activities, but they should also be facilitators through experience with many digital mediums of technology and communication.

Given the fact that the most active user of digital devices and digital information is youth generation, the future of our society will depend on how effectively the youth will cope with the changing social reality by maximizing the positive effects of digitization and minimizing the adverse effects. The digital citizenship scale presented in this study suggested the necessary competence and education to cultivate digital citizenship. In addition, it suggests that such education should be integrated not only in school but also in efforts to develop digital citizenship in a balanced way in both home and society.

Reference


Understanding University Students’ Thoughts and Practices about Digital Citizenship: A Mixed Methods Study

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ABSTRACT
The purpose of this study was to investigate university students’ thoughts and practices concerning digital citizenship. An explanatory mixed methods design was used, and it involved collecting qualitative data after a quantitative phase in order to follow up on the quantitative data in more depth. In the first quantitative phase of the study, a digital citizenship survey, including demographics and 5-point Likert scale questions, was conducted with 435 students of a private university. Factor analysis, descriptive statistics, and parametric test were used to analyze the data gathered by the survey. One of the important findings in the first phase was that university students do not prefer to engage in political activities online. The second qualitative phase was conducted to better understand the reasons behind university students’ thoughts and practices regarding digital citizenship. In this exploratory follow up, the data gathered in the first phase was tentatively explored with 10 students studying at the same university. Semi-structured interviews were conducted with the students and content analysis was used to analyze the data. Based on the findings, students indicated that they do not prefer to engage in political activities online because of emotional disturbance, pressure from society, and a fear of affecting their future lives in a negative way.

Keywords
Digital citizenship, University students, Mixed methods, Technology

Introduction
Digital citizenship has become a hot topic because of the mass use of information and communication technologies. Since younger generations spend most of their time with digital technologies, such as tablets and smartphones, there is a need to investigate digital citizenship (Hill, 2015). The integration of information technologies (IT) into people’s social and daily lives may contribute to digital citizenship practices. As Shelley et al. (2004) stated, IT helps citizens interact with government to accomplish their routine jobs. That is, citizens can conduct a variety of governmental tasks, such as paying taxes and traffic fines, through e-government applications (Simsek & Simsek, 2013). Online connection to services can be seen as a central point to perpetuate digital citizenship practices. The literature also supports that online access leads people to be involved in digital citizenship activities, such as online economic and political applications (Mossberger, Tolbert, & Hamilton, 2012).

There are several definitions for “digital citizenship.” The simple definition is that digital citizenship describes the norms of appropriate, responsible behavior with regard to technology (Ribble, 2008; Ribble, Bailey, & Ross, 2004). Gazi (2016) added the term “social” to the definition and defined it as “a socially constructed set of practices and the norms of behaviours where facilitates individual development and protects social values in digital society” (p. 139). Emejulu and McGregor (2016) also defined digital citizenship as “a reaction to technologies operating as disciplining devices compelling individuals and groups to adopt particular skills and ways of being in order to successfully exist in this newly and constantly disrupted world of work and leisure” (p. 3).


The aim of this study is to understand university students’ thoughts and practices about digital citizenship. Studies on digital citizenship typically focus on K-12 students or teachers (Blevins, LeCompte, & Wells, 2014; Gazi, 2016; Hill, 2015; Hollandsworth et al., 2011; Ribble, 2008; Ribble, 2012; Ribble & Bailey, 2004; Ribble et al., 2004; Richards, 2010). Ribble et al. (2004) provide nine areas of digital citizenship and suggest several strategies for teachers to help K-12 students by using emerging technologies in an appropriate way. Richards (2010) wrote a conceptual paper exploring the potential of Web 2.0 tools, which can be used for middle school students.
educators to improve digital citizenship understanding and experiences of students. Hollandsworth et al. (2011) created a discussion paper focusing on the experiences of various practitioners and experts to help K-12 students become better digital citizens. Blevins et al. (2014) conducted a mixed methods study exploring the impact of an online civics education gaming program. The participants of the study were K-12 students and teachers. Hill (2015) conducted a descriptive study with a follow-up survey exploring a virtual, 3D-gaming environment, which was designed and built by fifth grade students to help them learn digital citizenship and information literacy. Gazi (2016) employed a qualitative case study to investigate high school students’ and teachers’ perceptions and awareness of digital citizenship. Since there has been limited digital citizenship-based research studies including university students, this study aims to fill this gap in the literature. As a conceptual framework, this study is based on four categories: Digital citizenship as Ethics, Media and Information Literacy (MIL), Participation/Engagement (P/E), and Critical Resistance (CR) (Choi, 2016). Digital citizenship as ethics refers to appropriate and responsible behaviors on the Internet (Choi, 2016; Ribble, 2012; Ribble, 2008; Ribble & Bailey, 2004; Ribble et al., 2004). Digital citizenship as MIL refers to handling and manipulating information and online communication (Choi, 2016; Mossberger et al., 2012; Simsek & Simsek, 2013). Digital citizenship as P/E refers to political, social, economic, and cultural participation in terms of online engagement (Choi, 2016; Crowe, 2006). Digital citizenship as CR “pursues more creative, innovative, non-linear, and non-hierarchal forms of participation, potentially leading to a deeper level of digital engagement” (Choi, 2016, p. 581). The main research questions of this study are presented below.

- What are the factors affecting university students’ thoughts and practices regarding digital citizenship?
- What are the effects of gender, major, daily Internet use, devices used for Internet access, and following e-government services on university students’ thoughts and practices regarding digital citizenship?
- How do the factors affect university students’ thoughts and practices regarding digital citizenship?

Method

To answer the research questions, a mixed-methods approach was used to effectively understand the research problem by combining quantitative and qualitative inquiries (Creswell, 2014). The mixed methods sequential explanatory design consists of two distinct phases: Quantitative followed by qualitative (Creswell & Plano Clark, 2007; Creswell, Plano Clark, Gutmann, & Hanson, 2003). In this design, the researcher first collected and analyzed the quantitative data to produce statistical and numeric results. The qualitative data was collected and analyzed second in the sequence and helped explain, or elaborate, on the quantitative results obtained during the first phase. The second, qualitative phase built on the first, quantitative phase, and the two phases were connected while presenting the results and discussing them. The mixed methods sequential explanatory design allowed the researcher to better understand the reasons behind factors affecting university students’ thoughts and practices about digital citizenship by exploring participants’ views in more depth (Creswell & Plano Clark, 2007).

Quantitative phase

Participants

435 undergraduate students studying at a private university served as the participants of this study. After getting the required ethical form, the survey was administered to the university students and they voluntarily participated the study. This study was conducted during the Fall semester of 2016 – 2017. The mean age of the participants was 21.55. There were 238 females and 197 males. Most of the students’ major was Education ($n = 219, 50.3\%$). The average of daily Internet use was around 6 hours. Nearly all of the students had access to the Internet via smartphones ($n = 410, 94.3\%$). More than half of the students followed e-government services regularly ($n = 244, 56.1\%$). Table 1 shows the detailed demographics of the participants.

<table>
<thead>
<tr>
<th>Demographics</th>
<th>$n$</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>238</td>
<td>54.7</td>
</tr>
<tr>
<td>Male</td>
<td>197</td>
<td>45.3</td>
</tr>
<tr>
<td>Major</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Education Sciences</td>
<td>219</td>
<td>50.3</td>
</tr>
<tr>
<td>Applied Sciences (Engineering, Pharmacy, Architecture, Health)</td>
<td>134</td>
<td>30.9</td>
</tr>
<tr>
<td>Social Sciences (Business, Economics, Humanities)</td>
<td>82</td>
<td>18.8</td>
</tr>
</tbody>
</table>

Table 1. Demographics of participants
Data collection

For the quantitative phase, the survey method was applied. According to Fraenkel and Wallen (2006), implementing a survey is an effective way to understand the population’s common characteristics. As a survey instrument, The Digital Citizenship Scale (DCS), developed by Choi, Glassman, and Cristol (2017), was adapted for the current study. The scale included 26 items, and the items in the DCS were constructed based on the elements of the four categories that served as the basis for the conceptual framework of this study: Ethics, Media and Information Literacy, Participation/Engagement, and Critical Resistance (Choi et al., 2017).

A 5-point Likert-type scale was implemented in this study, although the original DCS scale was a 7-point Likert scale. The reason for this change was to increase the understandability of the scale, because students are more familiar with the 5-point Likert-type scale. After converting the scale, the language of the scale was translated into Turkish. To maintain the validity of the survey, the scale was reviewed by two experts, one from the Department of English Language Learning and one expert from the Department of Instructional Technology. After making the necessary revisions, the final version of the DCS scale, including 26 items with a 5-point Likert-type scale, was submitted to the participants. For reliability, Cronbach's alpha for all the items was 0.88 for the original scale. Researchers also provided the construct validity of the scale (Choi et al., 2017). Cronbach’s alpha for all items was 0.89 in the current study.

Apart from the DCS scale, the instrument also included the demographic information of the participants. For the demographic information, gender, age, major, daily Internet use, purpose of using the Internet, devices used for online access, and following e-government applications were covered.

Data analysis

Both descriptive and inferential statistics were applied to analyze the survey data. The software of SPSS Statistics 20 was used to perform the necessary analyses. Factor analysis was conducted to reveal factors based on the data retrieved from the DCS scale. Mean scores and frequencies were used to understand the descriptives of the data. T-test and ANOVA were also performed to compare the groups to yield statistical results. Only meaningful statistical results of T-test and ANOVA were provided to see the effects of gender, major, daily Internet use, devices used for Internet access, and following e-government services on the digital citizenship factors.

Qualitative phase

The follow-up step of the explanatory sequential mixed-method design was the qualitative phase. After analyzing the data gathered in the quantitative phase, the qualitative phase was performed to better understand the statistical results (Creswell, 2014). Semi-structured interviews were conducted to better understand the factors affecting university students’ thoughts and practices regarding digital citizenship.
Participants

Purposeful sampling was applied to select the participants. As Patton (1990) indicated, purposeful sampling strengthens the study by including information-rich cases. Hence, 10 students who could give detailed answers to the questions and showed an interest in technology and the Internet were selected as participants. The majority of the students were from the Department of Computer Education and Instructional Technology. Three female and seven male students participated in the study. Most participants’ daily Internet use was more than 10 hours. All interviewed students declared their competency on using technology. This competency means being able to easily handle and fix the simple problems that occur while using a variety of technological devices, such as computers, tablets, and smartphones. Table 2 shows the demographic information of the participants.

Table 2. Descriptive information of the interviewed students

<table>
<thead>
<tr>
<th>No</th>
<th>Age</th>
<th>Gender</th>
<th>Department</th>
<th>Daily Internet use</th>
<th>Competent on using technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>21</td>
<td>Female</td>
<td>Early Childhood Education</td>
<td>10 hours or more</td>
<td>Yes</td>
</tr>
<tr>
<td>P2</td>
<td>22</td>
<td>Male</td>
<td>Computer Education and</td>
<td>10 hours or more</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Instructional Technology</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P3</td>
<td>22</td>
<td>Male</td>
<td>Computer Education and</td>
<td>10 hours or more</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Instructional Technology</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P4</td>
<td>25</td>
<td>Male</td>
<td>Computer Education and</td>
<td>8 hours</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Instructional Technology</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P5</td>
<td>22</td>
<td>Male</td>
<td>Computer Engineering</td>
<td>10 hours or more</td>
<td>Yes</td>
</tr>
<tr>
<td>P6</td>
<td>23</td>
<td>Male</td>
<td>Computer Education and</td>
<td>6 hours</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Instructional Technology</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P7</td>
<td>25</td>
<td>Male</td>
<td>Computer Education and</td>
<td>10 hours or more</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Instructional Technology</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P8</td>
<td>26</td>
<td>Male</td>
<td>Computer Education and</td>
<td>4 hours</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Instructional Technology</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P9</td>
<td>23</td>
<td>Female</td>
<td>Computer Education and</td>
<td>10 hours or more</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Instructional Technology</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P10</td>
<td>24</td>
<td>Female</td>
<td>Architecture</td>
<td>10 hours or more</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Data collection

Semi-structured interviews were used to collect data during the qualitative phase. According to Brenner (2006), “a semi-structured protocol has the advantage of asking all informants the same core questions with the freedom to ask follow-up questions that build on the responses received” (p. 362). Since this qualitative phase was based upon the analysis results of the previous quantitative phase, an interview protocol was developed to better understand the specific points and factors. The interview protocol included two main parts, namely, demographic and content. In the demographic section, four questions were asked to determine students’ age, major, daily Internet use, and Internet activities. In the content section, 14 main questions were asked to students to understand their political, social, cultural, ethical, and collaborative activities in the context of digital citizenship. The interviews were conducted individually with participants in the office of the researcher. Participants attended the sessions voluntarily and a tape recorder was used with their permission. Interviews took 24 minutes on average.

Data analysis

For the analysis of data gathered via qualitative, semi-structured interviews, a content analysis technique was preferred. According to Krippendorff (2004), “in content analysis, data result from the procedures the researcher has chosen to answer specific questions concerning phenomena in the context of given texts” (p. 81). Similarly, Fraenkel and Wallen (2006) emphasized that content analysis allows researcher to derive meaning from written texts. Hence, in this study, tape-recorded interviews were transcribed to prepare them for qualitative analysis. Dey (1993) categorized qualitative analysis steps as reading and annotating, creating and assigning categories based on the coding process, splitting and linking data, and making connections. Based on these categories, the researcher read the interview transcripts carefully to fully understand the participants’ reflections. Then, the coding process was applied to find commonalities for the categories. These categories were put into related themes and meaningful connections were created based on these themes.
Results

Quantitative phase

Exploratory Factor Analysis (EFA)

Choi et al. (2017) found five factors based on the 26 items in the original DCS scale. The factors were Internet Political Activism, Technical Skills, Local/Global Awareness, Critical Perspective, and Networking Agency. An Exploratory Factor Analysis (EFA) was also conducted in this study to see whether the same factors appeared. Before conducting the EFA, the researcher checked the KMO and Bartlett’s test. Since the KMO value was 0.87 and the p value of Bartlett’s test was 0.0, the EFA could be performed. For the extraction method, maximum likelihood, under the category of Common Factor Analysis, was preferred. As Preacher and MacCallum (2003) stated, “a factor’s success is gauged by how well it helps the researcher understand the sources of common variation underlying observed data” (p. 21). For the rotation technique, the Varimax method was preferred. Table 3 indicates the factor loadings. As presented in the study by Choi et al. (2017), five factors emerged based on the EFA. Compared with the original factor loadings, only 1 item loaded into a different factor.

Table 3. Summary of factor loadings for the 26-item scale

<table>
<thead>
<tr>
<th>Factor I: Internet Political Activism</th>
<th>Factor loading</th>
</tr>
</thead>
<tbody>
<tr>
<td>I work or volunteer for a political party or candidate via online methods.</td>
<td>.71</td>
</tr>
<tr>
<td>I regularly post thoughts related to political or social issues online.</td>
<td>.71</td>
</tr>
<tr>
<td>I express my opinions online to challenge dominant perspectives or the status quo with regard to political or social issues.</td>
<td>.69</td>
</tr>
<tr>
<td>I belong to online groups that are involved in political or social issues.</td>
<td>.64</td>
</tr>
<tr>
<td>I sometimes contact government officials about an issue that is important to me via online methods.</td>
<td>.64</td>
</tr>
<tr>
<td>I sign petitions about social, cultural, political, or economic issues online.</td>
<td>.64</td>
</tr>
<tr>
<td>I organize petitions about social, cultural, political, or economic issues online.</td>
<td>.60</td>
</tr>
<tr>
<td>I work with others online to solve local, national, or global issues.</td>
<td>.58</td>
</tr>
<tr>
<td>I use the Internet in order to participate in social movement/change or protest.</td>
<td>.49</td>
</tr>
<tr>
<td>I attend political meetings or public forums on local, town, or school affairs via online methods.</td>
<td>.45</td>
</tr>
</tbody>
</table>

Factor 2: Critical Perspective

I think online participation is an effective way to engage with political or social issues. | .62 |
I think I am given to rethink my beliefs regarding a particular issue/topic when I use the Internet. | .57 |
I think online participation promotes offline engagement. | .54 |
I think online participation is an effective way to make a change to something I believe to be unfair or unjust. | .53 |
I think the Internet reflects the biases and dominance present in offline power structures. | .46 |
I am more socially or politically engaged when I am online than offline. | .39 |

Factor 3: Technical Skills

I can use the Internet to find and download applications that are useful to me. | .89 |
I can use the Internet to find information I need. | .75 |
I am able to use digital technologies (e.g., mobile/smartphones, Tablet PCs, Laptops, PCs) to achieve the goals I pursue. | .64 |
I can access the Internet through digital technologies (e.g., mobile/smartphones, Tablet PCs, Laptops, PCs) whenever I want. | .53 |

Factor 4: Networking Agency

I enjoy communicating with others online. | .70 |
I enjoy collaborating with others online more than I do offline. | .50 |
Where possible, I comment on other people’s writing in news websites, blogs, or SNSs I visit. | .48 |
I post original messages, audio, pictures, or videos to express my feelings/thoughts/ideas/opinions on the Internet. | .43 |

Factor 5: Local/Global Awareness
I am more aware of global issues through using the Internet. .82
I am more informed with regard to political or social issues through using the .76 Internet.

Reliability analysis was conducted for each factor. The Cronbach’s alpha values were 0.88, 0.78, 0.80, 0.69, and 0.84 for Internet Political Activism, Critical Perspective, Technical Skills, Networking Agency, and Local/Global Awareness, respectively. Cronbach’s alpha for all items was 0.89. The following section reported statistical analysis for each factor.

**Internet political activism**

According to the findings presented in Table 4, the mean scores of the majority of items about Internet Political Activism were lower than 3. That is, university students, in general, do not prefer to engage in political activism on the Internet. 57.2% of university students do not work or volunteer for a political party or candidate on the Internet. More than half of the students (57.2%) do not belong to online political or social groups on the Internet. The findings also indicated that only 29% of university students contacted government officials online. An interesting finding based on the scores was related with petitions on the Internet. More than half of the students (57.2%) sign petitions online. In addition, 57.2% of university students do not work or volunteer for a political party or candidate on the Internet. 57.2% of university students do not work or volunteer for a political party or candidate on the Internet. 57.2% of university students do not work or volunteer for a political party or candidate on the Internet.

<table>
<thead>
<tr>
<th>Table 4. Mean, frequencies and percentages of items for the factor of Internet Political Activism</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Items for internet political activism</strong></td>
</tr>
<tr>
<td>------------------------------------------</td>
</tr>
<tr>
<td>I work or volunteer for a political party or candidate via online methods.</td>
</tr>
<tr>
<td>I regularly post thoughts related to political or social issues online.</td>
</tr>
<tr>
<td>I express my opinions online to challenge dominant perspectives or the status quo with regard to political or social issues.</td>
</tr>
<tr>
<td>I belong to online groups that are involved in political or social issues.</td>
</tr>
<tr>
<td>I sometimes contact government officials about an issue that is important to me via online methods.</td>
</tr>
<tr>
<td>I sign petitions about social, cultural, political, or economic issues online.</td>
</tr>
<tr>
<td>I organize petitions about social, cultural, political, or economic issues online.</td>
</tr>
<tr>
<td>I work with others online to solve local, national, or global issues.</td>
</tr>
<tr>
<td>I use the Internet in order to participate in social movement/change or protest.</td>
</tr>
<tr>
<td>I attend political meetings or public forums on local, town, or school affairs via online methods.</td>
</tr>
</tbody>
</table>

An independent samples t-test was used to compare the mean scores of Internet Political Activism for male and female university students. The results indicated that there was a statistically significant difference in the average mean score of Internet Political Activism between female (M = 2.62, SD = 0.85) and male (M = 2.80, SD = 0.81) university students (t (426) = -2.19, p < .05, r = .39). On average, Internet Political Activism scores of male university students were higher than females (see Table 5).

| Table 5. Results of t-test for Internet Political Activism by Gender |
|---------------------|---------------------|---------------------|
| **Male** | **Female** | **Female** | **t** | **df** |
| Internet Political Activism | 2.80 | 0.81 | 194 | 2.62 | 0.85 | 234 | -2.19* | 426 |

*Note. *p < .05.
An independent samples t-test was used to compare the mean scores of Internet Political Activism for university students to determine whether they follow e-government services regularly. The results indicated that there was a statistically significant difference in the average mean score of Internet Political Activism between university students who follow e-government services regularly (M = 2.83, SD = 0.81) and those who do not (M = 2.54, SD = 0.84) (t (423) = 3.52, p < .05, r^2 = .17). The Internet Political Activism scores of university students following e-government services regularly were higher than those who are not following e-government services regularly (see Table 6).

### Table 6. Results of t-test for Internet Political Activism by e-Government Services

<table>
<thead>
<tr>
<th></th>
<th>Following e-Government Services Regularly</th>
<th>Not Following e-Government Services Regularly</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>Internet Political Activism</td>
<td>2.83</td>
<td>0.81</td>
</tr>
</tbody>
</table>

*Note.* p < .05.

### Critical perspective

According to the findings presented in Table 7, the mean scores for all items relating to critical perspective were higher than 3. That is, university students, in general, have a critical perspective in terms of political and social issues on the Internet. For instance, 57.65% of university students believe in the effectiveness of engaging with political or social issues online. More than half of the students (55.9%) think that the Internet leads them to consider their beliefs. The findings also indicated that 50.7% of the students believe in the importance of the Internet in changing something which is unfair or unjust. One interesting finding related with the statistics was that nearly half of the university students (48.6%) believe the dominance of real-life power structures in online environments.

### Table 7. Mean, frequencies and percentages of items for the factor of Critical Perspective

<table>
<thead>
<tr>
<th>Items for Critical Perspective</th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Undecided</th>
<th>Agree</th>
<th>Strongly agree</th>
<th>Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I think online participation is an effective way to engage with political or social issues.</td>
<td>24</td>
<td>50</td>
<td>108</td>
<td>196</td>
<td>51</td>
<td>3.47 (1.03)</td>
</tr>
<tr>
<td>I think I am given to rethink my beliefs regarding a particular issue/topic when I use the Internet.</td>
<td>16</td>
<td>56</td>
<td>118</td>
<td>191</td>
<td>50</td>
<td>3.47 (0.98)</td>
</tr>
<tr>
<td>I think online participation promotes offline engagement.</td>
<td>42</td>
<td>73</td>
<td>119</td>
<td>150</td>
<td>47</td>
<td>3.20 (1.14)</td>
</tr>
<tr>
<td>I think online participation is an effective way to make a change to something I believe to be unfair or unjust.</td>
<td>19</td>
<td>61</td>
<td>132</td>
<td>154</td>
<td>64</td>
<td>3.43 (1.05)</td>
</tr>
<tr>
<td>I think the Internet reflects the biases and dominance present in offline power structures.</td>
<td>16</td>
<td>77</td>
<td>128</td>
<td>159</td>
<td>50</td>
<td>3.35 (1.02)</td>
</tr>
<tr>
<td>I am more socially or politically engaged when I am online than offline.</td>
<td>35</td>
<td>104</td>
<td>116</td>
<td>134</td>
<td>41</td>
<td>3.10 (1.12)</td>
</tr>
</tbody>
</table>

An independent samples t-test was used to compare the mean scores of Critical Perspective for university students to determine whether they follow e-government services regularly. The results indicated that there was a statistically significant difference in the average mean score of Critical Perspective between university students who follow e-government services regularly (M = 3.46, SD = 0.69) and those who do not (M = 3.18, SD = 0.74) (t (422) = 4.07, p < .05, r^2 = .19). The Critical Perspective scores of university students following e-government services regularly were higher than those who do not follow e-government services regularly (see Table 8).

### Table 8. Results of t-test for Critical Perspective by e-Government Services

<table>
<thead>
<tr>
<th></th>
<th>Following e-Government Services Regularly</th>
<th>Not Following e-Government Services Regularly</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>Critical Perspective</td>
<td>3.46</td>
<td>0.69</td>
</tr>
</tbody>
</table>

*Note.* *p* < .05.
Technical skills

According to the findings presented in Table 9, the mean scores of all items relating to technical skills were higher than 4. That is, the majority of university students are good at using digital technologies. For instance, 93.5% of the students can connect to the Internet to find and download applications. In addition, 95.6% of the students are able to use digital technologies, such as smartphones, tablets, and laptops.

Table 9. Mean, frequencies, and percentages of items for the factor of Technical Skills

<table>
<thead>
<tr>
<th>Items for Technical Skills</th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Undecided</th>
<th>Agree</th>
<th>Strongly agree</th>
<th>Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I can use the Internet to find and download applications that are useful to me.</td>
<td>1 (0.2%)</td>
<td>4 (0.9%)</td>
<td>23 (5.3%)</td>
<td>187</td>
<td>216 (50.1%)</td>
<td>4.42 (0.66)</td>
</tr>
<tr>
<td>I can use the Internet to find information I need.</td>
<td>3 (0.7%)</td>
<td>8 (1.9%)</td>
<td>20 (4.6%)</td>
<td>192</td>
<td>208 (48.3%)</td>
<td>4.38 (0.72)</td>
</tr>
<tr>
<td>I am able to use digital technologies (e.g., mobile/smartphones, Tablet PCs, Laptops, PCs) to achieve the goals I pursue.</td>
<td>1 (0.2%)</td>
<td>6 (1.4%)</td>
<td>12 (2.8%)</td>
<td>161</td>
<td>251 (58.2%)</td>
<td>4.52 (0.65)</td>
</tr>
<tr>
<td>I can access the Internet through digital technologies (e.g., mobile/smart phones, Tablet PCs, Laptops, PCs) whenever I want.</td>
<td>2 (0.5%)</td>
<td>6 (1.4%)</td>
<td>16 (3.7%)</td>
<td>163</td>
<td>244 (56.6%)</td>
<td>4.49 (0.68)</td>
</tr>
</tbody>
</table>

Networking agency

According to the findings presented in Table 10, the mean scores of the majority of items related to networking agency were higher than 3. That is, most of the university students prefer attending collaborative and social activities on the Internet. For instance, 73.7% of the students enjoy communicating with other people online. Additionally, 60.9% of the students react to other people’s posts in online environments. 61.8% of the students also post messages, audio, videos, etc. to express themselves. Based on the statistics, it was found that only 23% of the students enjoy collaborating with others online more than they do offline. It can be inferred from this finding that, university students, in general, prefer real-life collaborations supported with online collaboration.

Table 10. Mean, frequencies, and percentages of items for the factor of Networking Agency

<table>
<thead>
<tr>
<th>Items for Networking Agency</th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Undecided</th>
<th>Agree</th>
<th>Strongly agree</th>
<th>Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I enjoy communicating with others online.</td>
<td>17 (4%)</td>
<td>37 (8.7%)</td>
<td>58 (13.6%)</td>
<td>210</td>
<td>104 (24.4%)</td>
<td>3.81 (1.03)</td>
</tr>
<tr>
<td>I enjoy collaborating with others online more than I do offline.</td>
<td>79 (18.5%)</td>
<td>146 (34.3%)</td>
<td>103 (24.2%)</td>
<td>56</td>
<td>42 (9.9%)</td>
<td>2.62 (1.21)</td>
</tr>
<tr>
<td>Where possible, I comment on other people’s writings in news websites, blogs, or SNSs I visit.</td>
<td>22 (5.2%)</td>
<td>65 (15.2%)</td>
<td>80 (18.7%)</td>
<td>180</td>
<td>80 (18.7%)</td>
<td>3.54 (1.11)</td>
</tr>
<tr>
<td>I post original messages, audio, pictures, or videos to express my feelings / thoughts / ideas / opinions on the Internet.</td>
<td>33 (7.7%)</td>
<td>67 (15.7%)</td>
<td>63 (14.8%)</td>
<td>178</td>
<td>86 (20.1%)</td>
<td>3.51 (1.20)</td>
</tr>
</tbody>
</table>

Table 11. Summary of ANOVA

<table>
<thead>
<tr>
<th>Source</th>
<th>Sum of squares</th>
<th>df</th>
<th>Mean square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily internet use</td>
<td>12.88</td>
<td>5</td>
<td>2.58</td>
<td>3.97</td>
</tr>
<tr>
<td>Error</td>
<td>272.26</td>
<td>419</td>
<td>0.65</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>285.14</td>
<td>424</td>
<td>4.98</td>
<td></td>
</tr>
</tbody>
</table>

Note. *p < .05.

One way analysis of variance was conducted to examine the effect of daily Internet use on the mean scores of Networking Agency. The independent variable, daily Internet use, included six levels: 0-2 hours, 2-4 hours, 4-6 hours, 6-8 hours, 8-10 hours, and 10 hours or more. The dependent variable was the mean scores of the Networking Agency factor. The ANOVA was significant, $F(5, 419) = 3.97, p = .002$. Post-hoc comparisons using the Tukey HSD test indicated that the mean score for the group of 10 hours or more ($M_d = 3.58$, $SD = 0.83$) was
significantly different from the group of 0-2 hours (\(M_d = 3.05, SD = 0.92\)) and the group of 2-4 hours (\(M_d = 3.19, SD = 0.87\)) (see Table 11).

**Local/Global awareness**

According to the findings presented in Table 12, the mean scores of all items related to local/global awareness were higher than 3. That is, the majority of university students use the Internet to get information and stay aware of local and global issues. For instance, 76.1% of the students are more aware of global issues through using the Internet. Additionally, 74% of the students are more informed with regard to political or social issues through using the Internet.

