Effects of Mobile Instant Messaging on Collaborative Learning Processes and Outcomes: The Case of South Korea

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ABSTRACT

The purpose of this paper was to investigate the effects of mobile instant messaging on collaborative learning processes and outcomes. The collaborative processes were measured in terms of different types of interactions. We measured the outcomes of the collaborations through both the students’ taskwork and their teamwork. The collaborative learning processes and outcomes in the Mobile Instant Messaging group (Mobile IM) were also compared with the Personal Computer-based Instant Messaging group (PC IM) and the Bulletin Board System group (BBS). A total of 48 students participated in this study, and the main results show that more cognitive and metacognitive interactions were found in the BBS group while social and affective interactions were the major types of interactions in the Mobile IM group and the PC IM group. As a result of the collaborative learning outcomes, the Mobile IM group shows better teamwork than the other two groups. However, better taskwork was found in the BBS group and the PC IM group rather than the Mobile IM group. Finally, the researchers discuss the implications of this study from the perspective of the educational potential of mobile learning.

Keywords

Mobile-based collaborative learning, Mobile instant messaging, Collaborative learning processes, Collaborative learning outcomes

Introduction

Many researchers have claimed that mobile learning will greatly influence the future of teaching and learning in collaborative learning contexts (El-Hussein & Cronje, 2010; Huang, Yang, Huang, & Hsiao, 2010; Ryu & Parsons, 2012). The main reason behind many researchers’ enthusiasm about mobile based collaborative learning stems from its spontaneous, portable, personalized, ubiquitous and situated characteristics (Motiwalla, 2007; Patten, Arnedillo Sanchez, & Tangney, 2006; Rau, Gao, & Wu, 2008; Ryu & Parsons, 2012). Moreover, mobile learning has gradually become stable and mature (Huang, Yang, Huang, & Hsiao, 2010) and has attracted an increased number of learners in recent years.

Educators in South Korea are particularly fascinated by the concept of mobile learning due to its potential to overcome the limitations of traditional education and web-based learning. According to Korea Internet & Security Agency (2011), the infrastructure for mobile learning (e.g., WiFi networks, high-speed internet connection) is well established in South Korea. The Organization for Economic Cooperation and Development (OECD) also recently reported South Korea has the most mobile wireless broadband subscriptions of 34 OECD counties (OECD, 2012). South Korea has 104.2 subscriptions per 100 inhabitants. Additionally, several South Korean universities have distributed free iPhones or smart phones and encouraged students to utilize them to participate in lectures, to access library sources, and to access educational administration system (Lee, 2010). Students’ adoption of mobile technology is not surprising, given recent statistics on Internet usage. The Korea Internet & Security Agency (2012) finds that the internet usage rate for university students is almost 100% (99.9%) and among instant message users, 49.4% use mobile instant messaging services. The rapid diffusion and use of mobile devices suggests students may be receptive to educators’ incorporation of these tools for learning or ubiquitous learning in South Korea (Park, Nam, & Cha, 2012).

However, the true extent of the impact of mobile learning on education is still contested, both theoretically and empirically (Motiwalla, 2007; Ryu & Parsons, 2012). Moreover, previous research is limited to two specific themes – the effectiveness of mobile learning and the design of mobile learning systems (Wu, Wu, Chen, Kao, Lin, & Huang, 2012). Researchers have typically measured the effectiveness of mobile learning using learning outcomes rather than learning processes (Chen, Chang, & Wang, 2008; Hwang & Tsai, 2011). These outcomes comprise motivations, perceptions, attitudes, academic achievement, and satisfaction of students.
In this respect, various research topics that can uncover the potential of mobile learning are warranted to present more practical guidelines in this area. To address this gap in the literature, the present study explores how mobile learning affects collaborative learning processes and outcomes. Specifically, we examine the extent to which students’ cognitive, metacognitive, and social/affective interactions vary in mobile-based collaborative learning environments. We also examine the quality of cognitive messages and the level of team effectiveness in order to measure taskwork and teamwork, respectively.

