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Identifying User's Perceptions Toward Integrating Mobile Applications in Science Education

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Abstract: Situated under the macro-context of the Korean government's initiative to provide mobile- and cloud-based learning resources in schools, the goal of this study is to examine potential users' perceptions toward integrating mobile applications in science education. The sample includes 632 students, 68 teachers and 141 parents from 11 Primary schools in Korea. Results reveal some important implications regarding users' acceptance of mobile applications for teaching and learning. First, the majority of students do not frequently access and use mobile devices, which might be associated with the school policy to ban or limit the use of mobile devices in the classroom. This finding may imply a conflict between the enacted macro-level policy and the reality of schools. Second, the teacher group is the most conservative in their perceptions toward integrating mobile applications in science education. Teachers' conservative attitude may be associated with the lack of perceived advantages of using mobile applications in teaching and learning. Lastly, there was a clear pattern observed in users' perceptions about science topics that are effective or ineffective in integrating mobile applications. Science phenomena that require a long duration of observation were perceived to be highly relevant to integrate mobile applications, supporting the continuity of observation experiences across physical contexts and time scale. Further, we found that mobile applications that provoke students' imaginations and curiosity, where students do not feel forced to learn, but are intrinsically motivated to learning science in daily life, are likely to be readily accepted and used by student users.

Keywords: mobile earning, science education, digital textbook, needs analysis

1. Introduction

For the past decade, leveraging the unique affordances of mobile devices such as connectivity, immediacy and multi-functionality, several research studies have explored the impact of mobile learning applications (Motiwalla, 2007). Despite the promises of mobile learning, however, the use and adoption of mobile devices and applications in schools have been slow, and we have not witnessed many successful examples of mobile applications or systems widely adopted in classrooms. Still, most-widely used mobile applications in educational settings focus on simple communication, presentation, and productivity functions. There is a lack of successful examples of mobile applications that have fully utilized the affordances of mobility to create a new form of learning experiences. As to the use of mobile technologies in science education, Avraamidou (2008) makes a critical remark that while several research studies presented the positive impact of mobile applications in science education, there is a critical need to "design technology-enhanced curriculum materials that can be implemented and used prevalently in the classroom" (p. 361). We concur with this remark that without widespread acceptance and use of mobile-enhanced curriculum materials among individual users, the promise of mobile learning cannot be realized.

The research project presented in this paper was part of the large-scale project to develop mobile applications that could be prevalently integrated in Primary Science curricula. At a

macro-level, this study is situated under the context of the large-scale ICT in education policy by the Korean Government that has planned the development and implementation of digital textbooks in schools. The key impetus underlying the "Digital Textbook for All by 2015" initiative is to promote self-directed learning practices with the use of digital resources and content. To date, the digital textbooks have been piloted in over 100 research schools to examine design and implementation issues (MEST & KERIS, 2012).

While the Korean government's plan is to introduce and implement digital textbooks to all schools by 2015, the majority of schools may not be ready to adopt digital textbooks. When moving from traditional printed textbooks to digital textbooks, schools may face transitory issues such as changes in teaching and learning practices, building necessary socio-technological infrastructures, and stakeholders' adoption of digital textbooks. That is, the transition toward digital textbooks involves not only the adoption of technology-based tools, but also changes in socio-technical structures and cultural practices surrounding the use of such a new form of technologies (Bielaczyc, 2006).

Understanding such transitory issues, we explored a hybrid form of learning where mobile applications are used to support learning with printed textbooks, prior to the full adoption of digital textbooks in schools. The ultimate goal of this project was to develop a series of mobile applications that could be used in conjunction with printed textbooks in Primary Science curricula. As an initial step toward this goal, we conducted a needs analysis study to examine potential users' perceptions, expectations, and concerns toward using mobile applications in science education. While the main user group includes primary school students, this study also included teachers and parents as important actors affecting the use and adoption of mobile applications in science education.