**Table 12. Mean, frequencies, and percentages of items for the factor of Local/Global Awareness**

<table>
<thead>
<tr>
<th>Items for Local/Global Awareness</th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Undecided</th>
<th>Agree</th>
<th>Strongly agree</th>
<th>Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I am more aware of global issues through using the Internet.</td>
<td>11 (2.6%)</td>
<td>39 (9%)</td>
<td>53 (12.3%)</td>
<td>217 (50.3%)</td>
<td>111 (25.8%)</td>
<td>3.88 (0.98)</td>
</tr>
<tr>
<td>I am more informed with regard to political or social issues through using the Internet.</td>
<td>8 (1.9%)</td>
<td>39 (9%)</td>
<td>65 (15.1%)</td>
<td>210 (48.7%)</td>
<td>109 (25.3%)</td>
<td>3.87 (0.96)</td>
</tr>
</tbody>
</table>

An independent-samples t-test was used to compare the mean scores of Local/Global Awareness for university students to determine whether they follow e-government services regularly. The results indicated that there was a statistically significant difference in the average mean score of Local/Global Awareness between university students who follow e-government services regularly (\(M = 4.06, SD = 0.83\)) and those who do not (\(M = 3.62, SD = 0.94\)) (\(t (370) = 5.11, p < .05, r^2 = .24\)). The Local/Global Awareness scores of university students following e-government services regularly were higher than those who do not follow e-government services regularly (see Table 13).

**Table 13. Results of t-test for Local/Global Awareness by e-Government Services**

<table>
<thead>
<tr>
<th>Following e-Government Services Regularly</th>
<th>Not Following e-Government Services Regularly</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local/Global Awareness</td>
<td>(M = 4.06)</td>
</tr>
</tbody>
</table>

*Note. \(^*p < .05.\)

**Qualitative phase**

Semi-structured interviews were conducted with 10 university students to better understand the results analyzed via quantitative techniques. 8 out of 10 students had not heard the term “digital citizenship” before. When asked about the meaning of digital citizenship, the majority of students described the idea of people’s online identities. Eight main digital citizenship-related themes emerged by conducting content analysis of the interview transcripts. These themes were:

- Using Online Services
- Political Activities on the Internet
- Social and Cultural Activities on the Internet
- Ethical and Moral Issues on the Internet
- Safety on the Internet
- Networking Activities on the Internet
- Digital Rights on the Internet
- Advantages and Disadvantages of Digital Citizenship

**Using online services**

Survey results indicated that social media is the most preferred online activity of university students. Qualitative findings confirmed that the interviewed students spend most of their time using social media applications, such as Facebook, Instagram, and Twitter. Based on the survey results, 56.5% of university students follow e-government services regularly. The qualitative findings showed that 7 out of 10 students follow e-government services. For instance, one student stated:
“I check my military and student status, use vehicle services, and register my IMEI number on the e-government Web portal” (P2).

Qualitative findings also pointed out that 9 out of 10 students use at least one online service, such as online shopping, online banking, and online appointment systems.

**Political activities on the Internet**

Quantitative findings showed that university students, in general, do not prefer being involved with political activism on the Internet. Content analysis in qualitative phase found out why university students hesitate to attend political activities on the Internet. First, 4 out of 10 students indicated that they feel uncomfortable with online political activities. For example, one student stated:

“Everyone supports their own ideology or political party on the Internet. Hence, politics can lead people to argue and use bad words. Since I believe in equality, these political arguments make me feel uncomfortable” (P1).

Secondly, another reason for not participating in online political activities was related to the fear of it affecting their future lives. 7 out of 10 students mentioned this fear. For instance, one student explained it as follow:

“I may have problems if I express my political views on the Internet. I would like to become an academic in future, so these political posts may harm my career” (P8).

The last finding related with the reasons for not participating in online political activities was related to pressure from society. More than half of the students mentioned this pressure when discussing political activities on the Internet. For instance, one student stated:

“People cannot freely share their political views online because of the pressure. If they share or support opposing views, they may have problems” (P5).

**Social and cultural activities on the Internet**

Based on the statistical findings, nearly half of the university students (45.7%) have signed online petitions related to social, cultural, political, or economic issues. The qualitative phase elaborated on this finding by concluding that all of the university students sign petitions that are useful for people. Students emphasized petitions relating to social issues rather than political ones. For instance, one student said:

“I sign petitions which can be helpful for people. These petitions can create social pressure on organizations. I signed a petition about protesting a thermal power station because it can damage people’s health” (P4).

In addition, survey results indicated that the majority of students are more aware of global issues and informed with regard to political or social issues through using the Internet. Similar to these findings, interview results revealed that nearly all of the students support social actions to improve the awareness of people. However, more than half of the students are not sure whether social actions on the Internet work or not. For example, one student stated:

“I participate in social actions and support social organizations online, but I don’t believe that it works because I have not seen any positive results yet” (P3).

The last finding was about cultural exchange. All of the university students support finding information about other cultures and sharing cultural posts through online methods.

**Ethical and moral issues on the Internet**

Another topic related with digital citizenship practices concerned ethical and moral issues. Based on the interview results, all of the students indicated that there is a need for ethical and moral values on the Internet, because people do not follow these values. Additionally, more than half of the students emphasized that there should be limitations or filtering of information on the Internet. Although 2 out of 10 students consider downloading unregistered copies of products as an unethical behavior, the majority of students see themselves as following ethical rules because they respect others and do not swear on the Internet. Lastly, 4 out of 10 students supported engaging in discussions about laws that affect people’s lives on the Internet. For instance, one student stated:
“People can criticize others on the Internet, but they do not have a right to swear or harass others. Additionally, we should have extended rights on the Internet. That’s why laws, valid in real life, should be discussed on the Internet” (P7).

Safety on the Internet

According to all of the university students, there is a need for safety on the Internet, because the Internet and social media are not secure. Safety can be a problem affecting their online engagement. Students use several strategies to keep themselves secure in online environments. All of the students emphasized that they use popular or well-known websites for online shopping or other e-services. Additionally, keeping information on Facebook private and checking for https icons or green-colored browser icons are the other strategies.

Networking activities on the Internet

Based on the quantitative results, most of the university students prefer participating in collaborative and social activities on the Internet. 73.7% of the students enjoy communicating with other people online. Interview results supported this finding that the Internet is useful for collaboration and communication. For instance, one student stated:

“I find the Internet useful because I can communicate with my friend in Germany. I can also get the latest news via the Internet” (P10).

Based on the statistics, one interesting finding was that only 23% of the students enjoy collaborating with others online more than they do offline. Half of the interviewed students explained that they communicate online with people they have met offline. It can be inferred from this finding that university students place importance on real-world collaboration. Quantitative results also showed that nearly 60% of the university students make comments and posts on the Internet. Interview results indicated that 7 out of 10 students share personal posts and use Facebook and WhatsApp groups to communicate and make comments on others’ posts. For example, one student said:

“We have a WhatsApp group to communicate with friends from the department. I generally post personal things, such as pictures of places I’m visiting, songs, or animations that I like” (P6).

Digital rights on the Internet

4 out of 10 students stated that people are not aware of their rights on the Internet. Additionally, students emphasized that they block people who show disrespectful behavior online. Moreover, students prefer penalizing people who do not respect others online rather than taking them to court. Lastly, the majority of students support an online governmental institution for maintaining the rights of people. For example, one student emphasized:

“I would like to complain about people to an online government institution if they steal my private information” (P3).

Advantages and disadvantages of digital citizenship

For the advantages, all of the students stated that online services make people’s life easier and enhance time management. For instance, one student said:

“I can pay taxes and tuition through the Internet. I do not need to go to institutions in person. This is very convenient for me, because I do not have to go out. It also saves my time” (P4).

For the disadvantages, more than half of the students mentioned that online services make people lazy and antisocial. They also emphasized their concerns about safety on the Internet.

Discussion

An explanatory mixed-method design was used to understand university students’ thoughts and practices regarding digital citizenship. Based on the descriptive statistics, 94.7% of university students use smartphones to access the Internet and nearly half of them are online at least 6 hours a day. As Mossberger et al. (2012) stated, young people prefer smartphones for Internet access because of their portability, popularity, and simplicity.
Survey results indicated that university students do not prefer to engage in political activities on the Internet. Qualitative results also explained the reasons for not participating in online political activities as feeling discomfort, fear of affecting their future lives, and pressure from society. This can be linked to the finding that less educated people tend to engage in online political activity more than highly educated people (Chatur, 2011). The results can also be linked to the interests of university students because young people’s interest and commitment to the news and politics is very limited (D’Haenens, Koeman, & Saey, 2007).

For Internet political activism, gender produced significant statistical results. Based on the findings, male university students are more politically active than female students on the Internet. This is similar to the finding that men tend to create posts about politics on social media more than women (Bode, 2017). Findings also indicated that following e-government services has significant effects on the factors of Internet political activism, critical perspective, and local/global awareness. The scores of university students following e-government services regularly are higher than those who are not. It can be inferred from this finding that the university students using e-government services regularly tend to be more active than other students in political and social issues on the Internet. Based on the statistics, only 40.7% of university students stated that they are more socially or politically engaged when they are online than offline. In addition, only 23% of students said that they enjoy collaborating with others online more than they do offline. Qualitative results showed that university students communicate online with people they have met offline. It can be inferred from these findings that university students see online communication or engagement as a support mechanism for offline engagement. Similarly, Chatur (2011) found out that people involved in offline participation are more likely to be engaged in online activities.

According to the quantitative findings, daily Internet use has significant statistical effect on the Networking Agency factor. The university students whose daily Internet use is at least 10 hours are more socially active on the Internet than students who use the Internet for a maximum of 4 hours a day. It can be understood from this finding that students spend a vast amount of time on the Internet for engaging in online activities, such as commenting, posting, and communicating. Quantitative results also revealed that the majority of university students prefer participating in collaborative and social activities on the Internet. Qualitative interview results proved that students use the Internet for collaborative and communicative purposes. They also communicate via social media groups and share personal posts, in general. Similarly, D’Haenens et al. (2007) described young people as e-communicating citizens, because they mostly use email and chatting on the Internet. Based on the survey results, the majority of university students use the Internet to get information and become more aware of local and global issues. To support this finding, most of the students mentioned cultural exchange on the Internet. This can be linked to the view that social involvement should be provided in online environments to make people informed and access to digital world (Missingham, 2009). According to the views of participants, most of the students are not aware of the term digital citizenship. Although they use online services and have some level of awareness on ethical, moral, safety issues, and digital rights, most of them can only define digital citizenship as a person’s identity on the Internet. Since the majority of interview participants were from the Department of Education, this lack of awareness about what digital citizenship is can be linked to the finding that teachers are not totally aware of digital citizenship (Gazi, 2016; Hollandsworth et al., 2011). Based on the statistics and qualitative results of this study, students are closely engaged in digital environments, especially social media. Hence, improving the awareness of digital citizenship can be seen as an important goal of education (Choi, 2016).

Conclusion

University students’ thoughts and practices concerning digital citizenship were investigated via mixed methods. Quantitative results indicated that university students’ online political activism is low while their online critical thinking, technical skills, networking, and local/global awareness are relatively high. Results also showed that students prefer collaborative activities with an element of Internet usage. Additionally, students following e-government services regularly are more engaged in online political activities. These students also show more critical perspectives and have local/global awareness than students who do not follow e-government services regularly. Another finding was that male university students prefer to participate in online political activities more than females.

The qualitative phase was conducted to better understand and explain the quantitative findings. Based on the qualitative results, university students are comfortable with using online services like online shopping and e-government. They prefer not to participate in online political activities because of discomfort, pressure from society, and fear of future ramifications on their lives. They support signing petitions and social actions to
improve awareness about human needs. They believe that ethical and moral values should be integrated into online environments because people, in general, do not follow these values. They emphasized that there is a need for safety on the Internet because the Internet and social media are not secure. The qualitative results showed that university students prefer to attend online collaborative and social activities, share personal posts, and use online groups to communicate with each other. Students also pointed out that they can penalize their peers online, and they believe a governmental institution should be established to preserve the rights of people on the Internet. The last qualitative result was that university students consider digital citizenship practices useful in terms of effective time management and making life easier, while they are also aware of the disadvantages, such as concerns about safety and increased antisocial behavior.

The term “digital citizenship” can be integrated into the content of several courses to improve the awareness of university students. Additionally, the results can be guide for researchers to investigate the practices and thoughts of university students related to online environments. Lastly, future studies can be conducted to deeply analyze students’ digital citizenship practices.

This study also has limitations. First, interviews were conducted only with a small number of students. Secondly, all the students who participated in this study were selected from a private university. Finally, the researcher was the main person doing all the transcriptions and data analysis.

References


Exploring the Influence of Parental Involvement and Socioeconomic Status on Teen Digital Citizenship: A Path Modeling Approach

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ABSTRACT

One important aspect of digital citizenship, defined as “the norms of appropriate, responsible behavior with regard to technology use,” is to reinforce ethical online behavior and discourage risky conduct. The purpose of this study was to examine the effects of parental involvement and socioeconomic status on teens’ digital citizenship, which includes: digital access, digital etiquette, and digital safety. A research–based path model was developed to explain causal relationships between these factors. This model was tested based on data gathered from 270 teens and their parents. The results provided significant evidence in support of the following hypothesized model: teens whose parents were more involved in their technology usage and online activities have higher reported levels of digital etiquette and digital safety; teens whose parents have better socioeconomic status have higher level of digital access, digital etiquette and digital safety. Overall, parental involvement and socioeconomic status was found to positively predict teen digital citizenship. The study findings have the potential for guiding future model development and to further influence positive social change by supporting parents and educators to promote online safety and digital citizenship development.

Keywords

Digital citizenship, Parental involvement, Socioeconomic factors

Introduction

With the emerging picture of youth and technology usage including cellphones, instant messaging, social networking sites, and online virtual communities, youth are more than ever in need of support to develop socially responsible citizenship in the internet age (Choi, 2016; Clark, 2009; Ito et al., 2009a; Khurana, Bleakley, Jordan, & Romer, 2015). Digital citizenship was defined by Ribble and Bailey (2007) as “the norms of appropriate, responsible behavior with regard to technology use” (p. 10). Instead of focusing on what technology can do, the aim is to think about how technology should be used (Ribble, 2009, p. 13). According to Ribble (2004), digital citizenship represents a more comprehensive view of appropriate technology usage. In addition, it would include considerations for youth safety and security, educational enhancement, ethical and legal behaviors, and becoming an effective member of digital communities (Hollandsworth, Dowdy, & Donovan, 2011). Teaching teen digital citizenship requires effort from schools, educators, technology professionals and parents (Hollandsworth et al., 2011). Parents are the child’s first and most influential teachers of civic values and attitude. “Parents need to be involved in the process of raising their children to be good digital citizens” (Ribble, 2009, p. 11). Three core elements of teen digital citizenship discussed in this study are: digital access, digital etiquette and digital safety.

One aspect of teenagers using digital technologies is using social media or social networking sites. Ahn (2011) analyzed survey results of social media usage related questions from parents and their teenage children and found that teenagers’ use of online social networking sites is positively influenced by parental internet use. The findings also reported that teenagers who access the internet primarily from home (versus other locations, such as, school, library, public services facility, etc.) are more likely to use social network sites (Ahn, 2011). Ahn’s (2011) study reported initial findings of parental influence on teenagers’ use of social media sites. On one hand, teenagers gain benefits such as social development and technical skills (Clark, 2009) from using digital and mobile technologies; On the other hand, the online risks that teenagers may encounter make parents concern about their children’s safety. According to the Pew Internet & American Life Project survey 2012, 72% of parents of online teens are concerned about how their child interacts online with people they do not know, with some 53% of parents being “very” concerned (Madden, Cortesi, Gasser, Lenhart, & Duggan, 2012). Parental involvement and monitoring has been found to mitigate online risks for teens. Khurana et al. (2014) reported that parental monitoring and efforts to regulate specific forms of internet use were associated with reduced rates of online harassment for adolescents. However, Rosen et al. (2008) found that parents with older children were more likely to have neglectful or indulgent parenting styles and less likely to set limits on online behavior. Furthermore, parents’ high estimates of online dangers were not matched by their low rates of setting limits and monitoring teens.
One of the explanations for these phenomena may be that parents have difficulties guiding teenagers’ technology use. With rapid development of new digital technologies, studies have revealed the digital gap between teenagers and their parents: parents may use digital technologies differently, or are even less experienced or knowledgeable about digital technologies than their teenage children (Clark, 2009; Norris, 2001; Yardi & Bruckman, 2011). As a result, parents lack confidence in guiding teens on using technologies that they are less familiar with. This is especially the case for teenagers in economically disadvantaged families (Clark, 2009; Duerager & Livingstone, 2012). We need to further understand parental involvement and home socioeconomic status’ influence on teen digital citizenship, in order to guide parents and the society on helping teenagers to use technologies appropriately and become better digital citizens.

Prior studies on influence of parental and socioeconomic status on teen online behavior focused mainly on specific aspects of teen digital citizenship, such as internet/social network sites access (Ahn, 2011), or online risks/harassment (Khurana, Bleakley, Jordan, & Romer, 2015; Rosen et al., 2008; Youn, 2008). There are conceptually oriented and non-experimental research on the matter too (Choi, 2016). But there is lack of quantitative research examining the parental involvement and home socioeconomic status on the multi-dimensional aspects of teen digital citizenship. The purpose of this study is to explore the influence of parental involvement and socioeconomic status on the three elements of teen digital citizenship: digital access, digital etiquette and digital safety.

In the next section we reviewed prior studies and proposed our research model. Then followed the method section with measurements and data analysis details. The results section presented the findings, with discussion and conclusion section further elaborated and discussed those findings.

**Literature review**

**Digital citizenship**

Digital citizenship is a comprehensive construct and was identified as including a set of elements. Choi (2016) identified 4 major categories that construct digital citizenship: digital ethics, digital media and information literacy, digital participation/engagement, and critical resistance based on concept analysis. Choi argues that “digital citizenship needs to be understood as a multidimensional and complex concept in connection with an interrelated but non-linear relationship with offline (place-based) civic lives” (Choi, 2016). Ribble and Bailey (2004) have defined nine general behaviors of digital citizenship: “(a) digital access, (b) digital commerce, (c) digital communication, (d) digital literacy, (e) digital etiquette, (f) digital law, (g) digital rights and responsibilities, (h) digital health and wellness, and (i) digital security.” As Ribble and Bailey also pointed out, topics within digital citizenship are wide and varied, researchers will need to use these topics as “buffet” and take what related to the research interests of one’s own. Because of parental involvement and socio-economic status are the studied constructs, this research specifically focuses on three most related elements that Ribble and Bailey (2007) and Choi (2016) both stressed: digital access, digital etiquette, and digital safety.

**Parental influence on teens’ digital citizenship development**

Livingstone’s EU Kids Online survey presented a detailed picture of online interactions experienced by 25,000 European youth from 25 countries. Results varied widely by country indicating societal norms and values influence youth behavior. The report (Livingstone et al., 2011) established five key policy recommendations: (a) parental awareness, (b) focus on younger users, (c) industry support for internet safety, (d) digital citizenship, and (e) positive content (pp. 145–147). Parental awareness as the first policy recommendation has grown increasingly important to teen digital citizenship (Livingstone, Mascheroni, & Staksrud, 2015).

Parents hope that their children will be able to learn what they need and differentiate what is right and what is wrong. However, without the basic knowledge of digital citizenship, children may not think of the consequences of their actions online (Khurana et al., 2015; Robinson, 2013). Fortunately, more parents than ever are trying to understand what their children are doing with technology (Ribble, 2009). However, parents are facing challenges in getting involved in mediating teen digital citizenship. Yardi and Bruckman (2011) conducted an interview study with 16 parents from suburban neighborhoods in Atlanta, GA to examine challenges in “techno-parenting,” which means parenting teens’ technology use. Parents said that they wanted more transparency in their teens’ use
of cell phones and the internet and they struggled with their own unfamiliarity with technology (Yardi & Bruckman, 2011).

Families with lower socioeconomic status were found to have even more difficulties in getting involved in teens use of digital technologies. Clark’s (2009) study conducted narrative-in-interaction analysis on interviews with 55 parents and 125 young people. The article described the generation gap between parents and youth with regard to digital technologies usage and considers how parents attempt to articulate authority in relation to digital media use among their teenage children as well as the ways in which teens interpret those parental attempts to express authority influence the strategies they themselves embrace regarding digital media (Clark, 2009). Clark’s (2009) research further revealed that parents of youth from economically disadvantaged homes experience deeper knowledge gap as regard to use of digital technologies. Teens in these families experienced frustration at their parents’ lack of experience.

To further explore the effect of parental involvement and socioeconomic status on teen digital access, digital etiquette, and digital safety, the following sections examine each of these aspects and reviewed relevant literature.

**Digital access**

Research concerning teens’ digital access found that access to technology was highly unequal. The term “digital divide” describes the concern about unequal access and participation in new technologies (Norris, 2001). Benefits from using these technologies were reported by many studies. For example, Clark (2009) argued that youth participation in online social network communities may signal the development of important technical skills and social development. Youth negotiate identity, learn social skills and become subject matter experts in topics of their interest through online interactions (Bennett, 2008; Boyd, Ghosh, Prabhakar, & Shah, 2006; Ito et al., 2009b). Web-based social networking sites and other online communication tools allow youth across the globe to get connected. Technology-mediated connections within and among teen virtual communities prompt teens to look beyond their own group and widen their horizons, which is referred as “bridging social capital” by Robert Putnam (2000). Youth that are systematically excluded from technology-mediated networking may also lose out on opportunities to develop technical skills, social interactions, and relationship networks (Ahn, 2011).

Studies have reported that ethnic minority groups were less likely to use technology (d’Haenens, Koeman, & Saeyts, 2007). Those from lower socioeconomic backgrounds also had fewer opportunities to use media tools (Zillien & Hargittai, 2009).

Ahn (2011) utilizes a nationally representative survey from the Pew Internet & American Life Project to investigate whether access and participation divides persist in teens’ use of online social networking sites (SNS). The results suggest that parents’ use of Internet is positively related to teenagers’ use of SNS. The findings also report that teenagers who access the Internet primarily from home (versus other locations, such as, school, library, public services facility, etc.) will be more likely to use social networking sites. However, the research also discovered that traditional socio-economic indicators such as internet access or parent education are not significant predictors of SNS use. Youth appear to find a way to get connected (Ahn, 2011).

Parental involvement such as giving informative advices for teenagers on using various types of technologies/digital resources, and suggesting solutions for technical/social problems may help teens getting better chance of using new technologies. However, parents’ lack of experience of technology use and parental restriction because of misconceptions toward certain technologies may reduce the opportunities for teenagers to get connected and use new digital technologies (Clark 2009). In addition, many of the young people in Clark’s (2009) study of lower income families made comparatively little use of the Internet, particularly when compared with young people from higher income families.

Conclude from the studies reviewed, parental involvement, such as parental technology usage, parental monitoring, and attitude/awareness toward teens’ digital technology access, etc., need to be explicitly examined as predictor of teens’ digital access in prior research. Whether parents’ socioeconomic status affects teen digital access also has contradicting findings. Therefore, the author proposes the following hypothesis concerning digital access:

H1: Active parental involvement of teens’ use of digital and mobile technologies will have a positive effect on teens’ digital access.

H2: Parents’ socioeconomic status will have a significant relationship to teens’ digital access.
Digital etiquette

Adolescence is marked by the desire for autonomy and independence. The Internet generally, and online social networking opportunities in particular, help adolescents feel autonomous. The Internet and other instant communication tools offer adolescents social, moral, recreational, and intellectual experiences that are not mediated by adults (Bradley, 2005). Digital etiquette defined electronic standards of conduct or procedure (Ribble, Bailey, & Ross, 2004). Ribble and colleagues (2004) argue that when the young generation saw adults using technologies inappropriately, they would assume it is the norm. This leads to inappropriate technology behavior on the part of youth.

Flores and James (2013) explored the extent to which youth’s approaches to online life include moral or ethical considerations drawing on interviews with 61 teenagers. The researchers reported the prevalence of three ways of thinking about use of social networks, massive multi-player games, Wikipedia, and file downloading. The finding revealed that individualistic thinking (focusing on consequences for oneself) dominated participants’ thinking; moral thinking (considering known others) was somewhat prevalent; and ethical thinking (acknowledging unknown others and communities) was least prevalent (Flores & James, 2013).

The moral development theory by Kohlberg (1973) and the domain theory by Turiel (1983) viewed morality as “entailing judgments, [and being] based on the proposition that children construct ways of thinking about welfare, justice and rights through a variety of social experiences. (p. 17)” The Internet can be treated as a social context that both frees young people from adult control and forces them into conflict and disequilibrium as they interact with others online (Bradley, 2005; Carlo, Fabes, Laible, & Kupanoff, 1999). According to Kohlberg (1973), interpersonal relationships with family and friends are key to forming societal values and norms during adolescence. For general advice and influence, parents are still the top source for teen internet and cell phone users (86%) (Lenhart et al., 2011).

88% of teens who use social media witnessed other people be mean or cruel on social network sites, 15% of teens who use social media say they have been the target of online meanness (Lenhart et al., 2011). Digital etiquette was defined as electronic standards of conduct or procedure (Ribble et al., 2004). People recognize inappropriate behavior when they see it, but before using technology, they do not learn digital etiquette.

Parental involvement such as setting limits, have conversations to address digital etiquette early and modeling appropriate digital technology usage/online behavior was suggested by America Academy of Pediatrics (2015) as effective means to help teenagers build digital etiquette. However, there is still lack of quantitative research on examining influence of parental involvement and socio-economic status on teen’s digital etiquette. Prior research offered theoretical and conceptual recommendations for parental role in the development of teens’ digital etiquette. Based upon discussed studies, hypotheses of this study are as follows:

H3: Active parental involvement of teens’ use of digital and mobile technologies will have a positive effect on teens’ digital etiquette.

H4: Parents’ socioeconomic status will have a significant relationship on teens’ digital etiquette.

Digital safety

Digital safety is an issue of high concern in teenagers’ use of technology. For teenagers, the online realm may be adopted enthusiastically because it represents “their” space, visible to the peer group more than to adult surveillance, an exciting yet relatively safe opportunity to conduct the social psychological task of adolescence: to construct, experiment with and present a reflexive project of the self in a social context (Livingstone, 2008). Despite the benefits of online networking technologies for teenagers’ social development, it has also facilitated certain forms of negative behavior such as cyber bullying, personal data misuse, and exposure to possible harmful content such as hate, violence, drugs, and suicide (Oksanen et al., 2014; Cole & Griffiths, 2007; Livingstone, Mascheroni, & Staksrud, 2015; Robinson, 2013).

Studies conducted in Europe and the United States indicated adolescents’ online risks in the digital age. According to the Net Children Go Mobile survey conducted by Livingstone and colleagues with 3500 European youth internet users in 7 countries in 2013/14, around half of all 11-16 year olds have encountered one or more of the 10 risks that researchers asked (Livingstone, Mascheroni, Ølafsson, & Haddon, 2014). The misuse of personal data is another growing policy issue, especially for children. Livingstone et al. (2011) noted “9% of surveyed children recently had a misuse of their personal data” (p. 101). The researchers also pointed out that
risks to children will evolve as the role of the Internet develops. Hundley and Shyles (2010) investigated adolescents’ uses of digital media devices by conducting focus groups with 80 middle- and high-school teenagers in United States. Four themes emerged from 11 focus group interviews: (1) an awareness of digital devices; (2) a sense of temporal displacement; (3) social functions; and (4) a palpable sense of risk associated with using them. Livingstone et al. (2011), and Hundley and Shyles (2010) have revealed the awareness of the safety issue when teenagers use online networking sites, gaming, instant messaging, etc. Livingstone et al.’s (2011) survey also included parental input, allowing researchers to correlate online youth risk with parental involvement. Although the levels of risk estimated by children and their parents were similar, when examining awareness of risk among individual parents matched with the children who had encountered those risks, parental awareness was low.

Valcke et al. (2011) conducted a long-term cross-sectional study on online risks. Based on the analysis of survey data from 10,000 young children, trends in their (un)safe Internet usage are studied in 2005-2009. Results clearly reflect risky, unsafe Internet usage. Also, no consistent reduction in unsafe internet behavior is being observed over the years. Parental and teacher control hardly increase, and hardly seem to impact the level of unsafe internet behavior (Valcke, De Wever, Van Keer, & Schellens, 2011).

On the other hand, Duerager and Livingstone (2012) reported that parents from higher SES homes do more active safety mediation but do not impose more restrictions.

Active mediation by parents is associated with lower online risk of harm, as well as children enjoying more online opportunities and gaining more digital skills (Hollandsworth et al., 2011; Livingstone et al., 2015). “Active safety mediation” is more often used after a child has experienced something upsetting online to prevent further problems. “Active safety mediation” and “monitoring” of internet safety is also associated with a higher tendency to engage in communicative coping. “Restrictive mediation” is also associated with lower online risk of harm, but also lower online opportunities and digital skills, because children are less free to explore, learn and become resilient. They are also more likely to adopt passive responses to online risks (Livingstone, 2015).

Does parental involvement and socioeconomic status actually help increase teens digital safety in an environment that embedded with digital media, internet, and mobile technologies? Since prior literature reported contradictory findings of parental influence on teen digital safety, this study will further examine this matter. The set of hypothesis are as following:

H5: Active parental involvement of teens’ use of digital and mobile technologies will have a positive effect on teens’ digital safety.
H6: Parent socioeconomic status will have a significant relationship with teens’ digital safety.

Research model

From the above hypotheses a research model of this study is proposed (Figure 1). This model hypothesizes that three elements of teen digital citizenship: digital access, digital etiquette, and digital safety, can be explained by parental involvement and parent socioeconomic status.
Method

Participants

The sample (n = 270) for this study was a subset data from a large national survey study conducted by Pew Research Center’s Internet & American Life Project (Madden et al., 2013). The project collected information about social media usage and related questions from teenagers and their parents in United States. Among the 270 teen participants for this study, 54.4% were male while 45.6% were female. The teen participants were from 12 to 17 years old, and the mean age was 14.56. Thirty seven percent of the parent participants were male and 63% were female. Mean age of parent participants was 47 years old. Participants who volunteered were given the survey questionnaire by the researchers to complete. They were briefed on the purpose of the study and their right not to participate, during or after data collection. On average each participant took about 30 minutes to complete the questionnaire.