**Theoretical background**

*Mobile-based collaborative learning in social and situated learning frameworks*

It is important to emphasize that the use of technology in educational settings must be in accordance with educational theories and specific pedagogical considerations (Patten et al., 2006). According to Ryu and Rarsons (2012), social and situated learning can be experienced through mobile-based collaborative learning since mobile learning facilitates seamless social interaction in learners by providing them advanced functions such as mobility and instant connectivity. Social learning theory emphasizes that learning occurs within a social context, which means people learn through observing and modeling other learners’ behaviors (Bandura, 1977; Hung, Looi, & Koh, 2004). Mobile-based collaborative learning can maximize the quality and quantity of interactions and observations through its rich communication channels. On the other hand, situated learning theory emphasizes authentic contexts and real learning activities (Lave & Wenger, 1991). Situated learning occurs in educational settings, which provide authentic contexts and activities to promote social interaction and collaboration (Herrington & Oliver, 1995; Lave & Wenger, 1991). Unlike traditional classrooms that decontextualize learners from authentic and practical situations, mobile learning provides a borderless context where learners can reach their goals and needs through real-time interactions. Thus, learners will experience enhanced social and situated learning through mobile learning. Also, mobile learning grounded in social and situated learning will provide learners with more updated learning environments.

*Mobile instant messaging for collaborative learning*

Collaborative learning is defined as ‘a situation in which two or more people learn or attempt to learn something together’ (Dillenbourg, 1999, p. 2). Collaborative learning can be mediated through many different tools, such as discussion boards, blogs, and instant messenger. Like computer-based collaborative learning, mobile-based collaborative learning is mainly text-based, which can enable students to express their opinions and to ask questions without the pressure or feeling of threat that can accompany traditional classrooms (Kitsantas & Chow, 2005; Rau et al., 2008; Ting, 2012). However, Chen & Huang (2010) note that computer-based collaborative learning has a limitation with respect to meeting learners’ educational needs, especially for students who want a more informal and flexible learning environment. In this respect, mobile-based collaborative learning can be more in accordance with their needs by providing ubiquitous and situated learning environments (El-Hussein & Cronje, 2010).

Instant messaging is one of the most widely-used mobile applications for education (Rau et al., 2008). Rau et al. (2008) found that mobile instant messaging supported social bonding between students and instructors. Additionally, Yengin, Karahoca, Karahoca, & Uzunboylu, (2011) investigate the potential of using mobile instant messaging for education, and they found the successful examples such as a quiz tool, an assessment tool and discussion tools in several previous studies (e.g., Attewell, 2005; Stone, Briggs, & Smith, 2002; Markett, Sánchez, Weber, & Tangney, 2006; Bollen, Eimler, & Hoppe, 2004; Holley & Dobson, 2008). Other studies suggested that when used as a discussion tool, mobile instant messaging can promote interactivity and led to more active collaboration (Markett et al., 2006; Bollen et al., 2004; Holley & Dobson, 2008). Despite positive findings from several studies, Ryu & Parsons (2012) and El-Hussein & Cronje (2010) point out that there is still a need to conduct additional research on how mobile instant messaging could facilitate collaborative learning beyond the ‘novelty effect’ of new mobile technology.

*Collaborative learning processes: Cognitive, metacognitive and social/affective interactions*

Mobile-based collaborative learning supports interactions among students as well as instructor-student interactions (Ting, 2012). Students can also enjoy the increased frequency of social interaction through mobile technology in group-based projects (Seppala & Alamaki, 2003). A number of researchers emphasize the quality of cognitive
interaction in learning environments, which is crucial for the success of collaborative learning. However, many researchers note that students’ metacognitive and social/affective interactions also play a fundamental role in collaborative learning (Efklides, 2008; Salonen, Vauras, & Efklides, 2005). Metacognition is defined as knowledge about knowledge or the regulation of cognition (Brown, 1987). Metacognitive interaction is regarded as the interactive activities that monitor, evaluate and revise other team member’s cognitive processes when they work as a team. They involve the sharing of metacognitive justification, evaluation and feeling (Efklides, 2006). Social/affective interactions are an inevitable part of human communication and play an essential role in collaborative learning (Shen, Wang, & Shen, 2009). Learners express a variety of emotional states (e.g., interest, curiosity and confusion) (Kort, Reilly, & Picard, 2001) as well as social expressions (e.g., greeting, complimenting, and expressing appreciation) (Rourke & Anderson, 2002) when they work together. Furthermore, Panitz (1999) argues that it is important to create an emotional environment that enables students to take initiative in expressing their opinions about any given topic while constructing a shared learning experience.