2. Methods

2.1 Participants

Three stakeholder groups, namely students, teachers and parents, were the participants of this study. As shown in Table 1, the sample includes 632 students, 68 teachers and 141 parents from 11 Primary schools in Korea. We employed a purposive sampling method to recruit participants in various geographical areas in Korea. First, we recruited participants from two schools that were piloting the use of digital textbooks in the science curriculum at Grades 3 and 4 levels. We purposely included the pilot schools since one of the main goals of this project was to examine the possibility of integrating mobile applications as complementary or supporting resources to the science digital textbook. Second, we purposely recruited teachers who participated as authors of the national science textbook since content knowledge and teaching experiences in a science subject area were critical to evaluate the feasibility and needs for developing mobile applications relevant to science curricula. Students and parents in the recruited teachers' classes were invited to participate in this research via an invitation letter explaining the purpose and process of the research study.

Regarding demographic profiles of the participants, the student group includes 342 Grade 3 students (54.1%) and 290 Grade 4 students (45.9%). The gender distribution was nearly even, 330 male (52.2%) and 302 female (47.8%) students. The teacher group includes diverse age ranges: 19.1% of teachers under 30 years old, 36.8% of those age 31-40, 36.8% of those age 41-50, and 7.4% of those 51 and older. Nearly three quarters of teachers are female. The parents group includes about 60% of those age 31-40 and 40% of those age 41-50. Almost 88% of parents who responded to our survey were female.

Table 1: Survey Participants

	Digital Textbook Pilot School	Non-Pilot Schools	Total
Students	187	445	632
Teachers	51	17	68
Parents	141	-	141

2.2 Data Collection & Analysis

This study employed both survey and interviews to identify users' perceptions toward mobile application integration in the science curriculum. The research team developed three different sets of survey instrument for a respective group. We used a Likert scale of 1 (strongly disagree) to 5 (strongly agree) in the teacher survey, whereas a four-point Likert scale (no mid-point) was used in the student survey and parent survey. Common factors measured across the groups are a) usage patterns of using mobile devices, b) prior experiences of using mobile devices and mobile applications in science learning, and c) perceived expectations and concerns toward mobile learning. Specifically, factors examined in a respective group are as follows:

- *Study survey*: a) student's interests in science learning, b) mobile device usage, and c) expectation toward using mobile applications in science lessons
- *Teacher survey*: a) mobile device usage, b) prior experience of using mobile applications for teaching, c) challenges in teaching science, d) topics in the science curriculum suitable for integrating mobile applications, and e) potential concerns and issues with mobile learning
- *Parent survey*: a) mobile devices usage, b) prior experiences of using mobile applications for child's learning purposes, c) expectation toward using mobile applications in science lessons, and d) areas in need for using mobile applications at home

In addition to the survey method, we conducted interviews with students and teachers to collect qualitative data concerning the factors abovementioned. The interview sessions were conducted in different formats to accommodate the participants' needs and schedules. For the student group, we conducted four focus group interview sessions with 28 students at the digital textbook pilot schools. We also interviewed 20 teachers, including 8 teachers from the digital textbook pilot school, and 12 teachers who were the authors of the national science textbook. We used a focus group interview format with the teachers from the digital textbook pilot school, whereas the remaining teachers were tele-interviewed via phone or web-conferencing platform, due to their geographical diversity. We were not able to interview parents due to a low number of parents who volunteered to participate in an interview session.

In the student interview, we asked questions concerning student's interest, motivation and self-efficacy in science learning, prior experiences of using the science digital textbook, using mobile devices in daily life, expectation toward using mobile applications in science lessons, and ideas/topics perceived to be suitable for using mobile applications in the science curriculum. The teacher interview includes questions regarding their prior experiences teaching the science subject, prior experiences using mobile devices (including both general personal use and teaching/learning purposes), challenges with using the printed mode of textbook, and topics/activities perceived to be highly relevant to integrate mobile applications.

For data analysis, SPSS was used to statistically analyze survey data. Interview sessions were audio-recorded and transcribed. We used an open-coding method to identify key themes emerged from the interview data.

3. Results

3.1 Student Group

3.1.1 Mobile Device Usage Patterns

To understand how Primary school students use mobile devices in daily life, we examined the types of mobile devices, the frequency of usage and the types of activities with mobile devices. It was found that while students typically use smartphones more frequently than other mobile devices such as tablet PCs and portable game players, the overall usage of mobile devices is not high. One-quarter of students reported that they do not use smartphones at all. Nearly two-thirds of students use smartphones less than two hours per day. Top three activities that students do with mobile devices are: 1) playing games (26.3%), 2) communication (24.5%), and 3) watching video clips (18.8%).