Measures

The questions used in this study were based on five constructs: parent socioeconomic status (2 items), parent involvement (4 items), teens digital access (4 items), digital etiquette (4 items), and digital safety (4 items).

The category of parent socioeconomic status includes two questions: parent education level and parent income. The parent involvement measure included scales as parental knowledge and concerns of teens online behaviors, which was related to parental monitoring measurement developed by Kerr et al. (2010). The 4 questions measured parental involvement of how teens manage online interactions, sensitive information, digital identity, and opportunities. The digital access measure assessed teen access to internet, emails, whether they own a cellphone or computer/laptop, and whether they access the internet using mobile devices. These access variables were in alignment with Ahn (2010)’s study. The digital etiquette measure included questions such as, if the teen participant used inappropriate information online, received inappropriate content, developed closer relationship and uncomfortable online interactions. The questions are based on Ribble’s (2004) examples of digital etiquette. Digital safety measures include questions such as personal data sharing online, privacy settings, etc. The questions were in accord with Livingstone’s (2015) scales. Most of the questions are likert-scale questions. The scales are: “very,” “somewhat,” “not too” and “not at all.” a few questions used “yes” and “no” as possible answers. See Appendix A for the questionnaire used by this study.

Analysis

A partial least squares (PLS) path modeling approach was adopted for the data analysis of this study. PLS path modeling is a multivariate statistical method to examine the relationship among a group of independent and dependent variables (Goggins & Xing, 2016). This approach is recognized as the second generation of multivariate analysis, composed of multiple regression, path analysis, principle component analysis and multiple discriminant analysis (Fornell & Larcker, 1981). While the linear structure relationships (LIREL) model is more suitable for theory testing and development, PLS path modeling is for predicative applications in a regression sense. Since this study is more explanatory in nature, the PLS path modeling is more suitable for model testing.

Specifically, the reflective measures were used to test the differences of the latent variables (SE and PI) effects on manifest variables (DA, DS, and DE). The factors revealed by EFA were subjected to confirmatory factor analysis (CFA) using R. Further analyses based on the model include t-tests and testing of the structural equation model based on the identified factors.

Results

Convergent validity

This section presents details on the reliability and validity of the data collected in this study. Fornell and Larcker (1981) proposed three procedures to assess the convergent validity of a set of measurement items in relation to their corresponding constructs. These are (1) item reliability of each measure, (2) composite reliability of each construct and (3) the average variance extracted. The item reliability is assessed by its factor loading onto the
underlying construct. Hair, Black, Babin, Anderson, and Tatham (2006) suggested that an item is significant if its factor loading is greater than 0.50.

As the review of literature indicated that the factor structure of the survey must be tested for validity and reliability, we first performed exploratory factor analysis (EFA) on the data of the five constructs: parental involvement, parent socioeconomic status, digital access, digital etiquette and digital safety employing the steps recommended by Hair et al. (2010). Factors with eigenvalues greater than 1 were retained. Items with initial loading below .5 were removed. As a result, items da1, da4, ds1, ds3, de1 and de2 were removed.

As shown in Table 1, all remaining factor loadings of all the items in the measure ranged from 0.65 to 0.92, which exceed the value recommended by Hair et al. (2006). Convergent validity is demonstrated at the item level.

Table 1. Factor loading and average variance extracted

<table>
<thead>
<tr>
<th>Latent variables</th>
<th>Item</th>
<th>Factor loading</th>
<th>AVE*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parents socioeconomic status (SE)</td>
<td>se1</td>
<td>0.923</td>
<td>0.781</td>
</tr>
<tr>
<td></td>
<td>se2</td>
<td>0.841</td>
<td></td>
</tr>
<tr>
<td>Parent Involvement (PI)</td>
<td>pi1</td>
<td>0.750</td>
<td>0.593</td>
</tr>
<tr>
<td></td>
<td>pi2</td>
<td>0.735</td>
<td></td>
</tr>
<tr>
<td></td>
<td>pi3</td>
<td>0.778</td>
<td></td>
</tr>
<tr>
<td></td>
<td>pi4</td>
<td>0.812</td>
<td></td>
</tr>
<tr>
<td>Digital Access (DA)</td>
<td>da1</td>
<td>-0.212</td>
<td>0.606</td>
</tr>
<tr>
<td></td>
<td>da2</td>
<td>0.808</td>
<td></td>
</tr>
<tr>
<td></td>
<td>da3</td>
<td>0.647</td>
<td></td>
</tr>
<tr>
<td></td>
<td>da4</td>
<td>0.460</td>
<td></td>
</tr>
<tr>
<td>Digital Safety (DS)</td>
<td>ds1</td>
<td>0.216</td>
<td>0.649</td>
</tr>
<tr>
<td></td>
<td>ds2</td>
<td>0.901</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ds3</td>
<td>0.384</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ds4</td>
<td>0.682</td>
<td></td>
</tr>
<tr>
<td>Digital Etiquette (DE)</td>
<td>de1</td>
<td>0.001</td>
<td>0.617</td>
</tr>
<tr>
<td></td>
<td>de2</td>
<td>0.343</td>
<td></td>
</tr>
<tr>
<td></td>
<td>de3</td>
<td>0.855</td>
<td></td>
</tr>
<tr>
<td></td>
<td>de4</td>
<td>0.689</td>
<td></td>
</tr>
</tbody>
</table>

Note. *AVE, average variance extracted, computed by totaling the squares of factor loading divided by the number of factors in the underlying construct.

The composite reliability of each construct was assessed using Cronbach’s $\alpha$. DeVellis (2016) suggested that $\alpha$ values between 0.70 and 0.90 should be considered good. The $\alpha$ values for DA, DS and DE are calculated using average inter-item correlation. The range for average inter-item correlation for reliability is 0.15-0.5.

Table 2. Construct reliability

<table>
<thead>
<tr>
<th>Construct</th>
<th>$\alpha$</th>
<th>SE</th>
<th>PI</th>
<th>DA</th>
<th>DS</th>
<th>DE</th>
</tr>
</thead>
<tbody>
<tr>
<td>SE</td>
<td>0.724</td>
<td>(0.884)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PI</td>
<td>0.778</td>
<td>0.025</td>
<td>(0.770)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DA</td>
<td>0.37*</td>
<td>0.184</td>
<td>0.045</td>
<td>(0.778)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DS</td>
<td>0.49*</td>
<td>0.140</td>
<td>0.111</td>
<td>0.074</td>
<td>(0.806)</td>
<td></td>
</tr>
<tr>
<td>DE</td>
<td>0.39*</td>
<td>0.112</td>
<td>0.110</td>
<td>0.138</td>
<td>0.002</td>
<td>(0.785)</td>
</tr>
</tbody>
</table>

Note. *Marked item used average inter-item correlation calculation. Diagonal, square root of average variance extracted from observed variables (items); off-diagonal, correlations between constructs. SE = parent socioeconomic status; PI = parents’ involvement; DA = digital access; DS = digital safety; DE = digital etiquette.
Discriminant validity

Discriminant validity is considered adequate when the variance shared between a construct and any other construct in the model is less than the variance that the construct shares with its measures (Fornell, Tellis, & Zinkhan, 1982). The variance shared by any two constructs is obtained by calculating the square of the correlation between the two constructs. The variance shared between a construct and its measures corresponds to average variance extracted. Discriminant validity was assessed by comparing the square root of the average variance extracted for a given construct with the correlations between that construct and all other constructs. The diagonal elements have been replaced by the square roots of the average variance extracted.

For discriminant validity to be judged adequately, these diagonal elements should be greater than the off-diagonal elements in the corresponding rows and columns. From Table 2 discriminant validity appears satisfactory, indicating that the constructs in the proposed research model are deemed to be adequate.

Path modeling analysis

In order to evaluate the proposed hypotheses, the researchers estimated the path coefficients between the constructs. PLS also helped the researchers measure the variances between the dependent and independent constructs. Figure 2 shows the results calculated for the proposed research model. Based on the path coefficient and t-statistics, the results indicate that only H1 was rejected. H2-H6 were supported by the path analysis results (Table 3).

Table 3. Path coefficients of the proposed research model

<table>
<thead>
<tr>
<th>Hypotheses</th>
<th>From</th>
<th>To</th>
<th>Path coefficient</th>
<th>Standard error</th>
<th>t value</th>
<th>Support hypotheses</th>
</tr>
</thead>
<tbody>
<tr>
<td>H1</td>
<td>PI</td>
<td>DA</td>
<td>0.050</td>
<td>0.0601</td>
<td>0.831</td>
<td>No</td>
</tr>
<tr>
<td>H2</td>
<td>SE</td>
<td>DA</td>
<td>0.186</td>
<td>0.0601</td>
<td>3.090***</td>
<td>Yes</td>
</tr>
<tr>
<td>H3</td>
<td>PI</td>
<td>DS</td>
<td>0.107</td>
<td>0.0603</td>
<td>1.78*</td>
<td>Yes</td>
</tr>
<tr>
<td>H4</td>
<td>SE</td>
<td>DS</td>
<td>0.137</td>
<td>0.0603</td>
<td>2.28**</td>
<td>Yes</td>
</tr>
<tr>
<td>H5</td>
<td>PI</td>
<td>DE</td>
<td>0.107</td>
<td>0.0605</td>
<td>1.77*</td>
<td>Yes</td>
</tr>
<tr>
<td>H6</td>
<td>SE</td>
<td>DE</td>
<td>0.110</td>
<td>0.0605</td>
<td>1.81*</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Note. *p < .10 weak significance; **p < .05 moderate significance; ***p < .01 strong significance.

Discussion and conclusion

This study contributes to past discussion of teen digital citizenship by examining the role of parental involvement and socioeconomic status in the three aspects of digital citizenship: digital access, digital etiquette and digital safety. The study revealed that parents’ socioeconomic status has a significant relationship with all aspects of teen digital citizenship: digital access, digital etiquette, and digital safety. Parental involvement also has a positively significant effect on teen digital etiquette and digital safety.
Parent involvement has been discovered as a significant predictor of teen digital etiquette and digital safety, but not for teen digital access. Despite the extent of parental involvement in teenagers’ technology usage, getting online has become the norm of teenagers’ everyday life. Data from Pew Research Center indicated that aided by the convenience and constant access provided by mobile devices, especially smartphones, 92% of teens report going online daily — including 24% who say they go online “almost constantly.” More than half (56%) of teens (defined in this report as those ages 13 to 17) go online several times a day, and 12% report once-a-day use. Just 6% of teens report going online weekly, and 2% go online less often (Lenhart et al., 2015).

Digital etiquette recognizes virtual communities (Rheingold, 1993) as new spaces where people live, interact, and communicate with each other on a regular basis. Ribble (2009) claimed that teaching teenagers to engage in internetworking appropriately, ethically and responsibly should be included in digital citizenship education. Parents need to be aware that rights to free speech; protecting privacy; intellectual property; copyright protection; and respecting self, others, and community, including reporting cyberbullies and harms, are important issues of digital citizenship. The influence of parental involvement on teen digital etiquette has been studied rarely in prior literature. This study has provided initial evidence that parental involvement positively influences teen digital etiquette. More specifically, parental knowledge and involvement in mediating teenagers’ online activities influence how teens behave appropriately and responsively when using digital technologies. Through the process of getting to know teens online activities and their inner thoughts about why or how they interact with people online periodically, parents could facilitate teens building digital identities, perspectives, values and appropriate conduct, at the meantime, support teens extending social connections to family and friends.

According to Duerager and Livingstone (2012), parent active mediation of internet use tends to decrease the experience of harm between 9 and 12 years, though there is no effect for 13 to 16 year olds. Our study further showed that teenagers’ (12-17 years old) digital safety was significantly influenced positively by parental involvement. Researchers also found that parental involvement has greater direct influence on online risk than parental restriction. Similarly, Livingstone et al. (2015) found that the use of ‘parental filters’ was not found to reduce online risk. The researchers reported a correlation such that more parental filtering is linked with less online risk, but when the researchers control statistically for the child’s age, this correlation disappears. It seems that parents more often apply filters for younger children and, separately, younger children encounter less risk since they use the internet less. Thus, there is no statistical link between parental filtering and level of risk after controlling for age (Livingstone et al., 2015). From these results, we learn that active parental awareness and involvement is more effective than parental restriction for teenager use of digital technologies. There is probably no such one-size fit-all kind of solution or strategy for different families to react to teenagers’ safety issues brought by digital interactions. However, awareness and knowledge of the risks in digital world will help parents pro-actively guide and monitor their teenagers. Parents also need to realize that growing up digital presents both opportunities and risks. Teenagers’ explorations in the digital world are not very different from those by earlier generations; the platform differs, not the behaviors. Teens use digital and mobile technologies for many purposes, risk is not always negative, and opportunities to fail safely can be valuable too.

In the past two decades, parents and teenagers experienced the most drastically changing world in the perspective of information technology. Chai, Bagchi-Sen, Morrell, Rao, and Upadhyaya (2009) argued, “The rapid development of information technology (IT) can make even the most aware users vulnerable” (p. 167). To maneuver in these new circumstances, youth are seeking guidance and strategies from parents, teachers, and friends (Chai et al., 2009; Lenhart et al., 2011). The implications of this research are four fold: (1) the findings of this research provides parents and educators with accurate information supporting teenagers develop digital citizenship specifically improve teen digital access, digital etiquette, and digital safety. (2) Extra support need to be provided to the teenagers from lower SES homes in regard to digital citizenship development. (3) Promoting parental awareness on getting involved with teen digital technologies use in order to help teens become better digital citizens. (4) The empirical evidence from this study can help school districts and educators to provide
practices and curriculum for parents who are in need of learning strategies of guiding teens digital citizenship development.

In conclusion, this article has examined parental and socioeconomic influence on teen digital access, digital etiquette, and digital safety. The results indicated that parental involvement efforts empowered teenagers online by enhancing their opportunities and skills while also going some way to reducing risk and harm from online risk. Although this study mainly focuses on parental and SES influence, it is no doubt that this is a community effort, including schools, teachers, parents, peers and the public, to educate our youth on how to be a good digital citizen. The limitation of this research is the scope of the study. We have mainly focused on the parental effects and three aspects of digital citizenship. Future studies could further explore extended elements of digital citizenship. Research on parental strategies when involved in mediating teen technology usage is another direction that could contribute to the current body of research.

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References


Appendix A. Questionnaire questions used by the study

**Demographic Questions**

RECORD SEX OF PARENT
1 Male
2 Female

ASK ALL PARENTS:
What is your race? Are you white, black, Asian, or some other race?
1 White
2 Black or African-American
3 Asian or Pacific Islander
4 Mixed race
5 Native American/American Indian
6 Other (SPECIFY)
7 Don’t know
8 Refused

RECORD TEEN SEX
1 Male
2 Female

**Socio-Economical Status**

**se1**
ASK ALL PARENTS:
What is the last grade or class you completed in school?
1 None, or grades 1-8
2 High school incomplete (grades 9-11)
3 High school graduate (grade 12 or GED certificate)
4 Technical, trade or vocational school AFTER high school
5 Some college, no 4-year degree (includes associate degree)
6 College graduate (B.S., B.A., or other 4-year degree)
7 Post-graduate training/professional school after college (toward a Masters/Ph.D., Law or Medical school)
8 Don’t know
9 Refused

**se2**
ASK ALL PARENTS:
What was your total family income from all sources, before taxes last year?
1 Less than $10,000
2 $10,000 to under $20,000
3 $20,000 to under $30,000
4 $30,000 to under $40,000
5 $40,000 to under $50,000
6 $50,000 to under $75,000
7 $75,000 to under $100,000
8 $100,000 to under $150,000
9 $150,000 or more
10 Don’t know
11 Refused

**Parental Involvement**

In addition to the ways the internet and cell phones are useful for teens like yours, some parents have concerns about technology. For each of the following, please tell me how concerned, if at all, you are about these issues.

**pi1.** How your child manages their reputation online

**pi2.** How much information advertisers can learn about your child’s online behavior

**pi3.** How your child interacts online with people they do not know

**pi4.** How your child’s online activity might affect their future academic or employment opportunities
**Digital Access**

*da1*
Do you use the internet or email, at least occasionally?

*da2*
Do you access the internet on a cell phone, tablet or other mobile device, at least occasionally?

*da3.* A cell phone... or an Android, iPhone or other device that is also a cell phone  
*da4.* A desktop or laptop computer

**Digital Safety**

*ds1*
Thinking about Facebook... When, if ever, was the last time you checked your privacy settings on that profile?

1 Sometime in the past 7 days  
2 Sometime in the past 30 days  
3 Sometime in the past 12 months  
4 When you first created your profile  
5 You have never checked them  
8 You don’t know or you can’t remember  
9 Refused

We’d like to know if you have posted the following kinds of information to the profile or account you use most often, or not.

*ds2.* A photo of yourself  
*ds3.* Your relationship status  
*ds4.* Your school name

**Digital Etiquette**

Have you ever done or experienced any of the following?

*de1.* Shared sensitive information online that later caused a problem for you or others in your family  
*de2.* Received online advertising that was clearly inappropriate for your age

*de3.* Been contacted online by someone you did not know in a way that made you feel scared or uncomfortable  
*de4.* Had an experience online that made you feel closer to another person
Digital Citizenship with Social Media: Participatory Practices of Teaching and Learning in Secondary Education

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ABSTRACT

This article explores how social media use in formal and informal learning spaces can support the development of digital citizenship for secondary school students. As students increasingly spend large amounts of time online (e.g., an average of six hours of screen time per day, excluding school and homework), it is critical that they are developing skills enabling them to find, evaluate, and share information responsibly, engage in constructive conversation with others from diverse backgrounds, and to ensure their online participation is safe, ethical, and legal. And, yet, in spite of the importance of students learning these skills, opportunities for digital citizenship in formal and informal learning spaces have lagged behind our ideals. The article provides a conceptual analysis of civic engagement as digital citizenship and considers how digital media applications can support citizenship education in middle- and high-school grades. Then, empirical research is provided that demonstrates how high school students develop digital citizenship practices through out-of-school practices. Finally, this article suggests that both dimensions of digital citizenship (i.e., in-school, traditional citizenship education and out-of-school activities aimed at civic engagement) can be integrated through a social media-facilitated curriculum. Finally, recommendations for teaching and learning through social media are offered to educators, community members, practitioners, parents, and others.

Keywords

Digital citizenship, Social media, Educational technology

The perception of internet risks and the need for digital citizenship

Digital citizenship is once again in the news, as parents, teachers, administrators and schools embrace the notion of teaching students about media literacy and safe and responsible internet use. Recently, spurred by the perceived dangers of online life, including cyberbullying, sexting, harmful contact, and other psychological or physical threats, states such as Washington, California, Texas and others have proposed or passed legislation calling for formal education that instructs students about how to use information technology effectively in order to maintain student safety, privacy, and health and well-being. While internet researchers instruct us to value the benefits from internet use (Livingstone & Brake, 2010), sensational stories are often quite persuasive, such as the Slenderman story. In 2014, two 12-year old girls lured a friend into the rural Wisconsin forest, stabbing her 19 times in an attempt to impress Slenderman, a fictitious character who appears online and in internet memes (Gretter et al., in press). The girls were taken in by Slenderman’s persuasive online presence, and according to authorities, convinced his followers they needed to kill somebody in order to earn his respect. Fortunately, the victim survived the brutal attack, though the dangers of life online were again exposed.

Sensational (if truthful) accounts such as these contribute to the need to teach K-12 students the media literacy skills that will keep them safe online. Washington’s proposal was supported by Common Sense Media, which is one of the leaders in the field, providing 76% of all public schools in the U.S. with digital citizenship curricula. This popular digital citizenship package teaches students a variety of topics, including internet safety, privacy and security, information literacy, and cyberbullying and digital drama (see www.commonsense.org). The risks to young people are real, even if most adolescents will thankfully never find themselves trying to appease a character like Slenderman. Livingstone and Brake (2010) reported that 72% of young people in the U.S. aged 12-17 had been bullied in the past year, suggesting the need for young people to learn effective strategies to remain safe online.

While recognizing the value of these programs and curricula, we suggest that there is a need for digital citizenship curricula to emphasize the real-life experiences, values, and personal interests and engagements of young people themselves. Influenced by scholars from political science, communication, and education (Bennett, 2008; Tufekci & Wilson, 2012; Freelon et al., 2016; Greenhow et al., 2009) who recognize how networked communications technology (e.g., social media such as Facebook, Twitter, YouTube, Instagram, Snapchat, and others) supports new forms of citizenship that are increasingly participatory, driven by expressions of identities, and linked to changing conceptions of literacy, we see the need for a new model of digital citizenship enabled by the affordances of social media.
This paper contributes to a growing field of research that seeks to explore the dimensions and possibilities of young people’s digital citizenship facilitated by digital and social media. To that end, it suggests two important contributions: (1) a connection between out-of-school social media practices with in-school traditional citizenship curricula, organizations, and models of community change; (2) it seeks to leverage the affordances of social media (i.e., its very socialness) to suggest a model that validates, and perhaps even prioritizes, the social values and identities of young people as they develop citizenship practices. That is, that as young people develop their own political networks and followers, attend social protests on livestream (#StandWithWendy), and contribute to community service projects (i.e., raising money for community issues), they are participating in a new form of digital citizenship enacted through digital (e.g., social) media activities informed by social values and identities.

**Toward a model of social media-enabled digital citizenship**

Digital citizenship is a concept that includes a range of theoretical conceptions, from those that emphasize the technological aspect, while others investigate the affordances of digital media to suggest new forms of citizenship. Scholars in a range of fields, including education, communications, and political science, have proposed a number of different conceptions of digital citizenship. We present some popular ones before explaining our own notion of digital citizenship, and how it can be developed among secondary students through the use of digital and social media.

First, there is the normative perspective, which proposes that digital citizenship is “the norms of appropriate, responsible technology use” (Rible, 2017, Welcome section, para. 1). The normative perspective emphasizes that students understand the “rights and responsibilities” of being a digital citizen, which includes acting “in ways that are safe, legal, and ethical” (International Society for Technology in Education, 2016). Digital citizenship is developed as teachers instruct students about a range of digital practices, including how to access digital media, how to follow copyright and other laws, and how to improve security measures. Researchers have proposed developing the concept of digital citizenship to increase respect and support finding that “youth who are proactively respectful and supportive online” are not only less likely to harass others, but also more likely to intervene when it does occur (Jones & Mitchell, 2016, p. 12).

Second is an approach that theorizes digital citizenship as the capacity to participate in society online (Mossberger, 2009). Mossberger and colleagues have examined the factors that support participation online, finding that those with regular (e.g., “frequent”) access to the internet, coupled with media and information literacy skills to “find, comprehend, evaluate and apply” this information (Mossberger et al., 2012, p. 2496), have access to greater social benefits. Digital citizenship is a precursor to political participation; the more access that one has to online information and services, the more likely they will benefit from this increased participation. As more young people “do politics online” (e.g., by finding, evaluating, and applying information), they increase their political knowledge, engagement with politics, and political participation (Mossberger, 2012).

Third is a perspective that there is a strong relationship between participation online and digital citizenship (Jenkins & Carpentier, 2013). Full participation in society demands proficiency in digital media, specifically the ability to produce, collaborate, share, and critique media using current and emerging technologies (Reilly et al., 2012; Jenkins & Carpentier, 2013; Hobbs et al., 2013; Mason & Metzger, 2012). Hobbs (2013) suggested that digital citizenship includes reading, writing, and engaging in dialogue that contributes to democratic discussion, made possible through digital media: “New forms of civic learning...focus on producing information that is created and shared by peers, learning to use...digital and social media, and participating in peer-centered special interest groups” (p. 232).

Finally, scholars from communications and political science have suggested that as a result of networked technologies and changing social, political, cultural and economic structures and practices, young people are developing new forms of citizenship (Bennett, 2008; Bennett & Segerberg, 2012; Kahne et al., 2012). Bennett proposed two forms of citizenship: dutiful and actualizing. Dutiful citizenship is predicated on civic responsibility, membership in civic organizations, and reflects a hierarchical style of both information dissemination and possibilities for leadership. In this model, students develop citizenship through voting, writing letters to the editor (or their local politician), or belonging to the local Kiwanis club. On the other hand, actualizing citizenship is predicated on “looser personal engagement with peer networks...that crowd source information and organize civic action using social technologies that maximize individual expression” (Bennett et al., 2012, p. 839). Bennett’s broader conception of citizenship centers young people’s expressive actions, often in digital (or social) media, that suggest particular values.
Recently, scholars have investigated the dynamic ways that social media may support political engagement by creating opportunities for young people to become socialized to concepts of citizenship (Xenos, Vromen, & Loader, 2014). Xenos et al. (2014) found that, across the United States, the UK, and Australia, young people’s social media practices supported political engagement, with “digital citizenship” type activities (i.e., discussion of civics topics) supporting individual and collective political engagement (p. 11). Couldry et al. (2014) have proposed that social media facilitates civic engagement by creating opportunities for communities to share stories that ultimately create trust, build connection, and suggest a vision for community development.

Our conception of digital citizenship is informed by synthesizing a number of these theoretical points, and yet we also suggest that ours offers a unique contribution to the field. We propose a model of digital citizenship that is student-centered (e.g., as opposed to teacher-directed), emphasizes participation via strategic creation, curation, and circulation (e.g., rather than passive acquisition of information), and grounded in the authentic, sociocultural practices of young people (e.g., rather than normative uses of technology). We theorize a strong relationship between new literacies practices (Lankshear & Knobel, 2011), identity development and expression, and the development of digital citizenship. For example, as young people use the microblog and social network site Twitter to organize for community efforts, mobilize followers around an emerging social protest, and document social protest movements in real time, they may be developing Twitter literacy, or Twitteracy (Greenhow & Gleason, 2012). This literacy, conceptualized as the ability to make informed decisions about how, and when, to participate on Twitter, develops through teenagers’ participatory play with digital media (Gleason, 2016b). Further, their participation in teenage Twitter demonstrates personal commitments (i.e., to feminist activism) that emerge as catalysts for a wide range of possibilities for teaching and learning.

This article contributes to an emerging research field within education that suggests that young people’s social media activity can support the development of digital citizenship (Greenhow, Robelia, & Hughes, 2009; Krutka, 2014; Keller, 2015). We conceptualize social media broadly, as platforms that allow people to create, share, and follow other users (Obar et al., 2012), including social network sites such as Facebook, the social network/microblog Twitter, image sharing platforms such as Instagram, and video sharing platforms such as YouTube and Snapchat. This paper explores the concept of a social media-enabled digital citizenship approach that leverages young people’s personal interests and engagements, what we conceptualize as commitments, in the service of individual and community-oriented participatory practices of teaching and learning. These activities blend offline and online action, in-school and out-of-school practices, representing what scholars have called “connected methods” (Leander & McKim, 2003) and “connective action” (Bennett & Segerberg, 2012).

Digital media has spurred material, social, technical, and cultural changes that have resulted, scholars argued, in a broader conception of what citizenship is, young people’s development of citizenship practices, and how these changes may result in the possibility of greater connection between young people’s authentic, personally meaningful activities and traditional approaches to citizenship and civic engagement (Bennett & Segerberg, 2012; Kahne et al., 2012; Freelon et al., 2016; Gleason, 2013; von Gillern & Gallagher, 2016). In this paper we utilize the affordances of digital and social media, notably their participatory, engaging, connected logics, as impetus for a rich, dynamic, citizenship curricula. While acknowledging differences between offline and online practices, this work draws on both as spaces of generative for the development of digital citizenship. Using both conceptual understandings and empirical research that demonstrate young people’s opportunities and commitments to civic engagement, we propose a social-media enabled approach to digital citizenship that integrates formal, in-school curricula with out-of-school, youth unsanctioned practices.

The digital citizen goes to school: digital media for civic engagement

Teaching civics and promoting civic engagement have long been goals in education (Krutka, 2014). In recent years, the National Council for the Social Studies (2013) reaffirmed the value and dedication of civic engagement through producing the College, Career, and Civic Life (C3) Framework, which calls on and prepares educators to help students to succeed in these areas in their lives. Furthermore, the C3 Framework recognizes the importance of preparing students to use technology to succeed academically and in life more broadly. This aligns with the Common Core English Language Arts Standards that recognize the value of developing students’ ability to engage in electronic communication and utilize digital and multimodal resources to communicate ideas (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010).

These ideas and standards complement the concept of digital citizenship, which has also been highlighted by the standards for students created by International Society for Technology in Education (ISTE) and provide reasons for educators from across disciplines to engage their students in activities that promote civic engagement and...
digital citizenship (International Society for Technology in Education, 2016). There are multiple ways for educators to help students develop their abilities to effectively engage in digital communication through in-class activities and activities that bridge students’ in-school learning and out-of-school experiences.

In this article, we discuss three notable ways for these learning experiences to unfold. First, we will conceptually discuss how students can create digital research projects, such as public service announcements (PSAs) that investigate issues that matter to them and their communities, raise awareness, and advocate for their beliefs with broader communities through social media. Second, we conceptualize and illustrate opportunities for students to investigate issues, prepare arguments, and connect with publicly elected officials with numerous goals in mind including:

- developing an understanding of the political process
- creating powerful and persuasive media
- participating in political processes
- connecting personal commitments and interests to systems, cultures, and histories
- influencing legislation

Third, we will present empirical data to illustrate how students’ participatory practices of teenage Twitter suggest the development of important digital citizenship practices (i.e., creating and sharing political information, participating in social protest, and volunteering for a worthwhile community cause). All of these activities align with digital citizenship and represent ways that teachers can help empower students to develop critical thinking abilities, enhance digital communication skills, and influence their communities by connecting their in-school learning with their out-of-school civic participation.