Interestingly, Ting (2012) suggests that mobile technologies can strengthen learners’ interactions and ultimately help learners achieve better collaborative learning outcomes. In addition, Rogers & Price (2006) indicate that mobile technology can change learners’ collaborative learning processes, particularly their cognitive, metacognitive and social/affective interactions. However, it is hard to find studies that focus on these specific types of interactions, even though much research has been done on the topic of computer-based collaborative learning (Guan, Tsai & Hwang, 2004; Hara, Bonk, & Angeli, 2000). In addition, Wu et al.’s (2012) meta-analysis on mobile learning using 164 published papers from 2003 to 2010 shows that evaluating the outcomes of mobile learning rather than processes was the most researched topic in the field of mobile learning. Thus, our study, which addresses how these interactions occur in mobile-based collaborative learning environments compared to collaborative learning via desktop computer or BBS, will be valuable to practitioners as well as researchers who are interested in facilitating students’ informal or seamless learning by applying mobile technologies to education.

Collaborative learning outcomes: Taskwork and teamwork

Unlike individual learning, collaborative learning not only needs task-related skills but it also needs team-related skills that enable team members to work together smoothly and effectively (Eccles & Tenenbaum, 2004). Moreover, a high performance team is characterized as a group of people that is effective in creating a balance between taskwork and teamwork (Johnston, Smith-Jentsch, & Cannon-Bowers, 1997). Mathieu, Heffner, Goodwin, and Salas & Cannon-Bowers (2000) describe taskwork as the skill necessary to accomplish a given task. Taskwork is identified by a learner’s cognitive activity. On the other hand, teamwork is described as the skills needed for effective team functioning such as proper role assignment/responsibility, using efficient communication channels and accurate decision making.

Although many researchers argue that teams develop both taskwork and teamwork through performing their team projects, the evaluation of collaborative learning tends to only focus on their task achievement in terms of how effectively and efficiently they accomplish their given tasks (Mathieu et al, 2000). However, Stott and Walter (1995) indicated that taskwork and teamwork are conceptually independent, but the nature of their functioning is intertwined and affects team performance. Therefore, it is more reasonable to measure both taskwork and teamwork as outcomes of collaborative learning instead of measuring taskwork by itself.

Research questions

To examine the extent to which learners’ cognitive, metacognitive and social/affective interactions vary in mobile based collaborative learning as well as the effects of mobile learning on collaborative learning outcomes in terms of taskwork and teamwork, the specific research questions are as follows.

First, are there any differences in collaborative processes in terms of learners’ three types of interactions when they use Mobile Instant Messaging in comparison to Personal Computer-based Instant Messaging and Bulletin Board Systems?

Second, are there any significant differences in collaborative outcomes in terms of learners’ taskwork and teamwork when they use Mobile Instant Messaging in comparison to Personal Computer-based Instant Messaging and Bulletin Board Systems?
Third, are there any differences in learners’ perceptions when they use Mobile Instant Messaging in comparison to Personal Computer-based Instant Messaging and Bulletin Board Systems?

**Method**

**Participants**

A total of 48 students in three classes from a large private Korean university participated in the study. All participants were enrolled in an introductory educational technology course which was a required course. Their average age was 21.57 (SD = 13). They participated in the study as part of their regular class activity. The three classes were randomly assigned to one of the following three groups: a mobile instant messaging group (Mobile IM; n = 22), a personal computer-based instant messaging group (PC IM; n = 12), and a bulletin board system group (BBS; n = 14).

