What Can We Learn From ‘S’ Elementary School?: Wireless Laptop Computers in Regular Classroom Activities

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Abstract: The joint efforts of the Korean Ministry of Education and Human Resource Development (MOE & HRD) and Apple Korea were employed to integrate mobile technology in elementary schools. This evaluation research intended to provide the implications of successfully building and implementing m-learning environment. It performed pre- and post-tests in order to measure learners’ achievements; surveyed to measure students’ satisfaction, efficacy, and motivation; and conducted qualitative field observation and interviews along with video/audio-recordings. As a result, the current research proved the potential power of the Mac-wireless computer integrated instruction/learning approach regardless subject, class, and gender. In addition, it reveals several success/hindering factors within the elementary school.

Keywords: m-learning, learning achievement, elementary education, success factors, satisfaction, motivation, self-efficacy

1. Research Problems and Rationale for Study

Various mobile technologies have emerged and have been developed into integrated forms. Those technological changes highlight the potential attraction of lower cost and equal opportunities higher than desktop computes and wired network systems. In a similar sense, wireless/mobile computer technologies might reinforce gradual changes in education in various ways (Lee, Song & Lee, 2006). With the number of mobile devices predicted to surpass the number of conventional computers in total web access in the near future and with bandwidth for mobile devices predicted to increase dramatically in the short term, mobile learning appears certain to become an important part of learning, education, and training in the future (Lee, 2003; Avellis et al., 2004).

Korea MOE & HRD and Apple Korea have employed joint efforts to integrate mobile personal computer technology in the form of wireless laptop computers into regular classroom settings. In the fall semester of 2005, S Elementary School was selected as one of the three model schools. During the spring semester of 2006, this school had implemented wireless laptop computers into the regular classroom activities. S School chose Korean Language and Social Studies as subject areas for this experiential approach. However, since its approach was not to be very systematic or well organized and at the outset of the second year, the MOE & HRD expressed the need for measuring learning achievement for the purpose of quality control. I was requested to provide suggestions and implications to successfully build and implement a ubiquitous education environment by conducting this evaluation research. The specific research questions are (1) Evaluate learning achievement of the five-week Mac-wireless computer integrated instruction/learning activities; (2)
Measure the level of learners’ satisfaction, self-efficacy, and motivation, regarding Mac-wireless computer integrated instruction/learning processes and the results; and (3) Discover in depth the features related to learning achievement and satisfaction, efficacy, and motivation; and to further analyze the cultures of school, teachers, and students.

2. Literature Review

Mobile learning can be defined as ‘learning using mobile and wireless computing technologies in a way to promote learners’ mobility and nomadicty nature’ (Lee, 2006). Mobile learning is bound by a number of special properties, such as ‘the form factor of mobile devices’ (Stone, 2004), which is the size and physical arrangement and configuration, the capability and features of devices, bandwidth and other characteristics of the network technologies being used, etc. Moreover, mobile learning is a heterogeneous environment; it encompasses a range of devices and network technologies (Stone, 2004).

The ideas of constructivism are most frequently discussed as underpinnings to be considered when designing mobile learning. Although the use of a mobile technology might seem, on the surface, to be an extremely isolated, individualistic activity, young people can communicate with each other quite successfully in the process of using the devices (Colley and Stead, 2004). Collaborative group work and communicating with peers and others can be a powerful way of confronting one’s own pre-conceptions and contributing to restructuring one’s cognitive schemas or creating new conceptions. Learners might simply use the mobile tools to carry out group work assigned in class. “In this sense, swarming could be viewed as one way in which mobile technologies can support collaborative work” (Lee, 2006)

Gay et al. (2002) suggest the use of mobile computers in education with the four-level objectives scheme. The applications provide tools to achieve the objectives of level one, productivity; level 2, flexible physical access; level 3, capturing and integrating data; and the most complex applications provide tools to achieve multiple objectives so that an application that enables collaborative work will also enable the collecting and analyzing of data, level 4 (Attewell and Savill-Smith, 2004).

The Concord Consortium suggests six different categories of handheld computer activities, especially considering K-12 student groups: organizing and planning, reference information, data gathering, data manipulation and display, individual learning, and communicating and collaboration (Crawford and Staudt, 1999). Another interesting guideline for handheld computer applications are found in the administration applications, communication and collaboration applications, and teaching and learning applications, which covers 101 educational uses for your handheld computer (For the original reference, see http://k12handhelds.com/101list.php).