**Public service announcements**

The first example that illustrates how teachers can promote digital citizenship and connect students to their communities is a public service announcement (PSA, see Figure 1). While opportunities exist at the elementary level, we focus on secondary students, as these activities may be more appropriate for older students and better aligned with curricula. Creating public service announcements is a way for students to identify an important issue, research that issue and its relevance for the community, and then prepare a persuasive form of media that can impact a community’s perceptions and actions (Selke & Selfe, 2008), presenting an opportunity for students to develop civic engagement. PSAs can cover a wide variety of topics, ranging from projects focused at the local level to the global, including political, environmental, social issues, and more. The PSA example in this article (see Figure 1) illustrates how students can use free infographic creation tools to convey important information and statistics related to food loss and waste around the world. (Note: this infographic was created with Canva, but other useful infographic creating platforms include Easel.ly, Piktochart, and Venngage.)

In order to prepare a PSA, educators can guide students in a few ways. First, educators can help students learn what PSAs are and their potential value for influencing attitudes and behaviors. Second, students can examine a range of PSAs to determine their characteristics, and what leads some to be more effective than others. Third, teachers can provide opportunities for students to brainstorm and choose potential PSA topics that are relevant to them or their communities, as well as select goals for their PSA, such as influencing their communities’ attitudes, actions, or both. After choosing topics and selecting goals, students can create, collaborate, and revise their PSAs.

In our own experiences teaching educational technology courses to preservice secondary educators at a large public university, we have had fruitful experiences providing opportunities for our students to create their own PSAs.

The PSAs they created varied, ranging from a humorous PSA on the dangers of walking while texting, to a serious PSA focused on prevention and treatment of sexual assault. Our students were empowered to create PSAs on topics that exhibited their personal interests, commitments, and agency. The preservice teachers recognized the activity as valuable and most showed interest in facilitating similar activities in their classrooms as a way for students to critically investigate a topic, create persuasive media, and share with their peers or broader communities.

Instructor and students need to determine the best way to disseminate their PSA, considering which audience is most appropriate (i.e., classroom, school, or community at large), and balancing students’ need for privacy with opportunities for “real world” publication and dissemination. YouTube, SnapChat, Tumblr, Twitter, and
Facebook are all viable audiences, but each platform has its own opportunities for publishing and implications in regards to audience reach and impact. Publishing in these venues allows students to share viewpoints that are valuable to them and validate their lived experiences. Posting anonymously online is an option to help maintain student privacy, as is sharing through a formal learning management system (such as Blackboard, Edmodo, or Canvas).

Figure 1. Example of Public Service Announcement Created with Canva
Social media can be an effective way for students to spread their ideas as a digital citizen through civic participation. Ultimately, creating PSAs can be a relatively simple activity that can help students develop their ability to communicate social and political messages in ways that promote civic participation and aligns with digital citizenship. The methods for organizing PSA creation activities will vary from context to context, as will the format of the PSAs and the methods for distribution. In short, students can learn valuable forms of civic participation and engage with various communities as a digital citizen.

**Contacting elected officials**

Teachers can also help students develop communication and research skills through activities that connect them with elected officials. While there are a variety of methods that accomplish this, the website democracy.io makes it easy for students to contact their representatives. This website allows individuals to enter their address (see Figure 2), which then automatically populates their elected representatives in the U.S. congress and senate (see Figure 3). Users can then type messages (see Figure 4) that will automatically be sent to their elected officials. This is a “quick and easy” way of engaging in civic participation that helps students understand ways that they and their communities can utilize to share their concerns and hopefully, effect change.

![Write to your representatives](https://democracy.io)

*Figure 2. Screenshot of Democracy.IO Website, Example 1*

It is also important for educators to help students created well-reasoned, articulate arguments to support or oppose a specific position or policy, which requires investigating current issues and legislation, and carefully constructing informative and persuasive writing. While valuable for one individual to contact their representatives to advocate for or against a particular policy, there is often strength in numbers. Students can use the affordances of social media to amplify their message, communicate quickly, and to set the stage for continued conversation with desired audiences (Obar et al., 2012). While requiring students to contact their representatives and advocate for or against specific positions and legislation may not always be appropriate in the classroom, teachers can still empower students to thoughtfully and critically develop coherent and well-supported arguments to share with their representatives outside of school in ways that help students bridge their in-school experiences with their out-of-school civic participation and digital citizenship.
Figure 3. Screenshot of Democracy.IO Website, Example 2

Figure 4. Screenshot of Democracy.IO Website, Example 3
Our examples of creating and distributing PSAs using social media and contacting representatives have been influenced by our conceptual understandings of civic engagement and digital citizenship, as well as our experiences working with preservice secondary educators. Valuable opportunities exist for secondary educators to prepare students to research critical issues, produce persuasive digital media, and strategically distribute their products through social media. Our conceptualizations of civic engagement and digital citizenship are also guided by findings from the first author that suggest a high level of engagement on social media with topics related to citizenship, including: community service projects, feminist advocacy (i.e., what one participant called “fourth wave activism”), and advocacy for increasing school funding, which we will examine next.

Digital citizenship in teenage Twitter

This section reports findings from a two-year research study that explored how adolescents’ participatory practices of teaching and learning in teenage Twitter (e.g., for a more in-depth discussion of this study, see Gleason, 2017). Twitter is a popular microblog and social network site, used by over 50 percent of young people aged 16-17 (Zickuhr & Rainie, 2014), that enables users to post 140 character messages (tweets), share them (retweets), and follow other users. Research from a pilot study with five adolescent Twitter users suggested that young people are skilled in creating multimedia compositions that use specific language and literate practices to dialogue (and persuade) their peers (Gleason, 2016). In order to maintain privacy for participants (who were minors when they consented to participate in the study), I have changed slightly the language used in tweets. I intend for this change to maintain the meaning(s) of the tweets, while making it difficult to discern the author of the tweets using internet search functions.

Following approval of the research study by institutional review board, three participants, all highly active (e.g., daily) users of Twitter, consented to the study and were enrolled in the study in March 2013. They were all at least 17 years old at the time of enrollment, identified as White, and in high school; two were juniors (i.e., Ryan and Lori), and one (i.e., Lucy) was a senior. Participants reported that their socioeconomic status was upper middle class. Twitter data was collected both progressively and regressively (e.g., progressively for a period of roughly two years, and regressively to when they started using Twitter). Conceptually, this study aligns with educational research that investigates how adolescents from “elite” communities develop citizenship practices rooted in social justice (Swalwell, 2013; Goodman, 2011).

All three participants demonstrated a commitment to contributing information on topics related to becoming a digital citizen, conceived broadly as relating to civic engagement. Ryan, Lucy, and Lori engaged in a number of practices on Twitter related to contributing information, including posting or sharing information (e.g., often about politics, civic engagement, or citizenship), and/or commenting on others’ posts. Since the data collection period included the run-up to the 2012 U.S. presidential election, there was a corresponding interest in the number of election-related tweets. For example, Ryan retweeted information about how the Affordable Care Act provided birth control “without co-pays or deductibles...potentially saving women hundreds of dollars per year” (@TheDemocrats, 10/21/12). Lucy shared “breaking news” from a legitimate political source that reported how Republican candidate Mitt Romney, following tradition of US candidates running for the highest office, planned to release his 2011 taxes (@ThinkProgress, 9/21/12). Lori contributed information explaining Obama’s position on women’s health: “I don’t think any male politician should be making health care decisions for women” (@BarackObama 10/25/12).

The presidential campaign captivated the interest of three participants, and one way they engaged with matters of citizenship (including issues about health care, public education, and national security) was by participating in conversation during the presidential debates. Participants expressed their commitment for an “open exchange,” such as when Lucy urged Governor Romney to “let her speak,” suggesting that this indicated his lack of “respect” for women matched by his “policies.” (10/16/12). Lucy suggested an interest in joining the larger conversation about the debates through her use of the hashtag #debates2012.

In addition to being engaged with politics, such as political campaigns, elections, and dominant political parties (e.g., Democrats and Republicans), participants engaged in matters broadly conceived as digital citizenship, such as engaging with more broad social issues. In 2013, a widely-debated issue was gay marriage. Here, participants shared a variety of information about gay marriage, generally corresponding with young people’s overall support of gay marriage, with roughly 60 percent of those under age 35 (the closest age grouping) supporting it. Lori retweeted Obama’s position, “Same sex couples should be able to get married” (3/26/13), while Ryan shared a post from an NBC News report on Hawaii’s legalization of same sex marriage in November, 2013. For her part,
Lucy shared a thoughtful post entitled “Supreme Court Gay Marriage: Is Marriage Equality Really the Last Civil Rights Struggle” (@mic, 5/31/13) that investigated the “limits” of marriage equality.

In addition to sharing information from multiple sources, livetweeting “just in time” events such as presidential debates, and commenting on important social issues such as gay marriage through teenage Twitter, all three participants developed practices relating to digital citizenship through “connective action” (Bennett & Segerberg, 2012) that integrated in-school and out-of-school opportunities for teaching and learning, and online civic education with offline public practices. Participants’ out-of-school practices in teenage Twitter strongly suggest the possibility of complementing student’s in-school civic engagement, such as the ones described above. The process of selecting a topic for a public service announcement could be aided by looking for evidence of young people’s engagement in public issues in teenage Twitter.

For example, Ryan, who described himself as “obsessed with politics,” participated in a number of connective activities, both online and offline, related to advocating for increased funding for his school district. Town residents rejected a proposed tax increase to fully fund educational offerings, resulting in what he called cuts to “ALL extracurriculars/clubs, all non-varsity sports, the Gifted and Talented program, Science Research, full-day kindergarten, as well as raising class sizes astronomically.” Online, Ryan mobilized support for a tax increase through writing an editorial in the town newspaper, starting a petition for additional federal aid on the White House website (since taken down), raising awareness through a number of tweets on this topic, and publicizing the efforts in his personal forum on the question-and-answer platform Ask.com. Offline, Ryan travelled to his state legislature to protest school budget cuts and to ask for “our fair share.” The group successfully petitioned the state capital, resulting in two million dollars in funding for the town. In addition, Ryan developed his digital citizenship through mobilizing resources via Twitter in advance of a speech to his local school board, who called it “articulate” and “civil.” Ryan’s hard work contributed to the successful passage of the school budget.

Meanwhile, Lori also participated in connective activities, posting or sharing 53 tweets about her school community’s Relay for Life over two years. These tweets were diverse, from cut-and-dry fundraising requests (i.e., the same message repeated, with only the @ name changed), to Instagram images of relay participants, to sharing logistical information (e.g., with time and place) about the Relay itself. In addition to posting context-dependent information with the appropriate hashtag, Lori retweeted peers, the high school principal, and even the soccer coach. Beyond the informational tweets, the tweets that Lori shared suggested the possibility that the explicit purpose of the Relay for Life initiated new dynamics among participants-- a sense of excitement, possibility, and momentum toward participation. For example, Lori retweeted one of her friends, who called the event “amazing” and noted that she was “proud” of participants and donors who “supported” them. Another friend called the event “astonishing” and reported feeling “blessed” as a result. The soccer coach posted a picture of an adult getting “pie’d” (e.g., hit in the face with pie) as a fundraising activity, and exclaimed “I can’t believe I’m missing this!”

Lucy also developed an intersectional feminist activity through participation in #StandWithWendy. A state senator from Texas, Wendy Davis, completed a 13-hour filibuster to prevent a vote on a bill that would deny access to reproductive care. The hashtag #StandWithWendy was created to organize against the legislation, and Davis found a troop of willing fans, including activists, politicians (including President Barack Obama), and everyday women-- in short, what Davis called her “feminist army.” In an interview, Lucy told me that participating in this social protest “was a way of engaging in action.”

Discussion

This article suggests that the development of a social media-enabled digital citizenship approach requires the integration of two critical elements: first, the use of a curricula that provides opportunities for secondary students to develop understanding of citizenship and civic education through the use of digital media applications, software, and games. Digital media offers an engaging way for young people to learn about significant dimensions of citizenship and civic education while lowering barriers to participation. For example, while many young people may not run for political office, volunteer for a politician, or even vote, they can still develop competencies and connections through digital media. Second, the use of social media (e.g., Twitter) is a way for young people to develop their competencies of digital citizenship through producing, sharing, and discussing information related to politics. Empirical findings highlighted young people’s diverse activities online and offline, from livetweeting political protest, to participating in community service projects, to mobilizing support for equitable school funding.
Through these online and offline activities, young people demonstrated their interest in participating in connective actions (Bennett & Segerberg, 2012) that benefitted their communities (e.g., school, town, state, and imagined) as well as being personally enjoyable and pleasurable. This suggests the need for an integrated social media approach for digital citizenship, the beginnings of which we will sketch below.

Our social media digital citizenship approach can be utilized in a number of ways. We have demonstrated three ways in this article: (1) creating and distributing PSAs, (2) contacting representatives, and (3) communicating values and enacting commitments through Twitter. Creating and distributing PSAs illustrates the potential for secondary educators to help students develop their ability to create persuasive media that can influence a community’s attitudes and behaviors. Contacting representatives provides students an opportunity for student civic engagement in which they learn how to develop and communicate effective political arguments. Finally, connecting young people’s commitments to participatory action with formal curricula of civic education provides teachers with an opportunity to center young people’s experiences, culture, and lives online.

Together, these elements offer new possibilities for secondary students to use digital media to participate in civic life, offers teachers a chance to become a co-learner alongside students in a process of creative digital play (Henricksen et al., 2016), and presents opportunity for students, teachers, community members, administrators, and parents to make student learning visible (Hattie & Yates, 2013). Using the affordances of social media for sharing, lowering barriers to participation, and flattening traditional hierarchies through activities like the ones described in this article, educators can prepare students for civic engagement and provide opportunities for their students to develop digital citizenship skills by providing relevant learning experiences in the classroom that can be utilized outside of school for their personal and political goals in life.

An important dimension of a social media digital citizenship approach involves a deliberate, pedagogical centering of student interests, competencies, and assets, conceptualized as commitments (Gleason, 2017). Over a two-year period of teenage Twitter, young people engaged with a number of different topical attractions including social conflict; friendship maintenance; recreational activities (e.g., concerts, sporting events); work (e.g., part-time jobs); academic challenges and successes; relationship initiation, development, and termination; and many more. While they were energized with the vital life stuff of teenage Twitter, taking an interest in the dynamic trending topics on Twitter, over time some of these interests stabilized. Informed by notions of connection to shared public values (Bennett, 2008), we conceptualize commitments as more substantive than affinities (Gee, 2005), involving a moral component, and strongly related to the concomitant intertwining nature of identity development and expression of values.

Here we are moved by a radical vision of how commitment is intertwined with individual and collective action, emotion, and connection: “We have to recognize that there cannot be relationships unless there is commitment, unless there is loyalty, unless there is love, patience, persistence” (West, 2009). Commitments can be thought of as simultaneously both individual and collective, mediated through sociotechnical practices inherently social (e.g., the hashtag), and informed by larger histories, practices, and systems of oppression (Holland & Lave, 2009). As a heuristic for interpreting how social media enables (or does not enable) digital citizenship, commitments suggest expanding researchers’ interpretative gaze beyond mere individual action to examine the relational aspects, dimensions, and practices at play as young people participate, make meaning, and align with particular identities facilitated through creating PSAs, contacting representatives, and utilizing Twitter and other social media platforms for influencing the attitudes and actions of various communities.

Centering young people’s commitments, such as Lucy’s commitment to intersectional feminist activism, suggests the promise and transformative potential of using social media to support digital citizenship. Consider Lucy’s participation in #StandWithWendy, a protest against the current trend of limiting women’s reproductive healthcare options. Over a period of about six hours, Lucy tweeted or retweeted 65 posts related to Senate Bill 5, the proposal to limit women’s access to abortion centers in Texas. These included an “explainer” article from the Washington Post providing background and context about SB5; a link to the livestream where almost 200,000 people stayed up until midnight to watch a filibuster; Lucy’s livestweet of key statements (e.g., Senator Leticia Van de Putte’s question: “At what point must a female senator raise her hand or her voice to be heard over the male colleagues in the room?”), and critiques over the bill’s eventual passing. Throughout 65 tweets, Lucy shared information, contributed opinions (i.e., her own, and other people’s), and highlighted connections to other spaces of digital citizenship (links to Tumblr, YouTube livestreams, and Planned Parenthood sites). Through it all, she demonstrated agency and received recognition from her followers for her commitment to feminist activism; one of her tweets (“hey y’all, this is fourth wave activism. Activism through social media. There would not be 190,000 viewers otherwise. #StandWithWendy”) was retweeted 10 times and favorited twice.
Viewing Lucy’s commitment to feminist activism as a significant component of digital citizenship allows teachers and researchers to build upon student experience, language (and literacies), and culture (Bartolome, 1994). In addition, it clearly offers the possibility for a variety of curricular connections, such as to public health, philosophy (feminist and otherwise), public policy, reproductive science, economics, the history of social protest, the use of media for organization and social mobilization, and countless others. Focusing on the topic of reproductive health could begin with a comparison of health care across the United States, investigating the relationship between what is deemed “essential” health care and what is excluded. From there, learners could explore the economics of healthcare, the biology of reproductive health, and even how social movements have pushed for increased health coverage, care, and liberty.

**Conclusion**

Digital citizenship manifests itself in many ways. While many young people are savvy at communicating their values and influencing the attitudes and behaviors of their peers with social media, secondary educators also have a role and opportunity to help their students develop skills that enhance students’ ability to identify problems, create persuasive media, and strategically distribute this media to their peers and communities. This article focused on political opportunities for digital citizenship, as the political represents valuable topics and opportunities for engagement, but digital citizenship is at its core a social endeavor and can incorporate a wide variety of both social and political topics and activities. These represent valuable opportunities for both educators to help students develop valuable digital citizenship skills and bridge in-school learning with the students’ out-of-school interests, values, and commitments. While requiring students to distribute PSAs, contact representatives, or engage in politically-centered Twitter activities may not always be appropriate in the classroom itself, educators can prepare students for such activities in the classroom and help them conceptualize methods and opportunities for these and other forms of civic participation that can be used for out-of-school activities and experiences.

Participants’ out-of-school, authentic (e.g., “unsanctioned”) civic education activities spur us to take seriously young people’s motivations, engagements, and desires for public participation as suggestive of their interest in a new kind of digital citizenship. Their practices of sharing information and opinions about relevant topics (e.g., gay marriage) indicate a desire to contribute to, and inform, public dialogue. For example, Lucy’s commitment to feminist activism demonstrates how young people use the sociotechnical affordances of social media to develop digital citizenship. Lucy’s engaged participation suggests a way forward: engaged participation, centered on young people’s authentic commitments to shared values that open up the possibility of educational experiments that begin with student experience, language and literacy practices, and cultures.

Innovative, secondary school teachers responsible for teaching digital citizenship (e.g., social studies, history, civics, and language arts educators) should consider integrating social media as a way to develop learning networks that connects students’ offline and online civic engagement activities with formal citizenship curricula. In this vision of a social media-enabled digital citizenship approach, the sociotechnical affordances of Twitter (e.g., ability to participate in “real time” political action organized around hashtags) lower barriers to participation while allowing students to develop important new literacies (Gleason, 2016; Greenhow & Gleason, 2012).

**References**


Middle School Students’ Social Media Use

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ABSTRACT

Cyber bullying, digital identity, impact of digital footprints, and use of inappropriate social media are topics that are gaining attention in K-12 schools. As more schools and school districts are implementing 1-1 and “bring your own technology” initiatives, attention to these topics is becoming increasingly important. A total of 593 middle school students were surveyed about digital footprints and concerns about social media. The results show that 17% started using social media at age nine or younger, 40% accepted friend requests from people they do not know, and 40% reported that their parents did not monitor their social media use, which calls for the needs of cyber-security education. These middle school students reported using social media most often to connect with their friends, share pictures, and find out what others are doing. They indicated that Instagram (27%), SnapChat (25%) and YouTube (25%) were their most used social media sites. These students have concerns about social media due to inappropriate postings, getting hacked, getting their feelings hurt, lack of privacy, inappropriate pictures, bullying, negativity, and stalkers. This study informs teachers, administrators, technology facilitators and parents on social media use by students.

Keywords

Digital citizenship, Social media use, Middle school, Digital footprints

Introduction

As students are increasingly engaged in technology and cyber learning at very young ages, there is a heightened concern for their safety. Cyber bullying, impact of digital footprints, and inappropriate use of social media are topics that are gaining attention. As more schools and school districts are implementing 1-1 and “bring your own technology” initiatives (Dunleavy, Dexter, & Heinecke, 2007; Lowther, Ross, & Morrison, 2003) attention to these topics is critical to the welfare of our students. The literature on social media use among teenagers points to benefits as well as risks for this population. On one hand, social media use provides great opportunities for connecting with others, creating and being part of online communities that foster creativity, knowledge and civic participation. For example, Facebook allows students to connect outside the classroom and collaborate on assignments and projects, thus creating more opportunities for learning. Through social media, youth can find out about volunteering opportunities and local political events (O’Keefe & Clarke-Pearson, 2011).

On the other hand, social media use presents several societal risks for middle school and high school students. Many have expressed concerns that this use may have negative impacts on various areas of teenage life. This was supported by a study that indicated that Internet use as little as three hours per week could lead to depression and social isolation in teenagers (Kraut, Patterson, Lundmark, Kiesler, Mukopadhyay & Scherlis, 1998). However, a recent study conducted with 130 7th-graders from a middle class public school in California on Internet use revealed that overall Internet usage had no significant correlation with psychological adjustment. Interestingly, this study found that teenagers who scored higher on social anxiety and loneliness measures were more likely to communicate via instant messaging with acquaintances. Even teenagers who felt well supported and connected to their peers at school sought out additional opportunities to interact with people they did not know well but very few close friendships were actually developed online (Gross, Juvonen & Gable, 2002). This raised questions about whether or not this makes anxious and lonely adolescents more vulnerable to online predators.

To investigate this issue, Dowell, Burgess and Cavanaugh (2009), surveyed 404 middle school students on their engagement in online risky behaviors. 31% of the sample reported posting personal information on social networking sites, including a picture of themselves. Twenty two percent of boys (compared to 6% of girls) reported having searched the topic of sex on the Internet and roughly, 40% of both boys and girls reported having encountered sexually inappropriate material on the Internet. Approximately 28% of the participants reported being harassed or bullied on social media sites. Furthermore, the results of this study indicated that simply posting your picture on a social media site did not necessarily constitute a risky behavior. However, the clustering of various risky behaviors such as posting the name of school and email address, corresponding with unknown persons, initiating online sex and online harassment, and overriding Internet filters and blocks may place vulnerable youth at jeopardy (Dowell et al., 2009). However, others have argued that previous claims that social networking sites present a great risk of victimization, as in unwanted sexual harassment and solicitation,
seem to be unfounded. Out of 1588 middle school students surveyed recently on this issue, 15% reported an unwanted sexual solicitation online (Ybarra & Mitchell, 2008).

A recent large national survey of 1588 middle school youth, ages 10-15, found that 32% had experienced online harassment, among which, 43% were via instant messaging (IM) in chatrooms and 28% via social networking sites (Ybarra & Mitchell, 2008). However, some empirical data is inconsistent with these results. For example, a recent study examining cyber bullying amongst middle school students was conducted with 1,915 girls and 1,852 boys in grades 6, 7, and 8 who attended any of six elementary and middle schools in the southeastern and northwestern United States (Kowalski & Limber, 2007). In this study only 11% (n = 407) of the students qualified as victims of cyber bullying and 78% (n = 2961) had no experience with cyber bullying. Cyber bullying victims are also victims of school bullying with nonheterosexual youth reporting more incidences. Cyber bullying leads to elevated levels of distress and depression and sometimes to suicide attempts (Schneider, O'Donnell, Stueve, & Coulter, 2012). Generally speaking, social media sites may influence suicide-related behavior negatively as well as positively. For example, studies have found that youth often encounter suicide-related content on message boards, chatrooms and YouTube videos. However, social networking sites such as YouTube and Facebook can also help with suicide prevention by providing information and connection to suicide prevention websites and hotlines (Luxton, June & Fairall, 2012).

Digital citizenship

The results on the use of social media have resulted in the need to educate K-12 students on becoming digital citizens who exhibit “the norms of appropriate, responsible behavior with regards to technology use” (p. 7) as defined by Ribble (2004). International Society for Technology in Education (ISTE) lists digital citizenship as an important aspect of educational technology. Ribble (2014), in his book titled “Digital citizenship in schools,” lists 9 elements of digital citizenship under the framework of Protect, Respect, and Educate.

![Figure 1. Nine elements of Digital Citizenship based on Ribble’s framework](image)

Table 1. NETS-S Standard 5 – Digital Citizenship

<table>
<thead>
<tr>
<th>NETS-S Standard 5 – Digital Citizenship</th>
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</table>
| Students understand human, cultural and societal issues related to technology and practice legal, and ethical behavior | • Advocate and practice safe, legal, and responsible use of information and technology  
• Exhibit a positive attitude toward using technology that supports collaboration, learning, and productivity  
• Demonstrate personal responsibility for lifelong learning  
• Exhibit leadership for digital citizenship |

In the section below, we review some of the key digital citizenship topics that K-12 students need to be educated about based on Ribble’s framework and ISTE NETS-S Standard 5.
Cyber bullying

One of the most talked about risks of social media use among teenagers is cyber bullying and online harassment, which is defined as “deliberately using digital media to communicate false, embarrassing, or hostile information about another person” (O’Keefe & Clarke-Pearson, 2011). Cyber bullying takes place when someone deliberately upsets or harasses someone else repeatedly using online or mobile technology. Signs of cyber bullying are when kids harass or embarrass others publicly, spread rumors, post hurtful information or images online, or say mean things that humiliate others in public. The effects of cyber bullying on students can lead to depression, thoughts of violence, and even suicide. When cyber bullying occurs, there is an obvious misuse of the online or mobile technology, requiring parents and schools to get involved (Ahn, Bivona, & DiScala, 2011; Al-Khateeb, & Epiphaniou, 2016).

Digital netiquette

When students are online interacting with others there are some “unspoken rules” that guide them on how to behave and communicate called netiquette (Brown, 2014). Students need to learn the do’s and don’ts of appropriate online behavior. Typically, different sites or online interactions require specific netiquette. For example, Facebook requires certain netiquette when posting comments, such as being polite, avoiding sarcasm, and avoiding rudeness or “shouting” (writing in ALL CAPS). Netiquette is also required when posting images, such as being authentic or linking to sources. Bottom line, basic netiquette is required to avoid discriminatory, defamatory or derogatory remarks online, and encourage being respectful and sensitive to others’ cultural differences. Researchers have designed reward based systems to help children develop good behaviors online (Valentine, Leyva-McMurtry, Borgos-Rodriguez, & Hammond, 2016).

Digital footprints

The culture of sharing information online is great for young people who want to express themselves, collaborate, and socialize with others. However, students need to become aware of the “digital footprint” they leave online and reflect on the kind of personal information they share about themselves (Grayson, 2011; Madden, Fox, Smith, & Vitak, 2007; Malhotra, Totti, Meira Jr, Kumaraguru, & Almeida, 2012). Today, anything can be created, copied, pasted, and shared to thousands of people online almost instantly. Each online post, image, or message is permanent and stored as a “digital footprint” that can be retrieved years later by classmates, teachers, college admissions officers, future employers, or the general public. Students should understand the public and permanent nature of the Internet so they can begin to build a positive digital footprint. Students need to learn more than just how to guard personal information, how to protect their own privacy, and how to respect others’ privacy. Guiding students to self-reflect before they self-reveal is a fundamental technique to assist them with consciously managing how they decide to present themselves online.

Digital privacy

Most middle school students are now accessing email, social media, online videos, and games, most of which require log in accounts, usernames and passwords. Students should learn how to create strong passwords and protect their private information on their user accounts. Aside from this, students must be careful about permissions when downloading files, media, or content online; most websites have privacy, copyright, plagiarism, fair use, and creative credit policies that students need to be aware of. For older students, it is necessary to understand the concept of identity theft, data theft, online viruses, and online scams, where third party companies “steal” personal information such as passwords, credit card information, and social security numbers to commit crime or fraud online. Students need to know where the boundaries are when sharing information about oneself and others online.

Digital identity

A vital part of growing up is forming our identity. Identity is often reflected as how you perceive yourself as well as how others perceive you. It is manifested in our relationships with others, our sense of self, and reputation. As students navigate websites and use various apps on their mobile devices, they use photos (i.e., avatars), “likes,” and “favorites lists” for example, to show (or hide) different aspects of their identities. Many times, people can
choose to be “anonymous” when they are asked to present an online identity, however, this is not the case offline. Students need to understand the similarities and differences in how they present themselves online and offline, particularly what it means to be responsible for their actions even when they are not easily identifiable or anonymous. Students also need to consider how different forms of self-expression form their online identity and how online identity can be different from one’s real self.

Middle school students and social media use

A 2013 report of the Pew Research Center’s Internet & American Life Project on teen social media usage between 2006 and 2012, reported that 95% of teens (N = 802) ages 12-17 used the Internet and eight out of ten online teens used some kind of social media, mainly Facebook and Twitter. Facebook attracted 77% of online teens. Still, 24% of online teens used Twitter, a figure that is up from 16% in 2011 and 8% in late 2009. Teenagers’ use of Twitter now overtakes that of adults (Madden, Lenhart, Cortessi, Gasser, Duggan, Smith, & Beaton, 2013). Overall, 94% of teens said they have a Facebook profile, and 81% said that Facebook is the profile they use most often. One in four teens said that they have a profile or account on Twitter and 11% have a profile or account on Instagram. By comparison, only 7% of teen social media users said they maintain a Myspace account, and none of the survey respondents said MySpace is the account they used most often. That is in stark contrast to the 85% of teens who said in 2006 that MySpace was their most frequently used profile (Madden et al., 2013). In 2015, according to the Pew Research Center statistics, 71% of youth between ages 13-17 (N = 1,060) use Facebook, followed by Instagram (52%), Snapchat (41%), Twitter (33%), Google+ (33%), Vine (24%), and tumbler (14%) and 71% reported using two or more sites (Lenhart, Duggan, Perrin, Stepler, Rainie & Parker, 2015).