**Three communication media for discussion**

Mobile Instant Messaging (Mobile IM): The Mobile IM group used the KakaoTalk application to conduct their discussion task. It is one of the most popular free mobile messenger applications in South Korea. It provides free text messaging and free calls. The students in the Mobile IM group can share various content and information such as photos, videos, and URL links. Group discussion is possible without the constraints of time and space.

Personal Computer based Instant Messaging (PC IM): The PC IM group used MSN Messenger in their desktop computers. The MSN Messenger is a form of communication over the internet on a PC that offers a quick transmission of text-based messages from sender to receiver. Computer instant messaging basically offers real-time online chat but students need to set a time and to log into the messenger for their group discussion.

Bulletin Board System (BBS): The BBS group used a discussion board system like Blackboard provided by the Learning Management System in a University. Through the BBS, students can do an asynchronous discussion while students can do synchronous discussion through Mobile IM or PC IM. Students in the BBS group are able to revisit their discussion board and post their message whenever they want.

To fairly compare the differences in the three communication media groups, both mobile and computer instant messaging groups are allowed to use only text-based messaging even though they can use voice chatting through their devices. Also, the BBS groups are only allowed to use the discussion board through their personal computer even though they can access it through mobile technology.

**Task and procedure**

The team task was an ill-structured problem describing a novice teacher who took on a very low achievement class with many troublemakers, and a school principal who directed her to increase student academic achievement within a year. Before students could solve the ill-structured problem, lessons on learning paradigms such as behaviorism, cognitivism, and constructivism were provided to the participants in a regular class. Then, they were randomly assigned to one of three communication media groups. Each group consisted of three or four students and they were asked to discuss a best solution to solve the given problem based on three learning paradigms within a week. All participants were required to discuss the topic using only an assigned communication medium. After the discussion week, participants answered an open-ended perception question which asked them what were the most and the least favorite aspects of the medium that they used for their discussion.

**Measures**

To examine the effects of Mobile Instant Messaging on collaborative learning, students’ interactions were measured as the learning processes of their collaborations, and taskwork and teamwork were measured as collaborative learning outcomes. The specific methods were described as follows.
Three types of interactions

The content analysis method was used to analyze the types of interactions. As Henri (1992) suggested, an individual theme or idea (thematic unit) was used as the unit of the analysis rather than a word, sentence or paragraph in order to maintain consistency in analyzing students’ discussion messages that occurred in the three different media. For example, the Mobile IM group expressed their opinions in a short phrase or word instead of using a full sentence (e.g., “when?”, “in this case”) while the BBS group usually posted at least one paragraph to state their idea. Therefore, the individual theme or idea was used as the unit of analysis in this study, so the unit of analysis can be any size text from a single word to a paragraph as long as it expresses a theme or idea.

The types of interactions are composed of three categories: cognitive or metacognitive interaction, social or affective interaction, and other interaction. Cognitive or metacognitive interaction is a task-related meaning unit. Social or affective interaction is a non-task-related meaning unit such as personal talks or the expression of feelings. Other interactions are interactions about managing the discussion such as scheduling for the task and setting discussion rules. Two researchers then developed a coding scheme and classified each thematic unit into one or more of the aforementioned categories. The coding scheme is described in Table 1 with samples of thematic units. Inter-rater reliability for the classification of categorical variables was determined by Cohen's Kappa, which measures the agreement between two raters who each classify thematic items into mutually exclusive categories. Cohen’s Kappa for the inter-rater reliability was 0.96 for the agreement of thematic unit and 0.94 for the classification of interaction. The two raters discussed until they reached a consensus, and a total of 1,850 messages were analyzed in this study.