3.1.2 Perceived Expectations

Next, we examined the students' perceived expectations about using mobile applications in science lessons. Overall, the students have positive perceptions of using mobile applications together with the printed textbook. Nearly 80% of students reported that it is not difficult to learn how to operate mobile devices, which imply that young users at this age do not perceive technical difficulties as a hindrance to learning with mobile devices. They perceived that science lessons could be more fun (89.4%), easier to learn (86.5%), and include more diverse types of activities (92.2%), with the use of mobile applications. During the focus group interview, we also observed students' positive attitude toward using mobile applications in science lessons. Students mentioned that with the use of mobile applications, "lessons could be more lively", "It would be easy to conduct dangerous experiments", and "learning with mobile applications would be more fun than learning with the traditional textbook". However, about 40% of students expressed some concern that lessons could be distracting with the use of mobile applications.

3.1.3 Relative Advantages: Digital Textbook vs. Printed Textbook

We examined how students perceived relative advantages of digital textbooks and printed textbooks. The students mainly mentioned multimedia features such as "we can watch video clips" and "I don't need to take notes" as advantages of using a digital textbook. Limitations of digital textbooks mostly involve technical issues (e.g., frequent error message, difficult to use) and health issues (e.g., affecting eyes and vision). In addition, as a way to compare and contrast digital vs. printed textbooks, we asked the students to generate ideas about science learning activities that are often limited in the traditional printed textbook, but could be better learned with a mobile application. Three distinctive categories of mobile application emerged from student-generated ideas. We categorized them according to the functional framework of mobile applications by Patten et al. (2006):

- *Referential*: scientific term search, learning scientific phenomenon or terms in daily life
- *Data collection*: observation of living and non-living things, raising a virtual pet like Tamagochi, complex/dangerous experiment (e.g., air current, dissection, natural disaster)
- *Microworld*: exploration, discovery-oriented games (e.g. survival in a deserted island, journey to the planet)

3.2 Teacher Group

3.2.1 Mobile Device Usage Patterns

Teachers reported that they use smartphones more frequently than other types of mobile devices. However, when we asked about what device or platform they use to search for teaching-related information and resources, the majority of teachers (97%) responded that they use a computer (i.e., desktop, notebooks). In the survey, about 47% of teachers reported that they had prior experiences using mobile devices for teaching purposes. Interview data reveal that while some teachers had prior experiences using mobile devices in science lessons, most usage patterns involve simple activities like term search, taking a picture, and video recording.

3.2.2 *Science Topics Suitable for Mobile Learning*

Next, we examined what areas/topics in the science curriculum teachers perceived to be suitable and effective for integrating mobile applications. The question item listed all topics in the Primary 3 and 4 Science curricula, and the teachers were asked to indicate the degree of expected effectiveness for each topic, on a five point Likert scale. From this data, we were able to identify a clear pattern in the nature of science topics that were perceived to be effective or ineffective in integrating mobile applications. Topics perceived to be highly effective are *Life cycles of animals* (86.8%), *Life cycles of plants* (86.8%), *Change of earth surface* (83.8%), and *Volcano and earthquake* (83.8%), which are

dealing with scientific themes or phenomena that are difficult to observe in a real-life context due to its dynamic nature and gradual changes for a long period. On the contrary, topics perceived to be ineffective in integrating mobile learning applications include *Separation of mixture* (55.8%), *Weight of object* (52.9%), *Use of magnet* (44%), and *Materials and matter* (39.7%), which tend to cover scientific phenomena easily observable and replicable in school contexts.

3.2.3 Relative Advantages: Digital Textbook vs. Printed Textbook

Among 12 teachers interviewed, three of them indicated that they did not have any difficulties using the traditional printed textbooks. It appeared that teachers often restructure and repurpose the content of textbooks to suit their needs, rather than simply follow the given format and structure. Teachers perceived limitations of printed textbooks when they a) teach topics requiring scientific experiments difficult to be conducted in school contexts, b) teach scientific phenomena involving a long duration of observation and field trips, and c) face difficulties accommodating various questions from students. Some teachers indicated that students do not completely understand instructions in textbooks when conducting an experiment. Digital content like video clips and audio materials explaining procedural steps were suggested to solve this problem.