Older teens that are social media users more frequently share: photos of themselves on their profile (94% older teens vs. 82% of younger teens), their school name (76% vs. 56%), their relationship status (66% vs. 50%), and their cell phone number (23% vs. 11%) (Madden et al., 2013). The 2004 Pew Research Center’s Internet & American Life Project survey, showed that 39% of online teens shared their own artistic creations online, such as artwork, photos, stories, or videos, 33% created or worked on webpages or blogs for others, including those for groups they belong to, friends, or school assignments, 28% created their own online journal or blog, 27% maintained their own personal webpage, 26% remixed content they found online into their own creations (Lenhart, Madden, Rankin & Aaron, 2007).

Parents of the surveyed teens were asked a related question: “How concerned are you about how much information advertisers can learn about your child’s online behavior?” A full 81% of parents report being “very” or “somewhat” concerned, with 46% reporting they are “very concerned.” Just 19% report that they are “not too concerned” or “not at all concerned” about how much advertisers could learn about their child’s online activities (Madden et al., 2013). In this report, 65% of 12-13-year-olds use social media compared to 89% of 14-17-year-olds. Amongst the younger teens (12-13), 52% report using social media daily compared to 73% of older teens (14-17). Older teens tend to visit social media several times a day and tend to have a larger number of friends or followers than younger teens (Lenhart et al., 2015). Due to the widespread availability of smartphones, 24% of youth between ages 13-17 go online almost constantly. The Pew Research Center reported in 2015 showed that 87% of teens (N = 1,060) had access to a desktop or laptop computer, 81% had access to a gaming console, 73% had access to a smartphone, 58% a tablet computer, and 30% a basic cell phone. The report indicated that 91% of teens accessed social media sites using the Internet on their smartphones (Lenhart et al., 2015).

Purpose of this study

The major research study in this area of middle school social media use was from the Pew Research Center. There is a need for more studies to validate and add to these findings in different contexts. The current study was conducted in two middle schools in Southeastern United States. The purpose of this study is to gather middle school students’ perceptions on the use of social media and their opinion towards cyber safety. The following questions were answered in this study:

- Which social media tools do middle school students use?
- Which social media sites do middle school students use most?
- Which social media site is a favorite among middle school students?
- What activities do middle school students do on social media sites?
- What technologies do middle school students use to access social media?
Do parents of middle school students monitor their use of social media?
Do middle school students accept friend requests from people they do not know?
How old were the middle school students when they started their social media account? Is there a gender difference?
How many times do middle school students check their social media account per day? Is there a gender difference?
What do middle school students like the most about using social media?
What bothers middle school students the most about using social media?

Methods
Participants
Five hundred and ninety-three middle school students (6th to 8th grade) from two schools in the Southeastern region of the United States completed a survey about their online activity on social media and their concerns about social media. One school was represented by 238 (40.1%) students and the other school was represented by 355 (59.9%) students. The age of these students ranged from 12 to 16 with a mean of 13.32 and a standard deviation of 0.55. The distribution of gender is 50.6% (n = 300) female and 49.4% (n = 293) male.

Survey
A survey with 14 items was designed to collect information about the participants’ use of social media and their opinions towards cyber safety. Other than gender (Item 1) and age (Item 2), the participants were asked to respond to multiple-choice questions: Which social media tools they used (Item 3); Which social media site they used the most (Item 4); Which social media site was their favorite (Item 5); What things they did on social media sites (Item 6); Which technologies they used to access social media (Item 7); Whether or not their parents monitor their use of social media (Item 8); Whether they accept friends requests from people they do not know (Item 13). The participants were also asked to respond to three open-ended questions: How old were they when they started their social media account (Item 9); How many times did they check their social media per day (Item 10); What they like the most about social media (Item 11); and What bothers them the most about social media (Item 12).

Data analytical procedure
Descriptive statistics were used to report the frequency and percentage of the categories participants chose as responses to the multiple-choice questions. Independent samples t-tests and Chi-square tests were employed to see if the responses differed by gender. Responses to open-ended questions were coded using thematic analysis. Qualitative data were coded into meaningful categories and then organized into themes through comparison, contrast, and identification (Sangasubana, 2011).

Results
Research question 1: Which social media tools do middle school students use?
The most popular social media tool that middle school students use is Instagram, which was reported by 432 (72.85%) students. The next popular tools were Snapchat and YouTube, each was reported by 385 (64.92%) students. Table 2 is a list of all tools used by the participants in this study.

<table>
<thead>
<tr>
<th>Table 2. Social media tools that middle school students use</th>
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<tbody>
<tr>
<td>Instagram</td>
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<tr>
<td>n</td>
</tr>
<tr>
<td>%</td>
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</tbody>
</table>

217
Research question 2: Which social media site did middle school students use most?

Consistent with the responses to Question 1, Instagram ranked the top of all the social media sites that middle school students use most. The frequencies of social media sites that were reported by the students were presented in Table 3.

<table>
<thead>
<tr>
<th>Social media site that middle school students use most</th>
<th>Instagram</th>
<th>Youtube</th>
<th>Snapchat</th>
<th>Facebook</th>
<th>Twitter</th>
<th>Pinterest</th>
<th>Vine</th>
<th>GooglePlus</th>
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<tbody>
<tr>
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<td>158</td>
<td>148</td>
<td>146</td>
<td>45</td>
<td>13</td>
<td>12</td>
<td>9</td>
<td>7</td>
</tr>
<tr>
<td>%</td>
<td>26.64</td>
<td>24.96</td>
<td>24.62</td>
<td>7.59</td>
<td>2.19</td>
<td>2.02</td>
<td>1.52</td>
<td>1.18</td>
</tr>
</tbody>
</table>

Research question 3: Which social media site is a favorite among middle school students?

Snapchat was the favorite social media site for the participants in this study (Table 4).

<table>
<thead>
<tr>
<th>Favorite social media site among middle school students</th>
<th>Snapchat</th>
<th>Youtube</th>
<th>Instagram</th>
<th>Facebook</th>
<th>Kik</th>
<th>Pinterest</th>
<th>Twitter</th>
<th>Vine</th>
<th>GooglePlus</th>
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<tbody>
<tr>
<td>n</td>
<td>149</td>
<td>144</td>
<td>119</td>
<td>34</td>
<td>24</td>
<td>22</td>
<td>21</td>
<td>17</td>
<td>2</td>
</tr>
<tr>
<td>%</td>
<td>25.13</td>
<td>24.28</td>
<td>20.07</td>
<td>5.73</td>
<td>4.04</td>
<td>3.71</td>
<td>3.54</td>
<td>2.87</td>
<td>0.34</td>
</tr>
</tbody>
</table>

Research question 4: What activities do middle school students do on social media sites?

The most popular activity is posting pictures. Table 5 shows the frequency of the activities reported by the participants.

<table>
<thead>
<tr>
<th>Activities middle school students do on social media sites</th>
<th>Post pictures</th>
<th>Read other’s posts</th>
<th>Delete videos</th>
<th>Comment on others’ posts</th>
<th>Post videos</th>
<th>Delete pictures</th>
<th>Reshare others’ posts</th>
<th>Reshare others’ videos</th>
<th>Reshare others’ pictures</th>
<th>Post status updates</th>
<th>Delete my posts</th>
<th>Delete my comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>494</td>
<td>397</td>
<td>333</td>
<td>333</td>
<td>234</td>
<td>209</td>
<td>150</td>
<td>129</td>
<td>129</td>
<td>110</td>
<td>69</td>
<td>39</td>
</tr>
<tr>
<td>%</td>
<td>83.31</td>
<td>66.95</td>
<td>56.16</td>
<td>56.16</td>
<td>39.46</td>
<td>35.24</td>
<td>25.30</td>
<td>21.75</td>
<td>21.75</td>
<td>18.55</td>
<td>11.64</td>
<td>6.58</td>
</tr>
</tbody>
</table>

Research question 5: What technologies do middle school students use to access social media?

The students used smartphone, laptop/Chromebook/Macbook/netbook, tablet/iPad, desktop computer, and gaming system (X-box). Table 6 is the frequency of the use of these technologies.

<table>
<thead>
<tr>
<th>Technologies middle school students use to access social media</th>
<th>Smartphone</th>
<th>Laptop</th>
<th>Tablet</th>
<th>Desktop</th>
<th>X-Box</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>503</td>
<td>489</td>
<td>283</td>
<td>109</td>
<td>40</td>
</tr>
<tr>
<td>%</td>
<td>84.82</td>
<td>82.46</td>
<td>47.72</td>
<td>18.38</td>
<td>6.75</td>
</tr>
</tbody>
</table>

Research question 6: Do parents of middle school students monitor their use of social media?

Table 7 shows the frequency counts of students’ report of whether or not their parents monitor their use of social media.

<table>
<thead>
<tr>
<th>Parents’ monitor of social media</th>
<th>Female</th>
<th>Male</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>I am not sure</td>
<td>35</td>
<td>54</td>
<td>89</td>
</tr>
<tr>
<td>No</td>
<td>115</td>
<td>120</td>
<td>235</td>
</tr>
<tr>
<td>Yes</td>
<td>150</td>
<td>119</td>
<td>269</td>
</tr>
</tbody>
</table>
Chi-square test showed a statistically significant difference between boys and girls with regard to their parent’s monitoring. Parents of girls seemed to monitor more than parents of boys, $\chi^2(2, 593) = 7.62, p = .02$.

**Research question 7: Do middle school students accept friend requests from people they do not know?**

Table 8 is the frequency counts of students’ report of whether or not they accept friends’ requests from people they do not know.

<table>
<thead>
<tr>
<th></th>
<th>Female</th>
<th>Male</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>168</td>
<td>186</td>
<td>354</td>
</tr>
<tr>
<td>Yes</td>
<td>132</td>
<td>107</td>
<td>239</td>
</tr>
</tbody>
</table>

Chi-square test failed to show a statistically significant difference between boys and girls with regard to their acceptance of friends’ request from strangers, $\chi^2(1, 593) = 3.45, p = .06$.

**Research question 8: How old were the middle school students when they started their social media account? Is there a gender difference?**

Table 9 shows the frequency distribution of the age when children started using social media.

<table>
<thead>
<tr>
<th>Age 9 or younger</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
<th>15</th>
<th>16</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>102</td>
<td>121</td>
<td>149</td>
<td>143</td>
<td>57</td>
<td>12</td>
<td>8</td>
</tr>
<tr>
<td>%</td>
<td>17.20</td>
<td>20.40</td>
<td>25.13</td>
<td>24.11</td>
<td>9.61</td>
<td>2.02</td>
<td>0.17</td>
</tr>
</tbody>
</table>

Independent samples $t$-test revealed statistically significant differences in gender, $t(591) = 3.64, p < .001$. Girls started using social media at an earlier age ($M = 10.81, SD = 1.27$) in comparison to boys ($M = 11.24, SD = 1.57$).

**Research question 9: How many times do middle school students check their social media account per day? Is there a gender difference?**

The reported frequency of daily use of social media ranged from zero to 300 with a mean of 12.74 and a standard deviation of 48.48. Independent samples $t$-test revealed girls used social media significantly more ($M = 19.69, SD = 64.30$) than boys ($M = 9.47, SD = 22.71$), $t(533) = -2.45, p = .02$.

**Research question 10: What do middle school students like the most about using social media?**

In response to the question “What do you like most about Social Media?” among 593 students four broad categories evolved during coding: information, communication, entertainment, and general (See Table 10).

In the information category, 127 students mentioned the knowledge social media provides for them to learn about other people/friends’ lives, what they are doing, and what is new with them. Having knowledge about news around the world (13), the ability to communicate with people around the world (12), the ability to upload videos (12), the functionality of posting pictures (11), and the ability to express yourself (10) were other reasons students mentioned for liking social media.

In the communication category, chatting and communicating with friends is another item that was mentioned by 110 students. The other common themes were interacting/communicating with others (53), seeing what people post (39), sharing/receiving information (36), and staying updated (27) are other popular reasons among students in favor of using social media. Viewing pictures was mentioned by 21 students, and 17 students said sharing what they do or like through social media is why they like using it.

In the entertainment category, using social media as entertainment is another most stated item by 77 students. Sixty-eight students found social media good to stay in touch with their family and friends who do not live close
by or who they do not see often. Watching videos or movies is among the most stated items that students like about social media. Sixty students said they like social media because they can watch videos or movies by it. However, 15 students said they either do not have social media or do not use it. Ten students stated that they do not like social media.

<table>
<thead>
<tr>
<th>Information</th>
<th>Communication</th>
<th>Entertainment</th>
<th>General</th>
</tr>
</thead>
<tbody>
<tr>
<td>Know what people/friends, are doing</td>
<td>Chat/communicate with friends</td>
<td>Entertaining</td>
<td>Don't have /don't use social media</td>
</tr>
<tr>
<td>Share/get info/stuff</td>
<td>Stay in touch with family and friends out of states or far away/ friends do not go to school with</td>
<td>Watch video/movies</td>
<td>Nothing/don't like it</td>
</tr>
<tr>
<td>Stay updated</td>
<td>Interacting/communicating with others</td>
<td>See posts</td>
<td>Everything</td>
</tr>
<tr>
<td>Share what you do/like</td>
<td>News around the world</td>
<td>See picture</td>
<td>Share /see experience</td>
</tr>
<tr>
<td>What celebrities are doing</td>
<td>Communicate with the whole world</td>
<td>Upload videos</td>
<td>I don't know</td>
</tr>
<tr>
<td>Know what they think about my stuff on SM</td>
<td>Express yourself</td>
<td>Upload/post pictures</td>
<td>Being fast</td>
</tr>
<tr>
<td>See what others are talking about</td>
<td>Meet new people</td>
<td>Games</td>
<td></td>
</tr>
<tr>
<td>Share memory</td>
<td>Texting</td>
<td>Post stuff</td>
<td></td>
</tr>
<tr>
<td>Stay in touch</td>
<td></td>
<td>Passing time</td>
<td></td>
</tr>
<tr>
<td>Commenting on friend's posts</td>
<td></td>
<td>Listening to music</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Show/see creativity</td>
<td></td>
</tr>
</tbody>
</table>

**Research question 11: What bothers middle school students the most about using social media?**

In response to what bothers you the most about Social Media, the four broad categories that evolved were content, people/behavior, safety/privacy and Internet (See Table 11).

In the content category, 64 students mentioned that they disliked disturbing or inappropriate posts on social media this was followed by dumb comments mentioned by 19 students.

In the people/behavior category, 85 students mentioned that they do not like meeting people who are mean on social media, followed by bullying and being criticized which was mentioned by 65 students. Twenty-seven students also mentioned drama and too much feeling and 26 students mentioned immaturity of those using social media as things that bother about social media.

In the safety/privacy category, 43 students have concerns about privacy and the accessibility of social media accounts and 24 students mentioned that they were concerned about their social media accounts being hacked.

In the Internet category, 9 students talked about low Internet speed, and startup issues and 8 found waiting time as bothering related to Internet and social media.

In the final category, 61 think there is nothing in social media that bothers them, 13 mentioned that advertisements and spams, also lying and tricks bothered them. Eleven students reported that they did not have social media accounts.
Table 11. Least liked characteristics of social media by middle school students

<table>
<thead>
<tr>
<th>Content</th>
<th>People behavior</th>
<th>Safety/privacy</th>
<th>Internet</th>
<th>General</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disturbing/ inappropriate stuff</td>
<td>64 Mean people</td>
<td>85 Privacy/ track you down/ having access Hacking</td>
<td>43 No Internet/ needs Internet Waiting/slow</td>
<td>6 Nothing</td>
</tr>
<tr>
<td>Dumb comments/ stuff</td>
<td>19 Bullying/criticize</td>
<td>65</td>
<td>24</td>
<td>8 Adds/spam</td>
</tr>
<tr>
<td>Inability to control content you see</td>
<td>7 Drama/too much feelings</td>
<td>27 Stalkers</td>
<td>8 Being slow/start up issues</td>
<td>9 Don’t have social media</td>
</tr>
<tr>
<td>Random stuff pop up</td>
<td>3 People don’t know how to use it/immaturity</td>
<td>26 Stuff stay there even if you delete it</td>
<td>7 Uses data</td>
<td>3 Not sure/don’t know</td>
</tr>
<tr>
<td>Too many notifications</td>
<td>5 See negative stuff about others/hatred</td>
<td>21 Your pictures end up on google Unsafe/dangerous</td>
<td>6</td>
<td>Everything</td>
</tr>
<tr>
<td>Fake news</td>
<td>2 Sharing too much and everything about self</td>
<td>19</td>
<td>5</td>
<td>Boring</td>
</tr>
<tr>
<td>Too much info</td>
<td>2 Fake people Lying/tricks</td>
<td>19 No answer</td>
<td>3 Apps kick me out</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>People you don’t know talking/following</td>
<td>11</td>
<td>Being blocked at school</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Creepy people Reporting inappropriate and nothing happens</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Arguing</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Show off</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Spending too much time. Neglecting world</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Exposing people</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Gossiping</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bad people</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

Discussion

Private information vs. privacy

The survey results demonstrate a very interesting aspect in middle school students’ usage of social media: from one side, they try to keep the information that they exchange from adults (especially their parents and teachers), while on the other side, they have not fully established the awareness and capabilities to protect themselves. If we examine the popular social media sites that they use, we can find that traditional sites such as Facebook and Twitter, which are widely used by more mature people (above 25), are less popular with teens. While there has been a lot of discussion on the rise of Snapchat and Instagram (Boyle, Earle, LaBrie, & Ballou, 2017; Piwek & Joinson, 2016; Vaterlaus, Barnett, Roche, & Young, 2016), we think that two properties lead to their popularity in the subjects surveyed. First, the parents and teachers of young students are usually more familiar with the social sites such as Facebook and Twitter. Therefore, it is more difficult for grown-ups to effectively monitor the communication contents among young students. Actually, there are articles showing that the user interfaces of
Snapchat are harder to use by people over 25 (Oremus, 2015). The second property is the unique technique in short information lifetime provided by these social sites. For example, people have to access posts in Snapchat within a short period of time or the posts will be removed from the user’s device. In this way, less digital footprint will be left for the users.

In contrast to the motivation of students who try to keep social information from their parents and teachers, they have not established full awareness and capabilities to protect themselves in the digital world. This is demonstrated from their willingness to accept friend requests from unknown people: about 40% of surveyed students will accept such requests. While the results do not consider other factors such as “common background” or “closeness of mutual friends” (Rashtia, Boshmaf, Jaferian, & Beznosov, 2014), it is obviously too high when we consider the safety of young students. This number shows that security education for middle school students deserves more efforts and attention.

Gender distinction

In their early stage of middle school, students will acquire a lot of knowledge and capabilities each year. Therefore, their objectives and frequently conducted activities on social sites could vary from year to year. At the same time, boys and girls start to develop different attitudes toward social media (Sentse, Kretschmer & Salmivalli, 2015). For example, our results show that girls are more willing to accept a stranger’s friend request than boys. They also check social media updates much more frequently than boys. These results justify the observations that more parents of girls intend to monitor their activities online than those of boys. From this point of view, we need to pay special attention to girls during security education.

Objectives and frequent activities

The activities that middle school students conduct on social media and their objectives should be aligned. The activities shown in Table 4 can be classified into two groups. In the first group, a student updates the contents in her/his social media account. The top operations focus on posting and deletion of videos and pictures. In the second group, the students provide feedback or comments on other people’s posts. Surprisingly, from Table 4 we find that the ratio between type 1 and type 2 operations is about 5:4, which means the students conduct more operations to share their stories than to read about others. These results show the intention of the students to express themselves instead of caring about others. This study also found that students use social media for a variety of things. As verified by our study, they keep up with friends, communicate with friends, post pictures, comment on pictures, like the posts of others, and share other information.

Technologies used to access social media – Smartphones and laptops

Our findings indicate that students access social media on smartphones and laptops more frequently than other devices. Consistent with findings of Lenhart et al. (2015), the Smartphone is used most frequently as most students have this device with them at all times. This can actually encourage students to be frequent users of social media. Students can access social media anywhere at any time with this device. Students also access social media frequently using laptops. Many schools provide laptops for students’ use both in school and at home. With Internet access, students can utilize the laptop to access social media. Given the ease of accessibility of these devices, it is important for both teachers and parents to monitor the use of these devices and the information that students are accessing on the devices.

Frequency and parents monitoring social media use

With the increase of social media use by middle school students, it is important for parents to monitor the frequency of students’ use of social media, the information they are accessing, and the friends with whom they associate. This study found that students used social media more than 10 times per day, specifically the girls used social media significantly more times than the boys. Students in our study express concerns for cyber bullying. Frequent monitoring of students’ use of social media can provide parents with information regarding potential cyber bullying which can assist parents with early interventions before students begin to feel threatened or vulnerable. Parents can also monitor students’ friends on social media and inquire about names they are not familiar with. This is extremely important to protect students from potential cyber stalkers and cyber bullying.
About 40% of students, both male and female in our study reported that they have accepted friend requests from strangers on social media to boost their popularity on social media sites. Most do not understand the consequences that this behavior could have. This underscores the importance of having adults who continually monitor students’ use of social media and the content of the information they are accessing.

Conclusion

Students are beginning to use social media at a very young age especially the girls creating social media earlier than boys and also befriending strangers more than boys. It is essential to educate the students, their teachers and parents on cyber bullying, digital identity, impact of digital footprints, and use of inappropriate social media. This study was conducted as a needs assessment to measure middle school student use of social media to develop a digital citizenship curriculum. The results of this study will benefit teachers, technology directors, parents, and school administrators to identify social media use among the middle school students. The results may also provide support to guide and inform instructional practices with the curriculum.

References


Patterns of Inclusion: Fostering Digital Citizenship through Hybrid Education

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ABSTRACT
Reconsidering the concept of digital citizenship and the essential component of education the authors propose that the concept of Hybrid Education may serve both as a guideline for the utilization of digital technologies in education and as a methodology for fostering new forms of participation, inclusion and engagement in society. Following T.H. Marshall’s conception of citizenship the authors suggest that becoming, belonging and the capabilities to do so is essential to digital citizenship in a culturally diverse and digitally mediated world. The paper presents a theory-based, value driven and practical orientated framework for innovation in education. The paper documents a process where participants situated around the globe worked in collaboration with a group of participants gathered at a workshop on the concept of hybridity in education and on identifying and describing educational patterns for Hybrid Education that are directly applicable in relation to the concept of digital citizenship. The process introduces a value-based and vision-driven design pattern approach to innovation in education by framing and aligning values and visions of the participants. This work resulted in approximately 85 unique pattern candidates that address various aspects of hybridity in education. In conclusion, the concept and practice of Hybrid Education is both productive and conducive to the reconsidered idea of digital citizenship proposed in the paper.

Keywords
Digital citizenship, Hybrid education, Educational design, Educational patterns

Introduction
This paper offers a reconsideration of the concept of digital citizenship especially focusing on the philosophical and normative underpinnings. Furthermore, the paper presents an introduction to the concepts of Hybrid Education and educational patterns that may serve as the practical and theory-based means to re-configure education in alignment with and framed by certain values and visions directly applicable for digital citizenship and education for digital citizenship. The paper documents a process of educational innovation conducted in collaboration between different educational researchers from around the world participating online and face-to-face. The three authors of this paper all participated in this process.

Citizenship and education
Education is central to the process of creating citizens. In his seminal essay on citizenship – Citizenship and Social Class – Marshall (1950) stressed the importance of education both as a basic social right and an individual obligation in relation to the state. Marshall suggested a tri-partition of citizenship rights into civil, political and social rights as he saw them evolve and materialize in England during the eighteenth century (civil rights), nineteenth century (political rights) and the twentieth century (social rights). Citizenship is defined as “a status bestowed on those who are full members of a community. All who possess the status are equal with respect to the rights and the duties with which the status is endowed.” (Marshall, 1950, p. 28). To become a full member of a community education was needed. Marshall saw education as a central social right and a right closely connected to citizen formation: “The education of children has a direct bearing on citizenship, and, when the State guarantees that all children shall be educated, it has the requirements and the nature of citizenship definitely in mind. It is trying to stimulate the growth of citizens in the making. The right to education is a genuine social right of citizenship, because the aim of education during childhood is to shape the future adult. Fundamentally it should be regarded, not as the right of the child to go to school, but as the right of the adult citizen to have been educated.” (Marshall, 1950, p. 25). Education is thus essential in the establishment and endowment of the universal status of citizenship and the enjoyment of the rights connected to this status.

Marshall (1950) saw citizenship as an evolutionary concept that increased the equality at every step of its expansion which was why it came into conflict with the concept of social class exactly because of its egalitarian scope which Lipset (1964) saw as the most central tenet in Marshall’s work. Consistent with his view of citizenship as an evolving concept reflecting the historical development and the expansion of rights and inclusion
of different social groups, Banks (2008) argues for expanding Marshall’s concept of citizenship to include cultural democracy and cultural citizenship given that virtually all liberal democracies are multinational or multiethnic. Given the ubiquitous and pervasive character of digital technologies in mediating communication, participation and forging of cultural identities (Johnson et al., 2014; Gillespie, 2010; Coleman, 2010) the expanded concept of citizenship should also include the aspect of digital citizenship defined as “representing capacity, belonging, and the potential for political and economic engagement in society in the information age” (Mossberger et al., 2008, p. 2).

Thus, we see digital citizenship as a continuation and broadening of the core Marshallian concept of citizenship. But the relationship between education and digital citizenship needs to be reconsidered to better fit the changing circumstances; the possibilities and dangers inherent in the advent of a digitally mediated world. It also brings into question the concept and practice of digital citizenship.

Digital Citizenship reconsidered

Taking into account both Banks (2008) and Mossberger et al. (2008) and their expansion of the concept of citizenship and consistent with Marshall’s evolutionary and egalitarian approach we suggest that becoming and belonging and the capabilities to do so is essential to digital citizenship. This takes into account that there are multiple paths of becoming and multiple spaces and places of belonging in a culturally diverse and digitally mediated world. Furthermore, that the capabilities to become and to belong are unequally distributed. These three parts of citizenship are also present and closely intertwined in Marshall’s conception of citizenship and depended almost entirely on the role of education for their realization. Therefore, education needs to be reconfigured to fit our changed context and in doing so begs the question of how to renew education.

Capabilities

Drawing on the insights of the practice-based participatory arts and media project, Digital Commonwealth, McGillivray et al. (2016, p. 724) conclude that “a critical digital citizenship agenda needs to be embedded in educational narratives, where young people are, through practice, asked to ponder how digitally mediated publics operate in the school setting and beyond. Integrating ‘making’ and ‘thinking critically’ about the benefits and dangers of pervasive digital media in and outside of school is imperative.” Furthermore, they concluded that pedagogies need to be aligned with technologies to prepare both students and teachers to deal with the opportunities and threats of a digitally mediated world (McGillivray et al., 2016).

Digital citizenship needs a critical stance in relation to the capacity for an ethically guided use of technologies. Our use of digital technologies is inherently ambiguous and involves both a positive and a negative universalizing gesture (Samuels, 2008). For example, digital technologies have made possible the connections on a global scale that enable people to both broaden or narrow their world-view (Colleoni et al., 2014). Digital technologies such as social media make it possible to connect to the rest of the world and at the same time disconnecting from the localities in which they are physically embedded. The exposure to and engagement with other voices can lead to openness and curiosity but also to echo chambers of meaning (Goldie et al., 2014). In rare cases these monotone voices can even underpin a process of radicalization where the exposure to and the appropriation of different narratives offer individuals the collective possibility of affirming themselves as actors and of finding compatibility between self-perception and group recognition that may in the mind of the perpetrator legitimize violent action (Archetti, 2015). Education for digital citizenship is not simply a matter of information, knowledge and know-how. It is also a matter of interpersonal and inherently ethical relations, of how we think about and behave towards others, particularly those who differ from us in their race, religion, class and the like (Kymlicka, 2002).

Drawing on the concept of capabilities (Sen, 1979) we propose a “basic capability equality” which by analogy lets us shift focus away from mere technologies to what technology enables people to do. What a person is able to do say with a smartphone for instance may vary greatly from person to person. The problems encountered by different people when using digital technologies are numerous and go under the simplified notion of the “digital divide” (Warschauer, 2004). The focus of the capability approach “is here on the freedom a person actually has to do this or be that – things that he or she may value doing or being.” (Sen, 2009, p. 232). The capabilities approach takes into account that people are different and as Sen remarks: “If human beings were very like each other, this would not have mattered a great deal, but there is evidence that the conversion of goods to capabilities varies from person to person substantially, and the equality of the former may still be far from the equality of the
latter.” (Sen, 1979, p. 219). Therefore, it is not enough that people have an equal right to some level of education if they for some reasons are unable to attend school at a regular basis. The right to education may be equal but the actual capacity for utilizing and exercising this right may be very unequal say between a young adult living at home supported by his or her parents and a single mom living on her own and working to take care of her child. A reconfiguration of digital citizen education should take this capabilities approach into account.