Table 1. Coding scheme for the classification of thematic units

<table>
<thead>
<tr>
<th>Categories</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cognitive/metacognitive</td>
<td>■ Talking about key concepts of learning theories</td>
</tr>
<tr>
<td></td>
<td>■ Talking about learning theories’ principles</td>
</tr>
<tr>
<td></td>
<td>■ Talking about implication of learning theories</td>
</tr>
<tr>
<td></td>
<td>■ Sharing learner’s opinion on learning theories and application</td>
</tr>
<tr>
<td></td>
<td>■ Speculating some issues on learning theories</td>
</tr>
<tr>
<td></td>
<td>■ Questioning something about learning theories</td>
</tr>
<tr>
<td></td>
<td>■ Summarizing what they discussed on learning theories</td>
</tr>
<tr>
<td></td>
<td>■ Reflecting what they discussed on learning theories</td>
</tr>
<tr>
<td>Social/affective interaction</td>
<td>■ Praising the other student’s utterances</td>
</tr>
<tr>
<td></td>
<td>■ Chatting about student’s private lives</td>
</tr>
<tr>
<td></td>
<td>■ Chatting about non-task-related topics</td>
</tr>
<tr>
<td>Other interaction</td>
<td>■ Talking about scheduling for the task</td>
</tr>
<tr>
<td></td>
<td>■ Talking about taking turns</td>
</tr>
<tr>
<td></td>
<td>■ Talking about setting discussion rules</td>
</tr>
</tbody>
</table>

Teamwork

A survey was used in order to measure teamwork. The survey consisted of five questions about team effectiveness: Efficiency of team management, Observance of team schedule, Conviction of team output quality, Adequacy of team output quantity, and Satisfaction with team output (e.g., “Our team management was efficient,” “Our team members kept our team schedule,” “we think the quality of team output was excellent,” “we think the quantity of team output was appropriate,” and “we are satisfied with our team output.”). Students responded on a five-point Likert scale ranging from “Strongly Agree” to “Strongly Disagree,” depending on how well they thought that the statement described their team effectiveness. The responses were coded in the following manner: strongly agree = 5, agree = 4, not sure = 3, disagree = 2, strongly disagree = 1. The reliability of the survey was .80 for the pilot test and for this study it was .78.

Taskwork

To examine how well learners discussed a given topic, we evaluated the quality of their group discussion. Specifically, we measured their cognitive messages based on four criteria: novelty, importance, relevance, and ambiguity. Among the 10 criteria in Newman, Webb, & Cochrane’s (1996) study, four criteria which measure the
quality of cognitive messages were selected for this study. Two researchers who specialized in educational technology scored each cognitive message as 1 or 0 based on the four criteria described in Table 2. The inter-rater reliability through Cronbach alpha analysis was 0.92.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Descriptions</th>
<th>Scores</th>
</tr>
</thead>
<tbody>
<tr>
<td>Novelty</td>
<td>New information, ideas, solutions</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Repeating what has been said</td>
<td>0</td>
</tr>
<tr>
<td>Importance</td>
<td>Important points/issues</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Unimportant, trivial points/issues</td>
<td>0</td>
</tr>
<tr>
<td>Relevance</td>
<td>Relevant statements</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Irrelevant statements, diversions</td>
<td>0</td>
</tr>
<tr>
<td>Ambiguities</td>
<td>Clear, unambiguous statements</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Confused statements</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 2. Four criteria for rating taskwork

Perception on communication media

For a more in-depth understanding of the characteristics of each communication medium, students’ perceptions on medium were measured by a survey which contained one open-ended question. The question asked students what was the most and the least favorite aspects of the medium in their discussion. One piece of paper was given to each student, and they described their thoughts about the given communication medium for 30 minutes.

Data analyses

Content analysis was conducted to examine how the types of interactions were different across the three groups. For the analysis of the comparisons of the three groups in terms of taskwork and teamwork, one-way ANOVAs were conducted. The perception survey data was analyzed qualitatively based on the main themes that students addressed as characteristics of the communication medium they used.

Results

Collaborative process: Types of interactions

This study was designed to discover if there are differences in the types of interactions such as: cognitive or metacognitive interactions, social or affective interactions and other interactions (not included in the two categories) among the three communication media groups. The interactions were analyzed by a content analysis and the percentage of each interaction compared to the total number of messages from each group was discerned. The results are shown in Table 3.