3.3 Parent Group

3.3.1 Mobile Device Usage Patterns

There was no dominant type of devices used by parents for searching education-related information. About 46% of parents reported using a computer (i.e., desktop, notebooks) whereas about 42% of them used smartphones to search for information related to their child's education. Regarding prior experiences, nearly 76% of parents reported that they had not used any mobile application to teaching their children, indicating an overall low usage of mobile learning applications among parent users.

3.3.2 Expectations

On the whole, the parents had positive expectations about using mobile devices and applications in science lessons. Parents responded that science lessons could be more fun (89.4%), easier to learn (86.5%), and include more diverse activities (92.2%) with the use of mobile devices and applications. Regarding the question "Lessons could be distracting", the percentage of parents who agree with this item (53.95%) was slightly more than that of parents who disagree (46.1%). Similar to the student group, parents tend to perceive the use of mobile devices not technically challenging for children. About 75% of parents indicate that it is not difficult for children to operate mobile devices.

4. Discussion & Conclusion

The main goal of this research was to identify potential users' perceptions toward integrating mobile applications in Primary Science curricula. We examined perceptions of three stakeholder groups, with a consideration that not only students but also both teachers and parents are also important actors affecting the use and adoption of mobile learning applications in science education. Technology use and acceptance is a long-lasting issue that has drawn much research interest. While several researchers have examined determinants of technology adoption in educational settings (e.g., Teo, & van Schaik, 2012), this study is different in that it has a focus to the use and adoption of mobile technologies particularly in the context of science education.

Overall, this research reveals some important implications regarding users' acceptance of mobile technologies for teaching and learning. First, while access to mobile devices is the foundational condition to meet prior to the use of any mobile learning resources and application, we found that the majority of students do not frequently access and use mobile devices. This finding may be associated with the school policy to ban or limit the use of mobile devices in the classroom. Contrary to the Korean Government's plan to introduce more mobile- or cloud-based learning

resources, students are not allowed to use a mobile device as a learning tool in schools, which may indicate a conflict between the enacted macro-level policy and the reality of schools.

Second, we found that the teacher group is the most conservative in their perceptions toward integrating mobile applications in science education. Unlike the student and the parent groups who generally showed positive attitudes and toward mobile learning, the teachers expressed several concerns regarding the use of both mobile applications and digital textbooks. We also found that many teachers prefer to use a computer rather than a mobile device to search for teaching-related information and resources. Teachers' conservative attitude may be associated with the lack of perceived advantages of using mobile applications in teaching and learning. This is consistent with the general Technology Acceptance Model where perceived usefulness and perceived ease of use are important factors affecting user acceptance of technology (Davis, 1989).

Lastly, this study also reveals that there are certain areas or topics in science curricula that are perceived to be more suitable and effective for integrating mobile applications than other topics. Science phenomena that require a long duration of observation were perceived to be highly relevant to integrate mobile applications, supporting *the continuity of observation experiences* across physical contexts and time scale. Curricula topics involving static phenomena that could be sufficiently covered with printed textbooks and physical objects were perceived to be less relevant to integrate mobile applications. We also found that mobile applications merely reflecting curricula content are not likely to attract student users' motivation to use them. The students generated several interesting ideas of mobile applications that could be potentially developed as promising learning tools. Using such ideas, mobile applications that provoke students' imaginations and curiosity, where students do not feel forced to learn, but are intrinsically motivated to learning science in daily life, are likely to be readily accepted and used by student users.

While the present study examined users' general perceptions, we see needs to conduct future research into mobile technology acceptance and adoption that particularly consider unique characteristics and issue associated with mobile technologies. Such research will contribute to better understanding of the complexity of users' perception and adoption of mobile devices and applications for teaching and learning (Sarker & Wells, 2003). In conclusion, we believe that this initial user study provides some important insight to how the three groups of users perceive the role of mobile technology and applications in the context of science education, and to what factors should be considered to develop mobile applications reflecting users' needs.

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