**Becoming**

Becoming is closely connected to Hannah Arendt’s ideas of natality and plurality. Natality for Arendt is that basic human condition; “the new beginning inherent in birth can make itself felt in the world only because the newcomer possesses the capacity of beginning something anew, that is, of acting” (Arendt, 1958, p. 9). Human beginnings in the political and historical sense is connected to the human activity of action. The human condition for Arendt is connected with three categories of activities; labor, work and action. Labor assures both individual survival and that of the species. Work produces human artifacts and bestow a measure of permanence on the mortal life of humans. Action that engage in the founding and preserving of the political life conditions memory and thus produces history. Action and natality is the central categories of politics for Arendt. But action would be an unnecessary luxury if humans were reproducible and interchangeable therefore the arena for action is a plurality of humans. Arendt writes: “Plurality is the condition of human action because we are all the same, that is, human, in such a way that nobody is ever the same as anyone else who ever lived, lives or will live.” (Arendt, 1958, p. 8). With action in plurality we become a someone and a somebody and this becoming is for Arendt central to the process of education.

Education for Arendt “is the point at which we decide whether we love the world enough to assume responsibility for it and by the same token save it from that ruin which, except for renewal, except for the coming of the new and young, would be inevitable. And education, too, is where we decide whether we love our children enough not to expel them from our world and leave them to their own devices, nor to strike from their hands their chance of undertaking something new, something unforeseen by us, but to prepare, them in advance for the task of renewing a common world.” (Arendt, 1954/1987, p. 196). First and foremost, it is important to bear in mind that education for Arendt is a passionate and ethically driven occupation that must strike the delicate balance between conservation and renewal. Secondly that responsibility is the central category of an education that leaves the possibility of renewal open. Authority of the teacher springs from his or her responsibility of the world. And as Arendt points out: “Anyone who refuses to assume joint responsibility for the world should not have children and must not be allowed to take part in educating them” (Arendt, 1954/1987, p. 189). Education makes both becoming of the individual and the renewal of the common world possible. Both possibilities hinge on the idea of responsibility which in turn in closely connected to belonging.

**Belonging**

To keep a sense of belonging and a feeling of inclusion build on heterogeneous groups can be very difficult as many attempts of integration have proven. To maintain some sort of inclusion of culturally diverse communities it is productive to think in terms of difference. This is partly empirically founded since our societies have changed so much that it is no longer viable to assume that strangers can be kept out. And as Bauman in a rather optimistic tone wrote “Postmodern times are marked by an almost universal agreement that difference is not merely unavoidable, but good, precious, and in need of protection and cultivation” (Bauman, 1997, p. 33). This was not a call for returning to some pre-modern plurality of “tribes” but a chance to rethink the conditions of individual freedom in diversity based on a more inclusive concept of citizenship, not reducing inclusion to the standard vocabulary of assimilation. This deprives the person destined to be assimilated of his or her culture and identity (Biesta, 2004). Belonging and being a member of a community was also central to Marshall, but that idea is very dependent on the inclusion via the creation of formal equality of rights. Another form of belonging respecting difference can be found in the reading of Alphonso Lingis. What Lingis (1994) shows is that there exists a different community, a community in which we are all in a sense strangers to each other, what Lingis refers to as a community of those who have nothing in common. This community differs from what Lingis calls the rational community and which echoes the community envisioned by Marshall where our voice is the voice of representation and rationality and one that is in principle recognizable to us via rational reconstruction or as Lingis puts it: “In our system of laws and our social institutions, we recognize our formulated experience, our judgment, our debated consensus. In our rational enterprises we find, in principle nothing alien to us, foreign, and impervious to our understanding; we only find ourselves.” (Lingis, 1994, p. 6). On the other hand, the community of those who have nothing in common is constituted by our response to the stranger. The
communication is ontologically prior to community but establishes community in the act of our response. As Biesta (2004, p. 318) remarks echoing both Lingis and Arendt: “It only matters that we respond, that we take responsibility, that we take our responsibility.” What constitutes this other community inside the rational community is our responsiveness. This community is one that we share in the ethical act of responding. In other words, it exists as a possibility not as something that we can assure or guarantee by any technological or deliberate way. In education which for the most part is catering for the rational community the only thing we can do is to sometimes suspend judgement of others and create opportunities to encounter what is different, strange and other. This opening up to a world of plurality is what constitutes the possibility of becoming and belonging through the acts of claiming responsibility. The digital practices of the students need to be incorporated into education or at least education needs to be reconfigured to be open to these cultural encounters.

This reconsideration of digital citizenship takes aim at the philosophical and ethical foundations for a reconfiguration of education. Thinking in education without some careful pondering at the foundations and underlying values can be problematic as Giroux points out: “Divorced from the imperatives of a democratic society, pedagogy is reduced to a matter of taste, individual choice, and job training. Pedagogy is a mode of witnessing, a public engagement in which students learn to be attentive and responsible to the memories and narratives of others.” (Giroux, 2011, p. 83).

In trying to uncover values and frame educational innovation we present a case of how this may practically unfold and hopefully give some inspiration and guidance for colleagues in education. Guiding the process was the idea of Hybrid Education and the methodology of educational patterns both of which may prove particularly important and relevant in relation to the education for and the practice of digital citizenship. These two ideas will be presented in the following.

**Hybrid education**

*Hybridity* as a term originates from Latin and has its roots in biology. In its most basic sense it refers to a cross-fertilization or amalgamation. For example, Charles Darwin used the term in this way in 1876 to describe his experiments in cross-fertilization of plants. Likewise, it has been used to describe the ways that in which the ancient Greeks and Romans to a large degree adopted and integrated elements from foreign cultures in their own, thus, in effect, creating hybridized cultures. In the field of archeology, the term has been widely used to describe the so-called “international style” of Eastern Mediterranean Late Bronze Age pieces of art, that “exhibit complete hybridization such that no one ‘foreign’ culture can be said to predominate.” (Feldman, 2006, p. 30).

The concept of hybridity has been closely connected to post-colonialism and multicultural awareness as well as an effort to remove the negative connotations from terms such as hybrid, bastard or mongrel and infuse it with more positive potentials and valuable productivity. Here, the focus is on the ability to open up new spaces, forms and understandings through the productive use of hybridity. Importantly, it is not a sequential blend of something like flipped classroom or blended learning that understands itself in sequences of online and offline, rather, it is something other, a new breed or something that is at least two places at once (Bhabha, 1994). With Bakhtin (1984), we can say that a hybrid is always polyphonic in nature, thus to be understood as a dialogically evolving concept. In recent times, hybridity has also been conceptualized as an effect of globalization, where new global and hybrid cultures emerge. In a globalized world, some remnants of different cultures intermingle and breed new ways of being and becoming a citizen. Today, many people are in effect not as much citizens of a specific nationality or nation-state as hybrid citizens in a digital world wherein they forge new hybrid ways of becoming and belonging between different cultures in local, national and global contexts in a seamless and continuous flow without a beginning and end akin to a rhizome (Deleuze & Guattari, 1980). In this way, a reconsidered concept of citizenship can be seen as a hybrid, rhizomatic, polyphonic and heterogeneous concept.

As a philosophical concept, hybridity suggests hesitation at a threshold. Hybridity is not an attempt to neatly bridge the gap, but extends the moment of hesitation and thereby evades easy categorization. And, as we allow two things to rub against each other, two things that might not otherwise touch, we invite them to interact, allowing synthesis and perforation along their boundaries. As the analog and digital, the physical and virtual, intermingle, we must let go of the containers for becoming and belonging to which we’ve grown accustomed. We must open up to hybridizing acts of citizenship to connections that are, like the web, associative and lively but also sometimes disturbing and deformed. In this, hybridity is not always safe, moving incessantly toward new breeds not yet known or described - something still not fully determined or categorized (Stommel & Rorabaugh, 2012).
Following from the above, Hybrid Education is likewise a rhizomatic, mongrel and heterogeneous composite that combines different elements to create something other, that is not a new blend but a new breed. Like a mule is neither a horse nor a donkey, but something third in its own right that came into being through the cross-breeding of horses and donkeys. Hybrid Education is such crossbreeding of different dimensions like online and on-site, digital and analogue, formal and informal. Hybridity as a term has been explored in relation to education, where it has been described as being “about the moment of play, in which the two sides of the binary begin to dance around (and through) one another before landing in some new configuration. [Hybrid Education] is not just about what will become of us in the wake of technological and cultural transformation, but also (and perhaps more predominantly) about the process of becoming itself.” (Stommel, 2012). Hybridity within education is the acknowledgement of otherness and difference as something productive and of in-between spaces which “provide the terrain for elaborating strategies of selfhood–singular or communal–that initiate new signs of identity, and innovative sites of collaboration, and contestation, in the act of defining the idea of society itself.” (Bhabha, 1994, p. 2). Furthermore, following from its close connections to globalization, hybridity accentuates how students increasingly build on a global hybrid culture base of experience that shapes both their identities and expectations of education. Hybridity emerges through the multitude of identities as a reality of the global classroom. Today, education is not for homogeneous citizens of a certain nationality belonging to a more or less uniform culture, but for a cascade of multifarious hybrid citizens that become and belong in the world in a myriad of different ways. Overall, the compound concept of hybrid education for hybrid citizenship promotes the potentials and possibilities for adopting values, activities, experiences, and formats in education that specifically focuses on the creation of new hybrids. As such, Hybrid Education is characterized by disruption, open-endedness, risk-taking, experimentation, empathy, dialogue, and critical creativity (Stommel, 2012). Capturing the idea of Hybrid Education in a practical manner and putting it to work on already existing structures of educational institutions needs some sort of methodological frame. The authors suggest that the language of educational patterns may serve as this frame.

Educational patterns and pattern language: Framework and workshop

Educational patterns provide the teacher with a set of pre-packaged examples of educational designs and a comprehensive language for making new educational designs. The idea of patterns and pattern language stems from the work of the architect Christopher W. Alexander and colleagues for them patterns “describes a problem which occurs over and over again, and then the core of the solution to that problem, in such a way that you can use this solution a million times over, without ever doing it the same way twice” (Alexander et al., 1977). Analogue to this definition of patterns, educational patterns are hypothesized solutions to recurring problems in an educational context e.g. the pattern PROBLEM ORIENTATION offers a solution to the difficulties of motivating the students when introducing a new topic. This pattern suggests to build on the student’s prior knowledge and to present a problem that the new topic solves (Fricke & Völter, 2000). Each pattern is part of a larger whole and exist in relation to other patterns. Therefore, patterns are organized in relation to one another in a network structure and explicitly mentions other patterns. The educational patterns for hybridity share the fundamental view of patterns and their relation to the world expounded by Alexander et al. (1977), that things are not build in isolation but must also repair the world around them. Furthermore, each individual pattern is formatted in a codified manner as to make it possible to evaluate and possibly modify it without losing the essence that is central to it. Educational patterns are specific examples of educational design that functions as representations of how to support learning in particular cases (Goodyear, 2005). They are procedural in nature and open to improvement. Patterns may in some cases even be highly speculative until they have been put to the test in real life setting. Existing educational patterns cover areas such as learning with technology (Goodyear & Retalis, 2010; Mor et al., 2014), MOOC-design (Warburton & Mor, 2015), assessments (Bergin et al., 2015), flipped classrooms (Köppe et al., 2015), lecture design (Köppe, 2013), seminars (Fricke & Völter, 2000), or general pedagogical practices (Bergin et al., 2012).

Pattern mining ground

EduPLoP is part of the Pattern Languages of Programs (PLoP) conference series and supported by both the Hillside Group and Hillside Europe. EduPLoP focus primarily on educational innovation through the collaborative design of patterns. It is designed as a pattern writing workshop where a small group of experts collaboratively works on identifying and describing patterns of a pre-defined domain in education. The first EduPLoP was held in 2015 in the Netherlands and the participants worked on patterns for Assessment-Driven Course Design (Bergin et al., 2015).
During the EduPLoP16 at Sandbjerg Estate in the southern part of Denmark on patterns for Hybrid Education the participants both worked on the concept of hybridity in education as well as working together in hybrid ways before, during and after the workshop through working digitally and materially, connecting remotely from around the globe from academic and non-academic spaces, working asynchronously and synchronously as well as individually and collectively. Through this framework, a hybrid group of experts within design patterns, hybrid pedagogy, educational technologies and online education collaborated on identifying and describing patterns for Hybrid Education. The EduPLoP16 was supported by both Aarhus University (DK) and University of Surrey (UK).

As Hybrid Education on the one hand is firmly based within the field of critical pedagogy (Stommel, 2012; Rorabouagh & Stommel, 2012) and on the other hand is focused on designing for educational experiences and interactions the group took a human-centered (Giacomin, 2015) and empathic (Gagnon, 2014; Köppen & Meinel, 2015; Battarbee, Suri & Howard, 2014) approach to hybrid education. EduPLoP16 was structured in a way that bears resemblance with the concept of value-based and vision-driven educational design thinking (Nørgård, 2016; Aaen & Nørgård, 2015; Mor et al., 2016) where design patterns are formed on the basis of specific values and driven by value-based visions. Accordingly, the EduPLoP16 workshop developed a pattern language for Hybrid Education through a workshop sequence in 6 steps structured around a value-based workshop, a vision-driven workshop, a brainstorm session, a sorting workshop, a pattern writing workshop ending with a convergent-divergent hybrid pattern writing workshop.

The value-based workshop

The value-based workshop focused on identifying the core individual values of the hybrid participant group and establish a collective value framework for designing hybrid education. The value framework made the underlying values of the group’s teaching and development practice explicit and enabled a collective alignment between the things we do (what and how) and the reasons for and purpose of doing so (why). The workshop was carried out to ensure that the group kept in touch with its educational values to realize the values, goals and purpose of hybrid education (see Figure 1).

The vision driven workshop

This workshop focused on activating the collective values in individual visions for hybrid education and subsequently transform these into a collective position or manifest that guide the development of design patterns. In this way, the values and visions guided the decision-making and design-arguments of the following pattern workshops thus making the pattern design not only focused on the what and the how but also on the why of the teacher and student experiences and interactions fostered and promoted by the design patterns. Overall, the value and vision workshop enabled the development of an intentional pattern language for Hybrid Education that provided the group with a secure foundation and intentional drive in the next step of the process where design patterns were brainstormed and developed.
The brainstorm session

The brainstorm session following the value and vision workshop to generate concrete examples of hybrid education from the group’s own development and teaching practice. These examples spanned well above 100 different sticky notes with specific titles of activities, practices and formats for Hybrid Education (see Figure 2).

![Figure 2. Brainstorming session](image2)

The sorting workshops

In this workshop session, the sticky notes from previous were collectively clustered and then sorted into higher-level categories. These categories combined a range of examples that were within the same affinity space. The clusters were given a common heading such as “hybrid production” or “inside out” to designate different areas of hybrid education (see Figure 3).

![Figure 3. Sorting workshop](image3)

The pattern writing workshops

Following the brainstorm and clustering workshops the group split up in different online-onsite hybrid sub-groups containing experts from different fields and practices and shepherded by an expert within design pattern writing to write up the different categories and examples as design patterns using a shared pattern template. The sub-groups distributed the different categories amongst them and moved them into pattern templates and categorization trees to develop a structured pattern language for Hybrid Education.

The convergent-divergent hybrid pattern writing workshop

In the final workshop the online-onsite sub-groups met together to discuss, merge, exchange and elaborate on the different evolving design patterns within the groups. This was done in a co-constructive manner to check for redundancy between patterns and make sure that the different patterns aligned with the shared values and visions.
of the group. Special attention went into the formulation of a synopsis for each pattern candidate explicating both the what, how and why of the pattern through a process of repeating review and questioning from both face-to-face discussions and online collaboration in Google Docs.

Results of the EduPLoP workshop - A Pattern language of hybrid education

The result of the EduPLoP16 at Sandbjerg was approximately 85 unique pattern candidates distributed between 9 categories. The categories and patterns were arranged into a graphic mind map showing related pattern candidates and every pattern had its own template under the different categories. By the end of the workshop some templates were still very rudimentary while some were more or less finished. All patterns were rated with `-symbols indicating the state they were currently in.

Value-based and vision-driven hybrid educational patterns

As outlined above, the development of a pattern language of Hybrid Education began with the value and vision workshop. The reason for putting the why-ness of design – the values and visions – before the how-ness and the what-ness, is to create a space for educational innovation and transformation. It is within the moral basis or virtues of educational design that the possibility for a new emancipatory space in education arises (Nixon, 2008). Change in educational practice stems from a change in the underlying values and visions for the future. In order to transform or innovate through educational design in ways that honors what is morally purposeful about education, and avoid crude instrumentalism we have to see it as “all of a piece and understand how the various activities that comprise it hang together” (Nixon, 2008, p. 1).

In other words, when developing a pattern language for Hybrid Education we need to make sure that the why, how and what are intimately connected and integrated. In this view, design patterns are always the putting into practice of what Nixon calls “virtuous academic practice” characterized by certain moral dispositions and a shared sense of moral purposefulness (Nixon, 2008, p. 8). Here, the value-based and vision-driven approach to developing a pattern language for Hybrid Education is taken to make explicit the moral foundation of the values and visions that sustain such an effort. And also, to practice those values and visions across a wide range of patterns.

Through the value-based and vision-driven approach each participant in the group started out by identifying the 5 underlying values driving their educational thinking and practice. These values were then shared and clustered into 6 core value categories shared by the entire collective and thus constituting a shared value foundation for further work. It is important to bear in mind that the identified core value categories are connected and not mutually exclusive, thus underlying values like for example sensitivity, experimentation or curiosity are shared across categories. The shared value foundation for Hybrid Education is presented in Table 1.

<table>
<thead>
<tr>
<th>Core value category</th>
<th>Underlying values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Empathy</td>
<td>Care, Respect, Commitment, Compassion, Sensitivity, Invitational</td>
</tr>
<tr>
<td>Belonging &amp; being</td>
<td>Contribution, Sensitivity, Care, Generosity</td>
</tr>
<tr>
<td>Playfulness</td>
<td>Joy, Creativity, Curiosity, Exploration, Experimentation</td>
</tr>
<tr>
<td>Agency &amp; empowerment</td>
<td>Autonomy, Resourcefulness, Self-determination, Freedom, Autonomy, Courage</td>
</tr>
<tr>
<td>Bildung</td>
<td>Thoughtfulness, Discipline, Professionalism</td>
</tr>
<tr>
<td>Discovery</td>
<td>Experimentation, Curiosity, Exploration</td>
</tr>
</tbody>
</table>

With these values as a collective basis for their work, the group then moved on to generate visions that should drive the development of Hybrid Education. Here, the values were integrated with the readings about hybrid pedagogy ahead of the workshop as well as opening talks by Maha Bali (The American University in Cairo, Egypt) and Bonnie Stewart (University of Prince Edward Island, Canada), one of the founders and editors of Hybrid Pedagogy - a digital journal of learning, teaching, and technology.

Fusing the notion of hybridity and hybrid pedagogy with the shared educational values (Table 1) produced individual vision statements that were then collected and put together to form a shared vision statement or manifesto about Hybrid Education. The shared vision statements that drove the development of the pattern language for Hybrid Education is presented in Table 2. Again, it is important to notice that the individual vision statements are not mutually exclusive and that the inspirational core value category in Table 2 are included to
give the reader an idea of the fusing process as well as provide some structure for arranging the individual vision statements.

<table>
<thead>
<tr>
<th>Inspirational core value category</th>
<th>Vision statements for a shared position on Hybrid Education</th>
</tr>
</thead>
<tbody>
<tr>
<td>Empathy</td>
<td>Hybridity promotes empowerment in order to establish autonomous learners through mutual respect and empathy</td>
</tr>
<tr>
<td>Belonging and being</td>
<td>Hybrid space strengthening belonging by broadening &amp; deepening perspectives</td>
</tr>
<tr>
<td>Playfulness</td>
<td>Hybridity fosters playfulness in order to develop openness through curiosity and experimentation</td>
</tr>
<tr>
<td>Agency and empowerment</td>
<td>Hybrid pedagogy supports empowerment in order to put control of the learning back in the hands of teachers and students</td>
</tr>
<tr>
<td>Bildung</td>
<td>Hybrid space invites discovery through different means of inquiry</td>
</tr>
<tr>
<td>Discovery</td>
<td>Hybridity promotes critical interaction by confronting us with unexpected opportunities and challenges</td>
</tr>
</tbody>
</table>

Following the development of a collective value-based and vision-driven approach to a pattern language for Hybrid Education the group moved onto first brainstorming examples of hybridity in education and hybrid teaching and learning, then clustering and categorizing the examples into hybrid educational patterns. Our intention is to evolve and develop all pattern candidates to full patterns and to describe them completely in future work. The categories themselves can also be seen as high-level patterns relating to and combining with other derived patterns, these patterns will be described in future work too.

**Hybrid education fostering Digital Citizenship**

This paper and the value and vision workshops it describes was sparked by an initial interest in the domain of Hybrid Education. However, we regard most of the established values and visions are also highly relevant for education in digital citizenship. Furthermore, we find that the field of Hybrid Education fills a gap between more traditional ways of teaching catering for the classic concept of citizenship. Here, Hybrid Education may underpin and foster our reconsidered concept of digital citizenship better because it specifically strengthens the dimensions of becoming and belonging and the capabilities to do so, that we find essential for digital citizenship and which to a great extent coincides with the findings of the value workshop (see Table 1). Thus, the uncovered values and vision that initiated and framed the design process of educational patterns for Hybrid Education takes aim at the level of practice. An educational practice that we contend will foster the practice and realization of digital citizenship reconsidered.

Often, educational development within a topic such as digital citizenship is preoccupied with identifying relevant curricula/content for that topic as well as pedagogical approaches for teaching these (Hollandsworth et al., 2011;
Bennett, 2008). Rather than conveying texts or knowledge on digital citizenship through teaching, we propose to use Hybrid Education as an entry point for practicing and expressing digital citizenship in education. Here, digital citizenship becomes embedded in educational practice since the values, visions and design patterns inherent in Hybrid Education transform the essential educational component of digital citizenship.

Bennett (2008, p. 21) stresses the importance of the student’s experiences of engagement and active participation within the educational system to shape the outcomes of citizenship for future generations. Therefore, it would be beneficial to shift the focus from education for digital citizenship to different ways of practicing and experiencing digital citizenship may be enabled with Hybrid Education. This also offers new possibilities to authentically include education for digital citizenship in all its facets in educational practice.

**Conclusion**

Digital citizenship can be fostered through a conceptual change of citizenship which takes into account the historical development and changes. We propose a reconsideration of the concept of digital citizenship by focusing on three intertwined philosophical underpinnings: becoming, belonging and the capabilities to do so. This has led us to reconsider the role of education in relation to citizenship and envision a change at the level of practice of the ways in which we perceive and act in education. Thinking and acting in hybrid ways change the scope and space for education making it more inclusive and conducive to the fostering of a digital citizenship that opens up to something other. In trying to bridge theory and practice we have presented a case of intercultural collaboration in a workshop format that resulted in approximately 85 educational patterns candidates for Hybrid Education. Judging from the outcomes and the following collaboration the concept of Hybrid Education and the process collaborative pattern mining can prove a viable pathway for innovation in education underpinning and fostering a new broader and value based conception of digital citizenship.

**References**


Concientization among People in Support and Opposition of President Trump

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ABSTRACT

Civic engagement in the United States has increased since the election of President Trump. This increase is evident online as people are using Twitter to assert their digital citizenship by voicing their opinions regarding President Donald J. Trump and demonstrating solidarity with various civic movements. President Trump’s election has caused many people to recognize how policies impact their daily lives and shed previous understandings as described by Freire (2005) as concientization. This study employed a Content Analysis to classify Tweets from #DisruptJ20 posted during inauguration week according to coniecticamento and Support or Opposition of President Trump. A Sentiment Analysis revealed that supporters of President Trump were much more negative than those who oppose President Trump. Results of the Logistic Regression found that variables related to network structure (Friends, Followers, and Likes) were more likely to predict Retweets than conicientization. Results of Hierarchical Linear Modeling indicate the average level of conientoization was positively related to being Retweeted. Implications include recognizing that digital citizens value content that illustrates how matters of state are impacting their lives. As conientoization increases in America, the more likely it is for people with opposing viewpoints to understand one another and work for mutually beneficial social change.

Keywords
Hierarchical linear modeling, Logistic regression, Concientization, Twitter, Digital citizenship

Introduction

The value of civic engagement can be seen as greater levels of participation in civic engagement increasing the chances for society to reflect the values of its citizens because there will be less of a disconnect between citizens and those elected to represent them (Coleman & Gotze, 2001). However, over a 25-year span, civic engagement has been decreasing at a rate of 9% in America (Montgomery, Gottlieb-Robles, & Larson, 2004). This trend of disengagement has changed course due to the election of President Donald J. Trump, which has catalysed Americans and people living abroad to engage in Social Action. Examples of Social Action associated with the election of President Trump are the Women’s March and the March for Science. In part, these movements owe their existence to the common perception that the President is disrespectful toward women and his statements regarding the science behind climate change.

People are awakening from their state of apathy because the President is forcing them into a state of Dissonance (Festinger, 1957) by creating fundamental contradictions between their internal views of the world (e.g., women should be treated with respect and government should work to protect the environment) and what is actually taking place. With so many people struggling with the new realities introduced by Trump’s presidency it begs the question, why did Americans elect Donald Trump in the first place?

The reasons Donald Trump was elected require further elucidation beyond existing interviews and exit polls because many instances of racism and anti-Semitism have surfaced since the election which threaten to disenfranchise large numbers of Americans. An examination of the statements made by people who support and oppose President Trump via the social medias site, Twitter, provides a unique opportunity to understand the identities of people on both sides and how they are exercising their freedom of speech in service of their digital citizenship. Twitter is an appropriate venue for this study because confidence in traditional methods of civic engagement is quite low (Coleman & Gotze, 2001) which ultimately drives people toward social media like Twitter to make their voices heard (Bonilla & Rosa, 2015). In addition, the combination of using Twitter and being an opinion leader on a given political topic has been found to significantly increase the chances of an individual increasing their civic engagement (Park, 2013). America currently stands as a house divided and the roots of these divisions must be identified in order to productively move forward as a nation.
Literature review

Imagined communities

Anderson (2006) developed the concept of Imagined Communities to describe nationalism as a sense of commonality regarding love for country regardless of the absence of direct intercourse among members. He provides the following definition: “It is an imagined political community - and imagined as both inherently limited and sovereign. It is imagined because the members of even the smallest nation will never know most of their fellow-members, meet them, or even hear of them, yet in the minds of each lives the image of their communion” (p. 5–6). He continues saying the nationalistic community is developed and maintained by participation in common activities. The idea that communities of people form based on interests, especially political interests, is important to this study because people who support and oppose President Trump are a subset of nationalists. These individuals will likely never meet (outside of Twitter) yet they all share similar views regarding the President and what they should or should not do to assert their views. Members of Imagined Communities form their identities based on prevailing stereotypes that exist within groups but also according to a person’s interpretation of how their actions are perceived by group members. Indeed Holland, Lachicotte, Skinner, and Cain (1998) note that “Persons develop through and around the cultural forms by which they are identified, and identify themselves, in the context of their affiliation or disaffiliation with those associated with those forms and practices” (p. 45). People who support and oppose President Trump form their own Imagined Communities. Within these communities, people are developing their identities through their talk about ideas surrounding societal and governmental issues and how they impact the lives of everyday Americans. This process is known as conscientization.

Concientization

Freire (1970) defines conscientization as “learning to perceive social, political and economic contradictions, and to take action against the oppressive elements of reality” (p. 35). Concientization represents changes in consciousness that reorient people to view their realities in a more critical light. The stages of conscientization per Freire (2005) are characterized as follows:

- Intransitive – silence about the circumstances of oppression and taking no action
- Semi-intransitive – submersion in historical processes characterized by introverted communities which cannot apprehend problems outside of their sphere of biological necessity. Represents a near disengagement between a person and existence.
- Naïve Transitive – oversimplification of problems and romantic view of the past that tend to have little interest in investigation and focus on polemics instead of dialogue
- Transitive – contending with problems outside their sphere of biological necessity by testing evidence which eventually replaces disengagement with almost total engagement and dialogue

Oppressed people generally start in the Intransitive stage and move gradually to the Transitive stage. To develop a critical consciousness oppressed people (e.g., minorities, people of low socioeconomic status, etc.) must engage in a critical confrontation of reality. In essence, the oppressed must critically state the nature of their oppression and name it as a first step in freeing themselves from their circumstances. However, when an oppressed people start to engage in sustained dialogue and reflection about the circumstances of their oppression, they often take action upon the world to initiate transformation, which is known as praxis (Freire, 1970). Praxis from a Transitive consciousness is the ideal outcome of conscientization. However, not everyone reaches the Transitive stage because people tend to fear freedom due to the difficulties involved in recognizing the way one has lived his or her life is built on oppressive constructs (Freire, 1970). To that end, the power of social media to move people from a passive role of information consumers to information producers facilitates the ability to participate in Social Action (Gleason, 2013). Digital Activism specifically encompasses the online actions that people take to initiate change in society.

Digital activism and identity negotiation

Digital Activism is defined by Whyte and Joyce (2010) as “the use of electronic tools to increase the effectiveness of a social or political change campaign” (p. 218). For example, research by Juris (2012) on the Occupy Wall Street movement linked Twitter activity to face-to-face actions finding when the city of Boston was trying to dismantle the protester’s encampment, activists got the word out on Twitter and people started to sing and dance in the streets until the city relented. Furthermore, Digital Activism is reported in the work of Bonilla
and Rosa (2015) who studied #Ferguson organizing. Their research found that very soon after news of Michael Brown’s death hit social networks, people organized digital protests as a sign of solidarity with those who protested in person. As people from across the globe unite in solidarity with those protesting racial violence, they are exposed to a deluge of viewpoints that ultimately provides them with the opportunity to negotiate their own identities based on what they think of the points being made. Bakhtin (1981) speaks to this negotiation process saying, “The importance of struggling with another’s discourse, its influence in the history of an individual’s coming to ideological consciousness, is enormous. One’s own discourse and one’s own voice, although born of another or dynamically stimulated by another, will sooner or later begin to liberate themselves from the authority of the other’s discourse” (p. 348). In other words, people initially engage in Social Action via Digital Activism using their own voice which is largely a product of socialization and experiential learning. As an individual engages in Digital Activism, he or she is provided with the opportunity to assess values and morals surrounding the subject of their activism. This assessment process is what Freire is referring to with conscientization. As such, the resulting decision to continue to portray external values (remaining oppressed) or to formulate an original position (toward freedom) is what liberates people from external discourses.