Table 3. Frequencies of Interaction Types by Communication Media Groups

<table>
<thead>
<tr>
<th></th>
<th>Cognitive/metacognitive interaction</th>
<th>Social/affective interaction</th>
<th>Other interaction</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobile IM</td>
<td>614(50.00%)</td>
<td>449(36.56%)</td>
<td>165(13.44%)</td>
<td>1,228(100.0%)</td>
</tr>
<tr>
<td>PC IM</td>
<td>205(45.15%)</td>
<td>166(36.56%)</td>
<td>83(18.28%)</td>
<td>454(100.0%)</td>
</tr>
<tr>
<td>BBS</td>
<td>123(73.21%)</td>
<td>32(19.05%)</td>
<td>13(7.74%)</td>
<td>168(100.0%)</td>
</tr>
<tr>
<td>Total</td>
<td>942(50.92%)</td>
<td>647(34.97%)</td>
<td>261(14.11%)</td>
<td>1,850(100.0%)</td>
</tr>
</tbody>
</table>

From the results, it was found that cognitive/metacognitive interaction accounted for approximately 50%, social/affective interaction 37%, and other interaction 13% in the group utilizing Mobile IM in their discussion. A similar tendency was found in the group utilizing PC IM with results that showed that cognitive/metacognitive interaction accounted for approximately 45% of the total number of messages, social/affective interaction 37%, and other interaction 18%. On the other hand, cognitive/metacognitive interaction accounted for more than 73%,
social/affective interaction 19%, and other interaction 8% in the group utilizing BBS for interaction.

In terms of the three types of interactions, the Mobile IM and PC IM groups showed similar results. However, the result reveals that the BBS group had more cognitive/metacognitive interactions and fewer social/affective interactions compared to the Mobile IM and PC IM groups. In addition, other interaction was also lower in the BBS group compared to the other two groups. The results are arranged into a pie chart as follows.

![Pie chart showing distribution of interaction types by communication media]

**Figure 1. Distribution of interaction types by communication media**

**Collaborative outcomes**

**Teamwork**

To identify if there are differences in teamwork scores across the three different communication media groups, the mean of the teamwork score was calculated as shown in Table 4. A one way ANOVA analysis was conducted to see if there were any statistically significant differences in the teamwork scores among the groups. The results are presented in Table 4.

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobile IM</td>
<td>22</td>
<td>4.12</td>
<td>.65</td>
</tr>
<tr>
<td>PC IM</td>
<td>12</td>
<td>3.47</td>
<td>.41</td>
</tr>
<tr>
<td>BBS</td>
<td>14</td>
<td>3.65</td>
<td>.58</td>
</tr>
<tr>
<td>Total</td>
<td>48</td>
<td>3.82</td>
<td>.63</td>
</tr>
</tbody>
</table>

From the results above, the Mobile IM group recorded the highest average points with 4.12 in the teamwork score, followed by the BBS group with 3.65, and the PC IM group with 3.47. As shown in Table 5, there were significant differences in teamwork scores between groups according to the type of media. From the results of the Scheffe verification, there was a significant difference between Mobile IM and PC IM at the 𝑝 < .01 level, however, significant differences were not found between the BBS group and the other two groups (Mobile IM and PC IM). That is, the result reveals that the Mobile IM group showed higher teamwork at a statistically significant level compared to the PC IM group.

<table>
<thead>
<tr>
<th></th>
<th>Sum of Square</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between groups</td>
<td>3.929</td>
<td>2</td>
<td>1.965</td>
<td>5.803</td>
<td>.006</td>
</tr>
<tr>
<td>Within-groups</td>
<td>15.235</td>
<td>45</td>
<td>.339</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>19.164</td>
<td>47</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Table 4. Teamwork scores by communication media groups**

**Table 5. ANOVA analysis of teamwork scores by communication media groups**
Taskwork

To identify if there was any difference in the taskwork score depending on the type of communication media, the total taskwork score was divided by the total number of cognitive/metacognitive messages in each group of communication media. The results revealed that the mean scores of taskwork were 1.89, 2.59 and 2.62 in the Mobile IM, PC IM and BBS groups respectively. The highest mean of taskwork score was found in the BBS group, and the lowest mean of taskwork score was found in the Mobile IM group.