When the negotiation of identity via conscientization occurs at a group level the impact on society is often great. Perhaps the most powerful example of consciousness raising on social media is the Arab Spring Movement which was responsible for overthrowing former Egyptian President Hosni Mubarak. The role of social media like Twitter, Facebook, and YouTube was so important to the success of the Arab Spring Movement that it is referred to as a “Facebook Movement” (Brym, Godbout, Hoffbauer, Menard, & Zhang, 2014). Specifically, this Facebook Movement owes its inception in large part to previous movements that allowed Egyptians to voice their concerns about social issues in their country including “We are all Khaled Said.” This online movement was organized around the Egyptian police beating Khaled Said to death in the streets reportedly because he was in possession of videotaped evidence incriminating police in sharing the spoils from a drug bust (Lim, 2012). Previously Egyptians were weary of police brutality but “We are all Khaled Said” provided Egyptians the opportunity to negotiate their identities and coalesce around a shared sense of victimization. This communal sentiment was vital in successfully overthrowing Hosni Mubarak. The advent of social media, such as Twitter, allows people to raise their consciousness regarding contradictions in society by providing a place to negotiate personal and group identity.

### Twitter features and discourse support

Twitter provides specific technological features that mediate the ability of people to negotiate their identity and communicate online. Twitter (2016) offers the following definitions of these unique features:

- **Hashtags** – A hashtag is any word or phrase immediately preceded by the # symbol. When you click on a hashtag, you'll see other Tweets containing the same keyword or topic.
- **Retweet** – A Tweet that you forward to your followers is known as a Retweet. Often used to pass along news or other valuable discoveries on Twitter, Retweets always retain original attribution.
- **Follower** – A follower is another Twitter account that has followed you to receive your Tweets in their Home timeline.
- **Like** – Liking a Tweet indicates that you appreciate it. You can find all of your likes by clicking or tapping the Likes tab on your profile.

In this study Retweets are operationalized as a measure of network diffusion and by proxy a measure of popularity. Research has identified that Twitter mediates communication in an examination of informal (self-directed outside of traditional classroom) learning. This research asserts that people learn on Twitter by structuring their communication according to Twitter hashtags which expose them to various perspectives (Gleason, 2013). Another unique feature of communication on Twitter is the limit of 140 characters enforced for all tweets. Blair (2013) found that the limit of 140 characters (recently changed to 280 characters) helps create engagement online and makes it easy to consume information. In a similar vein, Risse, Peters, Senellart, and Maynard (2014) note that the limit of 140 characters reduces the effort needed to engage in communication and focuses the message on core information. Buschmann, Bruns, Mahrt, Weller, and Burgess (2014) even go so far as to state Twitter’s character limit makes previously impossible discourses a reality. An example of such a discourse is found in this study where people who represent the far left (anarchists and socialists) and far right (religious fundamentalists and racists) of the American political spectrum communicate with one another and are ultimately exposed to totally opposing viewpoints. Interaction among these two groups is unheard of, especially outside of sanitized and mediated sessions, because their viewpoints are so incendiary to one another. Freire (1970) states, “Without dialogue there is no communication, and without communication there can be no true education” (p. 92–93). In other words, the exposure to diverse viewpoints allows ample opportunity for people to
learn from one another and begin developing their consciousness. Therefore, the purpose of this study is to compare people who support President Trump with people who oppose him in terms of Retweets accounting for average levels of concientization for people contributing to #DisruptJ20 and #OccupyInauguration on Twitter just prior to Inauguration Day. In addition, this study seeks to describe the sentiment of the messages sent by people who support or oppose President Trump.

**Research questions**

Sentiment Analysis, logistic regression, and Hierarchical Linear Modeling (HLM) were conducted to complete this study. The research questions that will be addressed in this study according to these methods are as follows:

*Sentiment Analysis Question:*
- How does the sentiment of people who support President Trump compare to people who oppose him in terms of the words they use in their tweets?

*Logistic Regression Questions:*
- Can the likelihood of a Tweet being Retweeted be accurately predicted by concientization, Friends, Followers, and Likes?
- Which variables are most important to predicting the likelihood of a Tweet being Retweeted?

*HLM Level 1 Questions:*
- How does a tweet’s level of concientization impact the number of Retweets?
- How does a tweet’s number of Followers impact the number of Retweets?

*HLM Level 2 Questions:*
- How does supporting President Trump impact the number of Retweets?
- How does being an individual impact the number of Retweets?

**Method**

The data for this study was analyzed according to (1) Logistic Regression and (2) HLM. Prior to conducting any analysis, data was scraped from Twitter. Data scraping is defined by Batrinca and Treleaven (2015) as “collecting online data from social media and other Web sites in the form of unstructured text” (p. 90). Twitter data was scraped using the OILS Twitter Scraper (Flor, 2014). This tool uses the Twitter API to transfer data from Twitter servers into an Excel spreadsheet. Data was delimited according to the search string used to search for tweets on Twitter.com. A sample search string used to scrape data is provided below:

q=%23OccupyInauguration OR %23DisruptJ20 since%3A2017-01-17 until%3A2017-01-18&src=typd

Data was scraped from Jan 16 - 21, 2017 but only data from Jan 16 - 18 was used in this study to avoid the potential influence of confounding variables introduced on Jan 19 - 21 due to live events and demonstrations that happened on those days. The dataset used for this study is considered “big data,” which means that data cleaning must be completed after data collection. Batrinca and Treleaven (2015) define data cleaning as the “correction or removal of erroneous (dirty) data caused by disparities, keying mistakes, missing bits, outliers, etc.” (p. 93). Data cleaning first limited the data only to the users who posted on all of the days that were going to be used in the analysis. This process yielded a total of 65 users who posted to all days. Assuring the consistency of the users helps to enumerate the ideologies of the tweeters because the analysis of their continued interactions over time elucidates their unconscious tendencies. Next, duplicate data was removed by examining Retweets using Excel’s Remove Duplicates function. 874 original tweets spread across three days remained upon the conclusion of this process. Note that the unit of analysis for this study is the original tweets. Having completed the data cleaning, the process moved to qualitative coding.

A Content Analysis (Krippendorff, 1980) was performed to code the tweets according to the four stages of concientization (Freire, 2005). Content Analysis involves forming an in-depth understanding of information contained in transcripts which is not discernible by a cursory viewing (De Wever, Schellens, Valcke, & Van Keer, 2006). This approach involves a close reading of the data to identify themes. The data was coded on a 4-point scale. 1 represented the first level of concientization and 4 represented the final level. Data was also coded according to the general sentiment of the tweet regarding whether it was in support or opposition of President
Trump. Support was coded as a 0 and opposition was coded as a 1. Finally, the users who contributed to the hashtags of interest were coded according to whether they were an individual or organization with 0 representing organizations and 1 representing individuals. Table 1 presents samples of Tweets according to the phases of concientization grouped by their support or opposition of President Trump.

<table>
<thead>
<tr>
<th>Table 1. Sample tweet concientization coding</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Concientization phases</strong></td>
</tr>
<tr>
<td>Intransitive</td>
</tr>
<tr>
<td>Semi-Intransitive</td>
</tr>
<tr>
<td>Naïve-Transitive</td>
</tr>
<tr>
<td>Transitive</td>
</tr>
</tbody>
</table>

Study 1 – Sentiment analysis

A Sentiment Analysis, defined by Batrinca and Treleaven (2015) as “the application of natural language processing, computational linguistics and text analytics to identify and extract subjective information in source materials” (p. 90), was performed in Excel using the OILS Twitter Scrapper. First a parser was used to generate frequency counts of both the most commonly occurring single words (unigrams) and word pairs (bigrams) in the dataset by running a preprogrammed routine. Note unigrams and bigrams are the most common features used in topic-based text classification (Liu, 2012). The unigrams and bigrams were manually reviewed to determine which ones should be included in the positive and negative lexicons. Specific words that were included in the positive lexicon include “join us,” “resilient,” and “bridges” while examples of words included in the negative lexicon include “demolish,” “crying,” and “Libtard.” The positive lexicon also included general sentiment words like “wonderful” or “fantastic” while the negative lexicon contained words such as “horrible” or “awful.” These lists were then used to produce a sentiment score which determines positive or negative sentiment by summing the numbers of positive and negative words in the data set (Liu, 2012). Positive words are counted as +1 while negative words are counted as -1 (Hu & Liu, 2004). Outcomes of the Sentiment Analysis are presented in the first subsection in Results.

Study 2 – Logistic regression

A Logistic Regression was identified to analyze the data because many tweets (n = 577) were never Retweeted. These null values mean that using HLM to analyze the entire dataset would have produced misleading results because the effects would have been heavily influenced by the high number of tweets that were never Retweeted. SPSS was used to conduct the Logistic Regression to determine which independent variables (concientization, Friends, Followers, Likes, Support or Opposition, and Individual or Organization) were predictors of whether a tweet was Retweeted. Data screening led to the elimination of five outliers based on their Mahalanobis distance which left a total of 868 cases to be entered into the analysis. Note that the variable that served as the case number for data screening was the ID variable. The regression method selected to conduct the analysis was Forward Likelihood Ratio. This method enters independent variables one at a time into the model and uses the Likelihood Ratio to determine which variables are included in the final model. The model completed four steps to finalize the model. Outcomes of the Logistic Regression are presented in the second subsection in Results.
Study 3 – HLM

To conduct the HLM the tweets that were never Retweeted were removed from the dataset in order to address the potential for producing misleading results. After tweets that were never Retweeted were removed, a total of 297 samples remained. An additional step was necessary to prepare the data for the HLM because the distribution of some study variables (Retweets, Followers, and Likes) exhibited a substantial positive skew. For example, some tweets were Liked thousands of times while others received only a handful of Likes. To address this, these variables were all log transformed which allowed the data to meet the assumption of normality. The log transformed variables were used in the HLM. Note that upon the completion of the HLM, the inverse log was calculated for each effect size to increase the fidelity of the interpretation.

Once the data was prepared, the effects of study variables on the number of Retweets were modeled in R. The variables included in the Level 1 equation are Retweets (Ret), conscientization (Conc), and number of Followers (Follower). Variables included in the Level 2 equations are Support or Opposition (Supp) and Individual or Organization (Ind). The final equations are as follows:

**Level 1**

\[
\text{Ret}_{ij} = \beta_{0j} + \beta_{1j}\text{Conc}_{ij} + \beta_{2j}\text{Follower}_{ij} + r_{ij}
\]

**Level 2**

\[
\begin{align*}
\beta_{0j} &= \gamma_{00} + \gamma_{01}\text{Supp}_j + \gamma_{02}\text{Ind}_j + u_{0j} \\
\beta_{1j} &= \gamma_{01} + u_{1j} \\
\beta_{2j} &= \gamma_{02} + u_{2j}
\end{align*}
\]

Conscientization was used as a Level 1 variable to capture the effects of the content of individual tweets. HLM Level 1 Research Question 1 will be assessed using the conscientization variable. Followers were used as a Level 1 variable because each tweet is sent individually to all followers. HLM Level 1 Research Question 2 will be assessed using the Followers variable. Support was used as a Level 2 variable because the people who support or oppose President Trump generally share the same sentiment as a group. Note that to operationalize Support at the group level, the mode of all messages posted by a user was used in the data analysis. Finally, the Individual variable which captures whether the tweet came from an individual or an organization was used as a Level 2 variable because individuals and organizations fundamentally have different degrees of network penetration that can be expected to influence the likelihood of a tweet being Retweeted. HLM Level 2 Research Questions 1 and 2 will be answered by the Support and Individual variables respectively. Outcomes of the HLM are presented in the third subsection in Results.

Results

Study 1 – Sentiment analysis

A parser in the OILS Twitter Scrapper was used to generate frequency counts for unique words \((n = 2567)\) and unigrams and bigrams for the Support and Opposition groups. Note that bigrams have a distinct advantage over unigrams because the pairing of words provides context that is vital to correct data interpretation (Bespalov, Bai, Qi, & Shokoufandeh, 2011). Table 2 displays the top 10 bigram noun phrases for both groups.

<table>
<thead>
<tr>
<th>Support</th>
<th>Counts</th>
<th>Opposition</th>
<th>Counts</th>
</tr>
</thead>
<tbody>
<tr>
<td>plotting</td>
<td>21</td>
<td>the Streets</td>
<td>19</td>
</tr>
<tr>
<td>undercover</td>
<td>20</td>
<td>we Will</td>
<td>14</td>
</tr>
<tr>
<td>groups</td>
<td>20</td>
<td>resist Trumps</td>
<td>13</td>
</tr>
<tr>
<td>investigation</td>
<td>20</td>
<td>we Need</td>
<td>12</td>
</tr>
<tr>
<td>exposes</td>
<td>18</td>
<td>to Resist</td>
<td>9</td>
</tr>
<tr>
<td>criminal</td>
<td>15</td>
<td>20-Jan 3pm</td>
<td>9</td>
</tr>
<tr>
<td>plot</td>
<td>9</td>
<td>e Colorado</td>
<td>9</td>
</tr>
<tr>
<td>you</td>
<td>9</td>
<td>stand Up</td>
<td>9</td>
</tr>
<tr>
<td>trump</td>
<td>8</td>
<td>trumps antiworker</td>
<td>8</td>
</tr>
<tr>
<td>acid</td>
<td>6</td>
<td>join Us</td>
<td>8</td>
</tr>
</tbody>
</table>
Note that the bigrams with the highest frequencies in both groups were all combinations of hashtags and URLs (e.g., #disruptj20 and [url]). While these bigrams are useful for determining the classification of tweets, they are not as useful as noun phrases in illustrating the actual message content. From the bigrams, it is clear that the Support and Opposition groups had very different messages. The Support group was mostly discussing the video made by a political activist who documented some people associated with organizing the Disrupt J20 protests planning activities like stink bombing a party for Trump supporters. Notice that the word “criminal” is mentioned several times which speaks to the tendency of those in the Support group to vilify everyone associating themselves with Disrupt J20. The Opposition group was mostly discussing the need for action and attempting to organize people to attend various face-to-face protests. Notice that the language of the Opposition group uses collective words like “we” and “us” painting a picture of the Opposition group as a community.

The Sentiment Analysis failed to classify 43% of the tweets in the Support group and 50% of the Opposition group as either positive or negative. The reason for this performance is many tweets do not use conventional language and only contain hashtags and links. An example of such a tweet is “https://t.co/O2WuIWWiPX #DisruptJ20 #LukeKuhn #altright #PresidentElecTrump #PresidentTrump #wolfblitzer #cnn… https://t.co/Uw8Zpift6m.” The results of the Sentiment Analysis are presented in Figure 1.

![Figure 1. Sentiment analysis results](image)

The sentiment score, represented by the difference between the positive and negative words, of the Support group was strongly negative (-152) while the sentiment of the Opposition group was slightly positive (29).

**Study 2 – Logistic regression**

Regression results indicated that the overall model of four predictors (concientization, Friends, Followers, and Likes) was reliable in distinguishing between whether the tweet would be Retweeted or not. The four steps in which variables were added to the model improved the \(-2\) Log Likelihood from 953.38 to 907.44 which indicates an improvement of model fit but also that the model fit can be improved. Logistic Regression Research Question 1 is satisfied as the model correctly classified 69.1% of the cases. Concientization, Friends, Followers, and Likes significantly predict Retweets ($\chi^2 = 288.104$, $df = 4$, $p < .000$). Regression coefficients are presented in Table 3.

<table>
<thead>
<tr>
<th>Table 3. Regression coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>B</strong></td>
</tr>
<tr>
<td><strong>Concientization</strong></td>
</tr>
<tr>
<td><strong>Number of Friends</strong></td>
</tr>
<tr>
<td><strong>Number of Followers</strong></td>
</tr>
<tr>
<td><strong>Number of Likes</strong></td>
</tr>
<tr>
<td><strong>Constant</strong></td>
</tr>
</tbody>
</table>

Logistic Regression Research Question 2 is addressed by examining the odds ratios for these variables which indicate Likes are overwhelmingly more likely to predict the number of Retweets than the other variables.
included in the model. That is, tweets that are Liked are about 60 times more likely to be Retweeted than those that are not. Followers and Friends were also found to predict Retweets but to a much lesser extent being only about 1.5 times more likely. Concietization was least likely to predict the number of Retweets but was still statistically significant.

**Study 3 – HLM**

HLM results indicate that all the significant effects occurred at the first level when examining how concietization and Followers impacted the number of Retweets. Results of the HLM are presented in Table 4.

<table>
<thead>
<tr>
<th>Outcome measures</th>
<th>df</th>
<th>Effect Size (Log)</th>
<th>Effect Size (Inverse Log)</th>
<th>Standard Error</th>
<th>t-value</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>245</td>
<td>-0.2048075</td>
<td>0.624011</td>
<td>0.4056303</td>
<td>-0.504912</td>
<td>0.6141</td>
</tr>
<tr>
<td>Concientization</td>
<td>245</td>
<td>0.0604927</td>
<td>1.149457</td>
<td>0.0305596</td>
<td>1.979499</td>
<td>0.0489</td>
</tr>
<tr>
<td>Followers</td>
<td>245</td>
<td>0.3034410</td>
<td>2.011134</td>
<td>0.0913375</td>
<td>3.322194</td>
<td>0.0010</td>
</tr>
<tr>
<td>Support</td>
<td>47</td>
<td>-0.2480536</td>
<td>0.564867</td>
<td>0.1758478</td>
<td>-0.760808</td>
<td>0.1649</td>
</tr>
<tr>
<td>Individual</td>
<td>47</td>
<td>-0.1150564</td>
<td>0.767262</td>
<td>0.1512293</td>
<td>-1.410615</td>
<td>0.4506</td>
</tr>
</tbody>
</table>

Concientization and Followers are both significant as \( p < .05 \) for both variables. Note that the \( t \)-values for these two measures provide additional evidence that the variables are significant because concietization can be rounded up to 2 and Followers is greater than 2. The effects for concietization and Followers were quite large. The effect size of 1.14 indicates that the higher the average level of concietization the more likely the possibility of a Retweet, which addresses HLM Level 1 Research Question 1. The effect size of 2.01 for Followers indicates that the more Followers are exposed to a tweet the more likely it is to be Retweeted, which addresses HLM Level 1 Research Question 2. Note that the effect of Followers is almost twice that of concietization which means that network structure is more important to determining the likelihood of a Retweet than the content of the message. Note that the value of the Level 1 random effects is .3827 standard deviations for the intercept while the value of the residual is .358 standard deviations. Neither of the second level effects were significant as \( p > .05 \) and the \( t \)-values for Support and Individual are below 2. Therefore, for both of the HLM Level 2 Research Questions it can be concluded that neither variable has any significant impact on the level of Retweets. These findings suggest that the most important factor in determining Retweets is network structure rather than the polarity (Support) or who the tweeter is (Individual).

**Discussion**

A primary finding of this study is that variables related to the network structure of Twitter (Followers and Friends) were strongly related to the likelihood of being Retweeted. Boyd, Golder, and Lotan (2010) confirm this result saying, “Retweeting for Social Action is most successful when the Retweeter has a large network and occupies structural holes, or gaps in network connectivity between different communities” (p. 7). People who occupy structural holes are often known as information brokers because they use their membership in various online communities to pass content into new domains (Bizzi, 2013). As mentioned earlier, Followers receive tweets from people they follow in their timelines. It follows that the more people who belong to different groups see a tweet, regardless of its content, the more chances the tweet has to find people who resonate with its content enough to Retweet it. Additional support of the impact of Followers and Friends is provided by Suh, Hong, Pirolli, and Chi (2010) who found that Followers are positively associated with Retweets in their random sample of 73 million tweets. Another Twitter network structure variable, Likes, was found to predict the likelihood of Retweets in the Logistic Regression. However, this finding is contested by Suh et al. (2010) who found that Likes were not used much by Twitter users and that Likes also explained little regarding the potential to be Retweeted. By definition, the random sample of tweets taken by Suh et al. (2010) did not focus on specific communities which have developed their own unique uses of Likes. The focused nature of this study on Imagined Political Communities means that by and large the people tweeting in this dataset are likely to have formed their own online practices. That being said, it also seems if someone “appreciates” a tweet enough to Like it, they would also Retweet the content.

A second finding is concietization positively influences the number of Retweets. Holland et al. (1998) notes that media messages are evaluated through the lenses of everyday communities. If true, the finding that tweets with a higher average level of concietization are more likely to be Retweeted and reach wider audiences can be
interpreted as a potential shift in the overall American political consciousness toward developing a critical understanding of how individuals are influenced by government policies. The actions people take in affiliation with Imagined Communities help people to imagine their own identities in light of their affiliations and disaffiliations (Holland et al., 1998). The Sentiment Analysis results are particularly important in this regard because they paint a clear picture of the messages people are exposed to. For instance, a Trump Supporter following the tweets associated with #DisruptJ20 would have been immersed in negativity among his peers. However, being exposed to positive messages coming from the Opposition group would create Dissonance. As such, the Trump Supporter would either change his beliefs and move toward freedom or continue falling in line with his peers. This process of negotiation is at the heart of conscientization and such critical evaluation of positionality is what may ultimately lead to lasting changes in the American political consciousness.

A shift in political consciousness has been considered regarding its potential impact on society. For example, Wojcieszak (2009), in her study of online extremist groups, writes that “Many—if not most—Internet users may go online simply to vent or express opinions. Feeling empowered by self-expression or seeing it as a sufficient way to address an issue, those users may not engage in any subsequent actions” (p. 579). These individuals may very well be Slacktivists who do not engage in any type of face-to-face organizing. On the contrary, a post-election poll found that Millennials who voted for Hillary Clinton are likely to engage in protests, volunteer, and attend public meetings (CIRCLE, 2017). Whether Social Action associated with growing awareness that government policies impact the daily lives of Americans remains online or expands into the real world is ultimately inconsequential because both are valid forms of civic engagement that provide people the opportunity to negotiate their identities. This process of negotiation and dialogue will facilitate conscientization and eventually redefine the boundaries between nationalistic Imagined Communities leading to new digital citizenship practices.

Implications

The findings of this study inform digital citizenship education in two ways: (1) conscientization provides a framework for generating productive dialogue by avoiding dehumanizing actions and (2) network structure elements provide context which contributes to appropriate message interpretation. Conscientization should be a vital element of digital citizenship education because it lays the foundation for people with very different viewpoints to learn about one another by identifying, removing, and avoiding dehumanizing actions. In this study dehumanizing comments were common especially among those in the Intransitive stage. For example, when a Republican calls a Democrat a “Libtard” or a Democrat calls a Republican a “TrumPet,” dehumanization is taking place because the human qualities of the individual are subjugated to a derogatory label that enforces the existence of a disempowered “other.” Neither deserves such treatment for even trolls negotiate identity and present their ideal self as they harass others online (Buckels, Trapnell, & Paulhus, 2014). People who operate from a Transitive consciousness are most likely to engage in productive dialogue with people who hold different opinions. The finding regarding the influence of network structure informs digital citizenship education because the information source and the size of the community need to be considered to correctly interpret messages. For example, comments made to #NotMyPresident and #PresidentCuck share a negative sentiment of President Trump. However, messages on #PresidentCuck (cuck is short for cuckold) would be more graphic than those posted to #NotMyPresident. In addition, in a cohesive community the larger the network the more likely it is for message sentiment to be highly polarized based on community values. An awareness of the network structure makes a meaningful contribution to digital citizenship education because it provides an appropriate context for interpreting online comments. Including conscientization in digital citizenship education provides a framework to help avoid dehumanizing behaviors which impede understanding and collaboration between people with differing viewpoints while awareness of network influences can help people contextualize and therefore interpret the messages they consume.

Conclusion

This study examined how conscientization of tweets influenced the likelihood of a tweet being Retweeted among people on the far right and far left of the American political spectrum. Findings indicate that conscientization and network structure elements of Twitter have a positive influence on the likelihood of being Retweeted. In their report on civic renewal, Levine and Liu (2015) challenge readers to engage people in trans-political dialogue in order to solve problems collectively as a nation instead of as partisan groups who fight tooth and nail over the boundaries of their Imagined Communities. Establishing a common understanding between polarized parties, via their online interactions is a productive first step to achieve this end. Indeed, the high negative sentiment among
Trump supporters can be used as a foundation to build this common understanding. Wojcieszak (2009) notes that participation in online extremist groups, like the anarchists and racists in this study’s dataset, “might increase the visibility of extreme groups, assure members’ representation in the political process, and ultimately reshape the political agenda” (p. 580). Dialogue is a critical element in this scenario because meaningful change does not result from unilateral communication (Freire, 1970). Holland et al. (1998) provides some useful guidance to establish such dialogue writing that behaviour is a sign of self-in practice rather than the essence of someone’s being. As groups and individuals, we must separate ideology from humanity if we are to engage in dialogue that will result in the genesis of meaningful social change.

Acknowledgements

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References


Beyond the Echo Chamber: Pedagogical Tools for Civic Engagement Discourse and Reflection

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ABSTRACT

How can educators leverage blogs and other social media spaces to encourage a reflective, critical discourse about civic engagement that fosters a true learning exchange over promoting one’s own ideas? This article reports upon a single case study of the “Community Engagement Learning Exchange,” a multi-author blog on civic engagement. Through qualitative content analysis and expert interviews with the blogger community we explored the interaction of digital citizenship and civic online discourse, in order to map out civic engagement pedagogies that make use of blogs or other shared writing / media tools. The content analysis of blog posts indicates that high verbosity scores for factual orientation, personalization and interactivity correlate with broader reach. The interview material was condensed into concept maps that identified specific themes for digital citizenship (inevitable, easy, transparent, technologically diverse and changing, unequal, divisive, difficult, superficial) and civic engagement pedagogies (content, format, authenticity, tone, listening, exemplary conduct, accountability, hope). Overall, in the community analyzed, ground rules and a shared writing style lead to discussions and learning processes that transcend differences in views, backgrounds and opinions. Further efforts to support and measure the right amount of friction that exemplifies diverse and even clashing opinions while keeping an online community together emerged from the case study as a future area of practice development for digital citizenship.

Keywords

Qualitative blog content analysis, Civic engagement, Edublogging, Expert interviews, Civic discourse, Civic reasoning, Informal learning

Introduction

In the literature, digital citizenship is a multi-faceted term, blending concepts such as literacy, critical thinking, participation, computer skills, Internet access, membership in social networks and online communities, societal and cultural values and norms, laws and rules, cyber-safety and well-being online, democratic processes, and individual rights and freedoms (Al-Zahrani, 2015). A recent whitepaper by Impero Software and Digital Citizenship Institute (2016) characterizes digital citizenship as a broad area of inquiry related to the ethics, concerns and opportunities associated with living a digital lifestyle. As a concept, it reflects our shared need to develop skills and perspectives for a safe, ethical, responsible, inspired, innovative and involved conduct online (Impero Software & Digital Citizenship Institute, 2016).

With the growth of “living online,” parts of online interaction are now part of citizenship. Mattson (2016) analyzed school curricula for teaching digital citizenship and found that the focus is typically on extending traditional citizenship through digital means. In many ways, the digital sphere transforms and extends “traditional” citizenship – petitions, interest groups, advocacy on issues, public attention and praising/shaming (including boycotts or blowback on “unacceptable” behavior, cf., de Zúñiga et al., 2014). Examples of “new” citizenship activities enabled by digital technologies include mash-ups of news, opinion and organization, interaction with government officials via social media, open data, free and open software applications for the common good, Wikipedia and a wide array of “civic media” work (Gordon & Midhalidis, 2016).

Digital citizenship can be systematically conceptualized in two ways: (1) participating in a global, digital society (cf. Ribble, 2011), (2) participating in society through online information and communication technologies. This article focuses specifically on civic engagement and discusses how participating online can constitute and inform activities in local communities.

Overall, opportunities to engage in “participatory politics” have expanded significantly (Kahne et al., 2016). However, the new opportunities to access and share information can lead to the spread of manipulative and deceptive messages (Mamlok, 2016, p. 95). Similarly, the ease to form communities of like-minded peers can result in echo chambers that lack critical discussion, divergent opinion, and political discourse.
To reach a level of active citizenship in the online world, the basic conditions of access and technical skills need to be enriched with digital literacy competencies and opportunities for civic participation and self-expression in one or more online venues. What does it mean to be or become a digital citizen and what pedagogical approaches can foster civic engagement through digital means? As Preston et al., (2017) pointed out, dimensions relating to values and dispositions can be stimulated by active debate. Educators can provide critical and dialogical opportunities so that learners are able to reflect on their values and beliefs in relation to others in both face-to-face and digitally-mediated contexts.

The “Community Engagement Learning Exchange” (see http://cele.sog.unc.edu) is an experiment in multi-author blogging that was initiated in December 2014 by three university faculty on two different campuses to engage a diverse group of public officials and grassroots citizens with a variety of experience and backgrounds in a shared discourse on civic engagement (for an overview of the concept see Stephens & Panke, 2016; Stephens, 2016).

We use the blog community of CELE authors and commentators to explore the concept of digital citizenship, civic engagement and informal, mutual learning in a digital space through qualitative interviews and content analysis of posts and comments. Our research question is: How can educators leverage blogs and other social media spaces to encourage a reflective, critical discourse about civic engagement that fosters a true learning exchange over promoting one’s own ideas? Figure 1 present a conceptual overview of the area of inquiry.

Figure 1. Mapping the components of Digital Citizenship, highlighted (dark background and italicized) are research focus and case study area (CELE blog)

The next section will explore the background of our case study, and review the concepts of digital literacy, civic online reasoning and, specifically, civic engagement. We argue that informal learning is an untapped resource to promote digital citizenship and civic engagement in pedagogy and practice. Our specific case study, which analyzes a blogger community on civic engagement, is a “best practice” (innovative example) for modeling and promoting civic discourse in a peer-to-peer learning exchange environment. Hence, we also review the literature on edublogging (blogging for educational purposes) and, more specifically, blogs as informal learning spaces.

Digital literacy, civic reasoning and civic engagement

Notions of digital citizenship are embedded within several popular models of digital literacy (Preston et al., 2017). The traditional view of literacy as the ability to read and write has expanded to encompass fluency in using digital tools and online information with aptitude and creativity. The UK-based organization JISC defines digital literacies as “those capabilities which fit an individual for living, learning and working in a digital society” (Hibberson, Barrett & Davies, 2015). “Digital Literacy is not just about ensuring that students can use the latest technologies, but also developing skills to select the right tools for a particular context to deepen their
learning outcomes and engage in creative problem solving” (Adams Becker et al., p. 24). It transcends isolated technical skills, and encompasses a comprehensive understanding of digital environments, appropriate behavior in online communities, evaluating, creating and sharing content, curation and co-creation of content with others, community etiquette, ethical choices, digital rights and responsibilities.

While government representatives and the media traditionally have filtered and directed communication around public issues, digital public deliberation can include all participants — citizens, politicians, bureaucrats, interest groups, the media — at every step in the policy making process, ranging from agenda setting to final vote (Holzer, et al., 2004).

With the Internet as “both the world’s best fact-checker and the world’s best bias confirmers” (Lynch, 2016), the ability to critically evaluate the merit of different sources becomes a substantive part of citizenship. Civic online reasoning – the ability to judge the credibility of information on the Internet – consists of three core competencies: (1) Who is behind the information? (2) What is the evidence? and (3) What do other sources say? In 2015-2016, the Stanford History Education Group prototyped, field tested, and validated a bank of assessments to evaluate civic online reasoning. In total, they collected and analyzed 7,804 student responses — middle school, high school and college level. Based on their findings, they come to a Cassandran conclusion: “At present, we worry that democracy is threatened by the ease at which disinformation about civic issues is allowed to spread and flourish” (Wineburg et al., 2016).

Civic engagement depends upon an informed citizenry, but it requires other abilities and agency beyond the critical reception of information, chiefly the willingness to act upon the information, and engage others in a fair and open debate. Jacoby and Ehrlich (2009) define civic engagement as comprising one or more of the following elements:

- Learning from others, self, and environment to develop informed perspectives on social issues;
- Recognizing and appreciating human diversity and commonality;
- Behaving, and working through controversy, with civility;
- Taking an active role in the political process;
- Participating actively in public life, public problem solving, and community service;
- Assuming leadership and membership roles in organizations;
- Developing empathy, ethics, values, and sense of social responsibility;
- Promoting social justice locally and globally.

Civic engagement through informal learning

Civic engagement encompasses actions wherein individuals participate in activities of personal and public concern that are both individually life enriching and socially beneficial to the community (Association of American Colleges and Universities, 2009). The actions can benefit the public good, the individual’s sense of purpose and well-being, or the economy. There is growing consensus that educational institutions are charged with developing students’ digital citizenship (Hatcher, 2011). Jacoby and Ehrlich (2009) describe it as higher education’s historic and fitting role to invest in developing the civic knowledge and skills needed to work with others to make a difference.

One of the primary ways in which higher education currently teaches civic engagement is through the redesign of curricula to incorporate community-based service activities that are integrated with traditional academic learning objectives (Bringle & Clayton, 2012). While service learning is a promising approach to increase civic engagement among traditional students, it may be less feasible in non-traditional, adult learning settings. However, enabling civic engagement is not a one-time effort performed only within educational institutions.

The role of informal learning in fostering civic engagement competencies is an untapped resource. As one can learn something about almost anything on the Web, the concept of informal, self-directed learning (prompted by curiosity or serendipitous discovery) has the potential to enrich formal learning experiences, foster lifelong learning, and change professional development.

The CELE blog is an example of an informal learning platform. It is not tied to a course with specific expectations and separate roles of learner and teacher. In contrast to many other public administration blogs that focus on professional development and news for employees in local government, CELE aims to give voice to active citizens and to attract a mixed audience to post, comment, and learn (Stephens, 2016).
Blogs as informal learning spaces

Blogs have become an integral part of everyday Internet culture. The appeal of blogging is not based on technological innovation, but on the emergence of specific use practices. Blogs constitute a form of “micro publishing” (Williams & Jacobs, 2004), that users flexibly integrate into different contexts to meet various motivations and needs. Reese et al. (2007) summarize the distinct characteristics as “ease of use, low barriers to creation and maintenance, dynamic quality, easy interactivity and potential for wide distribution.”

Though few blogs reach a wide readership, the rest show the typical “long tail pattern” (Anderson, 2013) in which the sum of niche audiences outperforms the mainstream. Bloggers document their own lives, provide space for personal expression and processing of experiences and feelings (Nardi et al., 2004). Furthermore, blogs can help in the development of ideas and thoughts and promote the communicative exchange in a group. (ibid.)

The entirety of all weblogs is called “the blogosphere,” a part of the web that is developing dynamically by its own rules and with changing protagonists. While bloggers come and go, the blogosphere grows incessantly (Whelan, 2003). The fascination of the blogosphere has left its mark in the field of education. Sim and Hew (2010) reviewed 24 empirical studies in a meta-analysis, focusing on the type of blog usage and its impact on learning and motivation (performance and affective aspects). The authors identify the purposes of blogs as: a learning diary, documentation of everyday life, expression of moods and preferences, communication, assessment and task management. Overall, the authors were cautiously optimistic that blogs foster learning: “results from self-report studies generally suggested that the use of blogs could help student learning” (Sim & Hew, 2010, p.156).

Blogs like CELE operating outside a specific class or assignment offer opportunities for informal and incidental learning. Whereas in formal, institutional settings, an instructor or facilitator takes care of providing the learning material, informal learning is dependent on resources available in the learner’s environment — “from family and neighbors, from work and play, from the market place, the library and the mass media” (Conner, 1997-2007; an overview on the genealogy of the term is given by Straka, 2004). Kurhila (2006) states that easy-to-use tools and wide access to networks result in informal learning becoming a larger part of all learning. Edublogging has contributed to seamless learning opportunities in academia (Panke, Gaiser, & Maass, 2012).

How can we conceptualize “learning by blogging” when blogs transcend the academic and policy advocacy spaces? How do both individual blog activity and blogging within a group contribute to learning outcomes? Learning in a blog environment can happen in multiple ways:

- Preparing a blog post and writing it can be valuable for organizing thoughts and thus “learning” as one presents.
- Others’ posts can point readers and contributors to citizen engagement techniques of interest for their local community.
- Readers who comment contribute a question, thought, challenge, etc. to the author’s original argument, allowing for wider attention and exchange.

Methodology

Our study is a single case study with attention to bloggers’ conceptions of digital citizenship, probing their perspectives and learning from comments and other posts, and a content analysis of the blog material. The methodology lends itself to exploratory inquiries within the qualitative paradigm. Instead of testing a hypothesis, we want to gain a rich understanding of a specific online community. We are specifically interested in the interaction of digital citizenship and community engagement.

Since the area of informal and mutual learning via blogs is relatively unexplored, a case study provides advantages for refining concepts and initiating theorizing. Robert Yin notes that a case study is “an empirical enquiry that investigates a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident.” (Yin, 2009, p. 14) Since we are adapting edublogging research to a less structured exchange (i.e., it is not an academic course with an instructor, nor a structured service learning opportunity for academic credit by participants), an approach of “thick description” of a “specific, unique, bounded system” (Stake, 2008, p. 443, p. 445) is particularly apt.

We interviewed a sample of CELE bloggers to map out civic engagement practices that have the potential to transfer to other shared writing environments and social media tools. We also conducted a content analysis of
CELE posts to better understand which prompts lead to further discourse and reflection and potentially reach a wider audience.

**Content analysis**

We conducted a qualitative analysis of 100 CELE blog posts from the time period of December 2014 to March 2017 connected to 22 different blog authors. We developed our coding scheme based on previous qualitative studies on academic blogs and other academic web profiles by Bukvova, Kalb & Schoop (2010) and Bukvova (2011). We slightly altered some categories to better match the context of both academics and professionals in civic engagement. In addition, we also coded for each post for how many comments and unique page views the post yielded.

**Blog Content:** We distinguished three types of content: expertise, activity and identification. Expertise-related content provides information on a topic. Activity-related content gave information about things that currently occupied the bloggers in their professional context. Finally, some content is apparently dedicated to describing the blogger as a person, including descriptions of interests, personal background information, or posts reflecting on personal experiences. Although Bukvova (2011) developed the three content categories as distinct, one post may comprise content from more than one category.

**Blog Verbosity:** Interpreted and evaluated as a qualitative measure, verbosity helped us to understand how the bloggers develop the content and how this relates to reflectiveness and discourse. For the purpose of this study, verbosity was assessed with regard to three categories: (1) the amount of factual information provided; (2) the level of personalization; and, (3) the level of interaction.

**Factual information.** This first category of verbosity describes the amount of balanced, sourced, factual information that the bloggers provided about the particular topic. It ranged from none (implicit), to basic facts, sourced information, detailed information, to elaborate, balanced discussion.

0. None/implicit. Facts about the topic were not provided (directly).
1. Noted. Factual information was provided, but not sourced.
2. Stated. Factual information was provided and sources stated.
3. Detailed. Factual information was provided, sources stated and context discussed.
4. Elaborate. Elaborate argument was provided, discussing facts as well as the context, offering different positions and sources.

**Personalization.** This second category describes the amount of information given by the bloggers about their personal relationship to the particular topic. Besides providing facts about a topic, bloggers typically chose to reveal their opinions, thoughts, or ideas. The level of personalization could be described using four levels:

0. None.
1. Personal notes. Few remarks about the individual’s personal relationship to the topic (e.g., experiences, opinions, thoughts, humor, likes, dislikes). The focus remained on the facts.
2. Personalized. The focus was mostly on the facts, but the relationship of the author to the topic formed an important part of the content.
3. Highly personalized. The focus was on the individual’s relationship to the topic. Facts were provided to give the audience background necessary to appreciate the individual’s argumentation.

**Interaction.** The third category describes the bloggers willingness to interact with their audience regarding a particular topic. This could be demonstrated in the text itself, e.g., through direct addresses of the audience, or in further measures taken by the researchers, e.g., participation in discussion about the topic in the comments section. The extent of interaction could be described using four levels:

0. None. No interaction about a particular topic.
1. Conversational. The content was written as if addressing the potential reader, e.g., using the second person.
2. Direct. The blogger appeals directly to the audience, e.g., asking for comments or participation. Unlike conversational addresses, direct interaction showed an expectation of response.
3. Active. The bloggers engaged in an active dialogue with the audience by responding to comments.

**Expert interviews**
Our research relationship allowed for co-constructing the concept of digital citizenship and civic engagement between researchers and interview partners. Through guided, partially-structured interviews, we aimed at preserving the multiplicity of perspectives and treating our interview partners as expert analysts of their media environment and blog contributions. The interview group was comprised of a purposefully selected subgroup of the CELE blogger community.

As detailed by Stephens (2016), three general categories of authors are (1) academics, (2) engaged community members, and (3) local government officials. Thus, sampling targeted one or more bloggers from each category. We recognize the imperfections of these categories. An “academic” may also be an engaged community member in settings other than professional associations.

A second screen consisted of differences by experience in (1) traditional and new media, and (2) nonprofit leadership and community advocacy. For example, a contrast between a former nonprofit director with a monthly column in a local newspaper and a photo-journalist with extensive Facebook personal and professional content was identified.

Changes in work status while doing the CELE blog posed opportunities for insights. One blogger was selected due to his government role as a public information officer while also completing a Master of Arts degree in Technology and Communication and becoming an adjunct instructor of courses about new media at two universities. The “academic” selected has extensive experience in teaching and researching civic skills development in undergraduate students and civic efficacy effects after graduation. In sum, seven of the 15 regular bloggers form the pool of interviewees. All of the interviewees had been writing for the blog for at least one year.

We conducted all seven interviews by telephone. On average, the interviews lasted about 20 minutes. We recorded and transcribed the conversations, evaluating the material through a comparative summary and organized statements along the topics of digital citizenship, CELE community, civic discourse pedagogy. We used concept mapping as a technique to reduce the material, capture, cluster and structure, and thereby identify themes (Cañas, Novak & González, 2004).

Results

Content analysis

A content analysis of the CELE blog posts allowed us to systematically chart this blogging community. In addition to coding and counting, we carefully read through the text corpus to get a feel for the culture of the blog community. This section provides both descriptive data and analytical insights into the CELE blog.

Comments. The number of comments per post ranges from 0 to 23. Seventy-seven percent of posts have at least one comment; 48% of those posts that have comments contain an author reply.

Figure 2. Unique Pageviews with trend line: Newer posts have slightly fewer pageviews, which indicates a longer shelf life of posts (people interact with the post by finding it through search engines)
**Pageviews.** The median number of unique pageviews is 97. There are two outliers: One post had only four views, another 1385. Half of the posts have between 50 and 150 unique pageviews (Note that all blog posts are accessible on the blog homepage, and this is the most viewed resource, see Figure 2).

**Content Orientation.** As depicted in Figure 3, the CELE bloggers use their posts to portray a public, professional persona. They rarely share personal information. Instead, the authors focused on documenting their professional activities or on sharing their expertise. Posts that use the individual biography of the blogger as material typically also talk about professional activities of a specific topic. Events in their personal lives serve as a hook, example, metaphor, or analogy to dive deeper into an issue. Posts that offer identification typically reach broader distribution and yield more discussion.

![Figure 3. Content orientation of blog posts](image)

**Verbosity – Facts:** The average score for factual information is 1.9. In 59% of the posts analyzed, authors provide facts and sources. Figure 4 shows the distribution across five categories.

![Figure 4. Factual Information: Scores overview for blog posts analyzed](image)

**Verbosity – Personalization:** The average score for personalization is 1.9. The majority of posts are factual, while offering some degree of personal experiences or viewpoints. As shown in Figure 5, approximately a third of the corpus was highly personalized, giving an individual outlook on a topic.
Verbosity – Interaction. The average score for interaction is 1.7 which indicates a moderate level of dialogue-focused writing by the blogger community. About one in four posts contain dialogue between blog authors and their audience through comments. One quarter of posts have direct appeals for comments or other follow-up communication. About one quarter, as depicted in Figure 6, are written in a conversational tone that addresses the audience.

We compared posts with a higher and lower pageview scores through a median split. Higher pageviews corresponded with higher factual, personalization and interactivity scores.

Interviews

How is citizenship shaped by the digital context? What are ways to promote meaningful civic engagement online and how does CELE in particular contribute to civic engagement? The CELE bloggers represent multiple and sometimes changing roles: local government public information officials, public administration academics,
writers, journalists, activists, citizens, and current for former nonprofit organization leaders. Thus, collectively, they provide a rich pool of perspectives on civic engagement in digital spaces.

**Digital Citizenship.** The interviewees offered a wide variety of concepts connected to digital citizenship that comprised being an active, engaged citizen in particular in local government, to being media-savvy and able to use digital tools to advocate for a political position, to having ethical standards and following netiquette rules of engagement and discourse.

- “Two things come to mind: One is being engaged digitally, being political online and the other is how one behaves online.” (Katy)

Do the interviewees observe changes over time in civic engagement? How do they see the potential of digital media to increase or decrease civic reasoning? There is consensus that engagement has increased, interaction has become easier and government activities more transparent. One thing that became clear from the interviews is that there is not a question if civic engagement online is happening, but how to use and orchestrate it and blend it with face-to-face activities.

- “Recognizing that you can’t fight the digital realm, you have to embrace it.” (Traci).
- “We do not really have a choice. That’s the way our world is going.” (Emily).
- “It is easier, quicker and less risky than knocking on doors. On the other hand, it is less personable. So face-to-face is important. The digital, it’s a way to dip their toe in the water.” (Beth).
- “Most of my work on deliberative dialog is conducted face to face. I use social media for organizing, mobilizing and providing background information.” (Katy).
- The interviewees shared concerns about groups and regions who are getting left out, and the decrease in quality of engagement.
- “But I also think about who is getting lost, specifically [people] 50 [years old] and above.” (Dan).
- “In NC rural areas broadband still hasn’t made it, a lot of folks depend on satellite, or 3G data on their phone. So your cool GIS data will simply not load on their phone.” (Emily).
- “It has increased but not necessarily in a positive way.” (Michelle).
- “Digital media have made it easier to participate, but have led to a decrease in civic discourse.” (Katy).
- “In a sense it can be propaganda. You need to be careful of what you are seeing and hearing online.” (Dan).
- “The information is there [but] it is not always easy to find that information. Websites are often created from the point of view of the people who work there – the terms, the hierarchy that makes sense to them.” (Brian).

![Figure 7. Digital citizenship themes derived from interviews](image)
Social Media Ecology. We were interested in the sense-making of the interviewees of the broader social media ecology and CELE. They were asked about social media tools they used in their general communication practice. The interviewees stressed the need to use the right mix of tools to reach an audience, and to be aware of the diverse and changing landscape of social media. Specific social media sites mentioned were nextdoor, Instagram, Facebook, Twitter, Snapchat, blogs, listservs, LinkedIn groups, and Slideshare. One interview partner contrasted CELE to the experience in a listserv:

- “It is different from CELE. It is not a place for learning, there is a lot of commentary.” (Katy),

Figure 7 applies concept mapping to delineate eight features of digital citizenship from the interview data, with illustrative comments from particular interviewees.

CELE Community. What are the benefits and drawbacks of blogging publicly about civic engagement? We were specifically interested in what the bloggers felt as the learning aspect of their blogging activities at CELE. Several interviewees reported that their writing about civic engagement improved.

- “I find it helpful and useful to communicate more clearly,” (Katy). She explained: “In academic writing you talk to an audience that has shared assumptions, you use jargon, and with the CELE blog I write in a way that is not overly academic and jargon-laden and asks people what they think.”
- “How to describe things as succinctly and clearly as possible.” (Beth).

Some bloggers broadened or changed their views due to reading and discussing other contributors’ content. Others saw the blog as a way to “get the message out” or “reach more audiences and connected networks.” The main benefit of CELE is the diverse network of blog contributors.

- “It’s not just that there are people from different sets of careers, also different age levels, and different career stages.” (Emily).
- “It’s good for connecting networks. There is great benefit in the network of contributors.” (Traci).
- “It has helped me connect to some of the other people who write for the blog and learn more about what they do and hopefully improve what I do.” (Brian).

We wanted to know if our interview partners see other social spaces as similar to or different from the CELE blog. They contrasted CELE along different dimensions, i.e. the quality and civility of exchange, the frequency of comments, and the quality of postings.

- “The tone on the listserv is very different. The listserv is not a resource where we learn from one another, there is a lot of commentary on the events of the day that degenerates quickly into disrespect.” (Katy).
- “The blog gives us an opportunity to write in more depth. It’s not the expectation that we always have a ton of responses; it’s different from social media like Facebook where we expect more immediate reaction.” (Traci).

What effect does the blog have? One important lesson is that interaction and reach do not necessarily equate to comments in the blog – and, it is not the most important goal for all bloggers.

- “I have had a lot of people come up to me and give positive feedback, but they do not necessarily leave a comment [on the blog].” (Traci).
- “It’s amazing, the number of people who stop me in the street and say ‘Oh, I know you — you are writing this stuff.’” (Beth).

Another lesson is that it is difficult to keep up with the goals of the community, specifically interaction with one another and commentators.

- “I wanted to provide a strong answer, and then I ended up not getting back to the person. It was information that I had, but it was a time constraint.” (Dan).
- “The drawback is, the back and forth we really hope for, that is easy not to do. It is a problem of accountability. I don’t feel it matters too much if I am not constantly engaged.” (Katy).

Most CELE bloggers stressed that they were authentic in their writing on CELE, and wrote as individuals, not as agents of their organization. However, there is a continuum within the community of using the blog as a personal or as an organizational voice.

- “The way I see CELE, it’s me and the way I see things.” (Dan).
- “The blog is my outlet to be less objective and take a side which I cannot usually do [as a journalist]. It is a reflection of my personal experience.” (Michelle).
- “You can blog about it, but are you blogging about it as an employee? I have been blogging for a while through a lot of different positions. Most of the times I tried to wear my ‘citizen-activist’ hat.” (Emily).
Pedagogy of Civic Interaction. What role can social media play in practicing and learning about civic engagement? All interview partners agreed that the status quo of civic engagement in social media (and beyond) is lacking important civic discourse and mutual learning qualities.

- “We are not very good examples to the next generation.” (Emily).
- “2015 to 2017 has been the most negative.” (Michelle).

The authors on the CELE blog model a certain tone of civic discourse in their writing. They are deliberately writing in a specific way to reach others, and to connect across positions and provide factual information.

- People respond positively to what I write, because I am saying it in the friendliest way possible. They comment that I am writing in way that does not put people down (Beth).
- “This is not a blog to say we are right; you are wrong.” (Dan).
- “Academic minded, making arguments based on a source. Articulate comments lead to improved discussion.” (Michelle).
- “The tone of CELE is a conversational, yet friendly, it’s not a combative place. The goal is to provide information that is helpful to people.” (Brian).

However, as one interview partner pointed out, merely being polite is not enough. She is looking for honest feedback and authentic interaction.

- “I don’t want people to yell and scream, but I would rather have their authentic reaction than a pat on the back, because then, we can have a discussion about it.” (Beth).

Several interview partners mentioned clear ground rules as one of the characteristics of CELE. One person stated that from a local government perspective, clear rules of engagement are a key to successfully engaging citizens. Spreading hope, sharing stories and humanizing issues were seen as strategies to set an engaging and inclusive civic discourse tone.

- “CELE has set out some ground rules from the beginning.” (Katy).
- “The process and intent has to be very clear. You have to be mindful what you are promising.” (Traci).
- “Issues need to be humanized. People are so scared. Fear keeps people from engaging in a positive way.” (Michelle).
- “It’s the framework and the culture. We are not going in there with the specific goal of going after the other side.” (Brian).

![Civic Discourse Pedagogy Themes](image_url)

*Figure 8. Civic discourse themes derived from interviews*
Can ground rules and a shared writing style lead to true discussions and learning processes that transcend differences in views, backgrounds and opinions? Conversations that are meaningful and learning-oriented take place among the blogger network, and, to an extent between bloggers and their largely anonymous audience.

- “We all tend to read things we agree with. In my work, the biggest part is reaching people who basically agree with me, but need information about the specifics to act. It’s hard to know, though. People may change their mind more than you and they know. Nobody will believe X, read a blog post, and then believe Y. But people mull it over, and weeks or months later it’s ‘Hey, they had a point’.” (Beth).

One person observed that the long-form of the blog allows for more nuanced argumentation than microcontent focused channels such as Facebook and Twitter. Another interviewee mentioned the pace of CELE: it is not focused on speedy production, but on the quality of contributions.

- “We can put information in a long format. There is more room to explain what you are trying to explain.” (Brian).
- “There is no drive for content, it’s more about the quality.” (Emily).

Concept mapping yields Figure 8 to summarize prominent factors related to civic discourse pedagogy from interview data.

While several bloggers agreed that CELE has qualities that can translate into general best practices online, one interview partner was noticeably more skeptical – and observed a broader trend of not engaging with other people’s arguments, regardless of the space. “If people meet in person and not digital, so very often the person is actually not listening, but just waiting for the other person to be finished to start talking” (Michelle).

**Discussion**

Today’s media landscape and social media channels are deeply divided. Consistent liberals and conservatives often live in separate media worlds and show little overlap in the sources they trust for political news (Rainie, 2017). To illuminate current attitudes about the potential impacts of online social interaction over the next decade, Pew Research Center and Elon University’s Imagining the Internet Center canvassed 1,537 technology experts, scholars, corporate practitioners, and government leaders in summer 2016. Based on the results, Rainie, Anderson and Albright (2017) stated that many experts fear uncivil and manipulative behaviors on the internet will persist — and may get worse.

Through the expert interviews, we have grown to understand digital literacy and digital citizenship as lifelong commitments, not a one-time achievement. Digital citizenship is a competency – not something we have, but rather something we do, and a continuing reflective practice. It is a complex bundle of ability, motivation and willingness to perform and interact in specific ways (Baartman et al., 2007).

All interviewees agreed that through ease of use, instant access, low-barriers to contribution, and potential for wide distribution, social media serve as catalysts for civic engagement and civic reasoning. Especially from the local government and civil service perspective, there is no alternative to embracing the digital space for civic engagement. Digital civic engagement platforms can provide an attractive and accessible means for participation (Sokhn, Evequoz & Zufferey, 2016).

However, while the quantity, frequency and speed of civic engagement has increased, almost all interviewees were struck by a decrease in the quality of interactions through either their participating or witnessing in their social media environment. It is worth noticing that all bloggers judged CELE as an exception to this trend.

Preston et al. (2017) pose the question of whether the processes for humans connecting are fundamentally different in the physical and digital world and argued that they may be one in the same, especially where there is a strong affective element. They chiefly see differences in the scale, impact, and transparency of digitally mediated social interaction and reaction across platforms. Though our interview partners claimed that their own writing and behavior is fairly consistent in their online and offline personas, they typically characterized face-to-face interactions as more prone to civil dialogue. However, it is worth noting that the person most pessimistic about the potential for pedagogy efforts to spread civil civic engagement based her judgment partially on experiences in face-to-face settings, i.e., political rallies during the 2016-17 US election cycle and aftermath. “I cannot believe I saw somebody getting hit in the face, someone walking up to a stranger saying: I hope ISIS kills you and your whole family.”
Both online and in face-to-face encounters, people struggle with agreeing to disagree and yet be able to engage in a mutual learning process. We analyzed the CELE blog as an example of a community that from its outset cultivates a civil discourse about civic engagement. Having ground rules, focusing on learning and information sharing, and ‘not putting people down’ were qualities that the bloggers associated with their CELE blog experience.

To have an impact, a civic engagement platform like CELE has to gain momentum. All interviewees stressed that they hope for a wider readership for the blog and, to varying degrees, more interaction both with their audience and with one another through comments. Which posts are best suited for these purposes? Based on the content analysis, we saw that high scores on factual information, interactivity and personalization corresponded with wider distribution. Posts that offer identification typically reach broader distribution and yield more discussion comments. Interestingly, the expressed wish to have more exchange with the audience did not necessarily translate into CELE bloggers actually responding to comments. The digital space made it easy to deprioritize commitment to the community.

**Conclusion**

According to Torney-Purta et al. (2015), civic learning is increasingly recognized as important by the higher education community. The authors identify civic competency and civic engagement as two key domains within civic learning. This single case study research offers initial guidance for edublogging on civic discourse in an informal learning space, and directions for future research.

Generalizable, definite conclusions cannot be based on a single case study. Instead, the purpose of our case study and the applicability of our findings can be characterized as exploratory and intrinsic following the typology described by Baxter and Jack (2008). While closely analyzing one community we gained an intrinsic understanding of the case at hand and discovered the inner workings of the blogger community that appears to exhibit a specific style of civic, civil discourse that at least some community members experience as unique in their environment. At the same time, we have exploratory results that offer background information and allow to formulate more precise research questions for later investigations.

We offer three points for edublogging practice and two for research:

- **Blog post features.** Guiding bloggers to incorporate sourced information, interactivity and personalization is a working hypothesis for fostering posts that reach a broader audience and thus enhance opportunities for mutual learning. The combination of these factors was reflected in the content analysis and elaborated through the interview data.

- **Accountability challenges for multi-author blogs.** When “everyone is responsible,” it is too easy avoid individual culpability. Interviewees point to the gap between their desire for more comments on their posts and a stronger give and take, contrasted with their minimal activity offering comments or following up on comments to their post. How to incentivize regular commenting for informal learning spaces is a need demonstrated by the CELE experience.

- **Start-up of a blog is crucial for high quality civic discourse.** Ground rules that emphasize candor and respect were part of CELE’s initiation. Interviewees further noted the blog administrators’ encouraging reinforcement of the norms. However, a focus on being “civil” may result in “being too polite” and missing a stronger level of engagement and mutual learning through specific differences and more challenging comments. Further efforts to support and measure “the right amount of friction” that exemplifies diverse and even clashing opinions while keeping an online community together is a final area of practice development for digital citizenship.

Turning to research, we see two points of departure from this case for future investigation:

- **Length of writing and/or kind of media presentation.** The CELE blog used only words and still pictures to convey authors’ community engagement ideas. Other mash-ups may result in different qualities of civic discourse, greater willingness of readers to comment, and further dimensions of digital literacy and citizenship. Interview data noted the value of longer-form entries in the CELE blog compared to Facebook and Twitter platforms. The amount of space per entry was considered a positive factor for civic discourse. Thus, research on civic discourse communities that use shorter-form or more multi-media formats is a frontier for both content analysis and interview studies (for example #AppellateTwitter).
- Extend existing online social system vs. starting something new. CELE was a from-scratch environment where bloggers and readers only came to know one another through the blog. A different research question is if pre-existing community or neighborhood-oriented blogs (e.g., nextdoor or e-democracy forum) could grow into the candor, respect, and reflection exhibited by CELE. For example, social systems that have a mix of face-to-face and online interactions may be better able to handle contention because of the ability to draw on richer relationships and utilize face-to-face setting to clarify or defuse passions generated online.

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