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Total # of cognitive/metacognitive messages</th>
<th>Total taskwork score</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobile IM</td>
<td>22</td>
<td>614</td>
<td>1,160</td>
<td>1.89</td>
<td>.97</td>
</tr>
<tr>
<td>PC IM</td>
<td>12</td>
<td>205</td>
<td>530</td>
<td>2.59</td>
<td>1.00</td>
</tr>
<tr>
<td>BBS</td>
<td>14</td>
<td>123</td>
<td>322</td>
<td>2.62</td>
<td>1.09</td>
</tr>
<tr>
<td>Total</td>
<td>48</td>
<td>942</td>
<td>2,006</td>
<td>2.13</td>
<td>1.05</td>
</tr>
</tbody>
</table>

The ANOVA analysis was conducted to determine if the taskwork score was statistically different across the three communication media groups. The results are shown in the following Table 7.

<table>
<thead>
<tr>
<th></th>
<th>Sum of Square</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between groups</td>
<td>109.640</td>
<td>2</td>
<td>54.820</td>
<td>55.370</td>
<td>.000</td>
</tr>
<tr>
<td>Within-groups</td>
<td>938.589</td>
<td>948</td>
<td>.990</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1048.229</td>
<td>950</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

As shown in Table 7, there were statistically significant differences in taskwork scores between groups. To identify which groups showed the difference, a Scheffe verification was conducted, and its results revealed that there was no difference between the PC IM group and the BBS group, but significant difference was found in the Mobile IM compared to the PC IM and BBS groups at the $p < .001$ level. That is, the taskwork score of the Mobile IM group was significantly lower than the other two groups.

Perception on communication media

Based on the results of the student perception survey, the following seven major themes were perceived to be the most or the least favorable aspects of each communication medium for their discussion.

Theme 1- Time Constraint: Mobile IM enabled students to contact their team members whenever they needed them. Most of the students using mobile devices said they liked that it did not have constraining time features of Mobile IM.

“'I think our team discussed the topic all day long because we talked whenever we are available. Even though it’s short time... So, I love it. One day, I had a lot of classes but I could read the members’ opinion between the classes and respond them. So, I could keep up with my team members’ discussion.’”

However, the students in the PC IM group pointed out that it was difficult to find an available time for all team members to log into the PC IM, even though they did not need to be in the same place.

“’It is hard to find the time which all the members can participate because of the differences time schedules. Some of the students wanted to night time and the others didn’t. A student was available on weekend only. It was so hard!!’”

Theme 2 - Limitation of Location: The students in the Mobile IM group could participate in their group discussion while they were working or moving to another place. Many students in the Mobile IM group pointed out that this was one of the most favorable aspects of the technology.
“I am working at a café as a part time job. Sometimes when there were a few customers, I can respond to the team members’ opinion. It’s the most strong point of mobile IM because if I use BBS or PC IM, I cannot involve the discussion frequently.”

However, some of the students in the PC IM and BBS groups who used PC computers were limited by their location. Students could access chat rooms or discussion boards only where there was a computer available.

“It is hard to get the chance of using computer at the school because the number of the computer in the lab is not enough. So I can access the discussion board at home... sometimes when I came back home lately or I was so tired, I didn’t want to participate the discussion. It bothered me....”

Theme 3 - Availability for Searching Resources during Discussion: The PC IM group and BBS group reported that they could search the Internet to find any necessary resources related to their discussion topic while they were communicating. They could refer to any references and write their opinions for as long as they wanted without any sudden interruptions by other students. On the other hand, most of the students of Mobile IM felt it was inconvenient to locate necessary references such as textbooks or articles, especially when they participated in their discussion outside of the home or classroom.

“Sometimes I could not remember the detail of a theory which I learned. I really wanted to back up my opinion.... In that case, I want to search the Internet but it is little bit inconvenient through mobile chat. In a mobile chat, multitasking is exceedingly cumbrous.”

Theme 4 - Emotional Closeness: Most of the students in the Mobile IM group claimed that Mobile IM offered a more comfortable and friendly environment where they could talk about private topics as well as their discussion topic using various emotional and social expressions. However BBS and PC IM group students rarely addressed this point as an advantage.

“I usually start to say ‘Hello’ or ‘The weather is great’..... like my team members are besides me. Or sometimes I complain my headache or a lot of papers of the other classes to my team members. I feel free to talk to them about my private stories through mobile chat.”

Theme 5 - Chance for Careful Thought and Reflection: Most of the students in the BBS group commented that the BBS enabled them to post their opinions or responses after having enough time to think about the given discussion topic and to review other team members’ postings. Also, Mobile IM students had enough time to review other team members’ messages and provide thoughtful feedback as compared to offline discussion. On the other hand, some of the team members only focused on typing their opinion without reviewing or considering other members’ postings. Therefore, it was difficult for them to have a more convergent discussion in the PC and mobile IM environments. That point was addressed as a disadvantage of mobile and PC IM groups.

“Some members talk so long when we discuss at offline meeting. In that case, I am sure that I forget what he or she was talking about for the first time. However, in the mobile chat, I can review the full message, so I do not forget what I prepared for the comments”

Theme 6 - Participation of the members: The students in the BBS group reported that some team members did not frequently visit their discussion board, which resulted in delayed responses and disjointed group discussions.

“A group member didn’t visit the discussion board after his first posting. That was it... I was annoyed that we could not discuss anymore. However, there wasn’t any alternative because we had to discuss through BBS only.”

Theme 7 - Inconvenience of Using Communication Media: The most common problem voiced by Mobile IM students was that the relatively small keyboard and screen on their mobile phones constrained them when typing a lengthy opinion or response during their discussion.

“I hate typo but the keyboard of my mobile phone is so small. So, I cannot help mis-typing. Also, the screen is so small. When I read all the discussion, I have to drag the message for a long time. It so irritates me.”
Conclusion and suggestion

Our study contributes by extending the scope of research on mobile learning. Unlike previous research, our study focuses on the effects of mobile learning on collaborative learning processes and outcomes. Social and affective interactions as well as cognitive and metacognitive interactions were also considered as important factors in the collaborative learning processes. Moreover, teamwork that was often ignored as the outcome of collaboration was measured along with taskwork. Based on the results of the study, it is recommended that students use Mobile IM or PC IM in order to facilitate their social and affective interaction at the beginning of their team project when they need to invest in getting to know one another (Lee & Johnson, 2008). Once students have progressed beyond the initial stages of the project, BBS could be the best communication medium to promote students’ cognitive and metacognitive interaction. The results of this study suggest that BBS, PC IM and Mobile IM should be used for different purposes. The BBS and PC IM would be good communication media to improve students’ taskwork while the Mobile IM would be the best choice to facilitate their teamwork. Therefore, understanding the unique characteristics of each communication medium is pivotal to maximize the quality of instruction, and, ultimately, students’ performance.

Future studies are suggested in the following three directions. First, it would be interesting to examine the affective and social aspects of learning as the result of collaborative learning outcomes. In this study, we measured learners’ taskwork and teamwork by focusing primarily on their cognitive development and team effectiveness. However, it will be necessary to examine how much their motivation and attitudes are improved after using Mobile IM for their collaborative learning. Second, we measured learners’ interactions and outcomes that occurred in a one week discussion, but future study is needed to conduct the measurement at least three times to see the change in learner interaction patterns and how their teamwork and taskwork develop over time. According to Fiore, Salas, Cuevas, and Bowers (2003), a team as a cognitive community goes through three coordination phases consisting of pre-process, in-process, and post-process. Depending on each phase of the processes, learners’ interactions and their focus vary. Therefore, it would be a good research topic to examine the change in learner interaction patterns and the development of teamwork and taskwork along with the three coordination phases. Third, from a more practical standpoint, future study also needs to focus on the design of mobile based collaborative learning environments with consideration of the results of this study and provides specific guidelines for effectively and efficiently launching mobile-based collaborative learning in online and offline classrooms. Specifically, it would be interesting to design and develop online instructions using a combination of mobile IM and other online communication tools depending on types of team activities and expected interactions for students’ informal or seamless learning.

References