In addition to discussions on relatively micro and learning level, there are works dealing with success factors in various areas including learning, instruction, organization, communication, and technology. Among them, Hill, Reeves & Heidemeierd (2000), after reviewing various educational projects in ubiquitous computing environments, provided comprehensive recommendations for u-computing environments using portable technologies in three areas: teachers and teaching, students and learning, and communication activities.
3. Methods and Processes

Participants in the current research were 78 students in S school (Refer to table 1). Main software implemented was Safari, Keynote, Pages, Garage Band, Comic Life, ARD and imovie HD. The following Figure 1 introduces some of the software:

![Software Examples](image)

Table 1. General Information of Participants

<table>
<thead>
<tr>
<th>Grade</th>
<th>Class</th>
<th>Subject</th>
<th>Numbers</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>1</td>
<td>Korean Language</td>
<td>26</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Social Studies</td>
<td>27</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Social Studies</td>
<td>25</td>
<td>78</td>
</tr>
</tbody>
</table>

In order to measure learners’ achievements (research question 1), pre- and post-tests were performed before and after the five-week sessions (Nov. 6\textsuperscript{th} to Dec. 15\textsuperscript{th}, 2006). This school applied its own test items, developed by its internal teaching staff, in order to ensure content validity and reliability the most. In this process, the researcher reviewed the conformity between instructional goals/content and content/test items; and gave specific consultation for improvement.

In order to measure the level of learner satisfaction, self-efficacy, and motivation (research question 2), a 38-item survey was administered during the final day of the program implementation. The questionnaire in the category of ‘satisfaction’ were organized into the questions of 10 learning content/goal/program, 4 learning process, 4 learning effects (cognitive), 5 learning effects (affective), and 6 computer. And the efficacy and motivation questionnaire was organized into the questions of 3 learning efficacy, 2 IT efficacies, 2 self-confidence/locus of control, and 2 endurance. Each item was designed with 5-point Likert scales, using values of 5 for strongly agree and 1 for strongly disagree. Post-hoc, internal consistency reliabilities were measured with Cronbach’s alpha = .916. One-way and two-way ANOVA and t-tests were computed for questionnaires and 5-point Likert items with negative descriptions were reverse scored for convenient interpretation.

To discover in depth the features related to learning achievement and satisfaction, efficacy, and motivation (research question 3), a qualitative case study was implemented. Various documents produced by schools were reviewed, interviews with focus groups were conducted and observations in and outside classrooms were made during the period of 6\textsuperscript{th} of Nov. - 15\textsuperscript{th} of Dec, 2006:
### Table 2. Survey Questionnaires of Satisfaction, Self-efficacy, and Motivation

<table>
<thead>
<tr>
<th>No. of items</th>
<th>Categories</th>
<th>Questionnaires</th>
</tr>
</thead>
</table>
| 10           | Satisfaction (learning content/goals/program) | 1. I felt easy to understand class materials during m-learning class.  
2. I felt instructional content interesting during m-learning class.  
3. I was able to focus on content during m-learning class.  
4. The content was provided according to learning goals during m-learning class.  
5. I felt difficulties with m-learning class due to overloaded learning amount.  
6. I felt bored with m-learning class due to little amount of learning.  
7. The programs used in the m-learning helped me learn.  
8. The programs used in m-learning were easy and convenient to use.  
9. It was easy to find programs in the computer used in the m-learning.  
10. It was easy to upload assignment or opinions to the homepage, blog, or server within the computer used in the m-learning. |
| 4            | Satisfaction (learning process) | 1. I have given chances to share opinions with friends online and offline in the m-learning class.  
2. My teacher helped me in the m-learning class.  
3. I have given chances to collaborate with friends in the m-learning class.  
4. Other students helped me as necessary in the m-learning class. |
| 4            | Satisfaction (cognitive learning outcome) | 1. My information searching ability has been improved due to the m-learning class.  
2. My presentation skill has been improved due to the m-learning class.  
3. My ability of doing assignments has been improved due to the m-learning class.  
4. My self-regulated learning ability has been improved due to the m-learning class. |
| 5            | Satisfaction (affective learning outcome) | 1. I became to feel more interested in school life since the m-learning class has begun.  
2. I became to feel more interested in study since the m-learning class has begun.  
3. I feel my academic grad improved since the m-learning class has begun.  
4. I’d like to apply what I learned in the m-learning class.  
5. I’d like to continue studying through m-learning |
| 6            | Satisfaction (computer) | 1. The computer used in the m-learning was convenient to me.  
2. The computer used in the m-learning was light enough to carry.  
3. The software used in the m-learning was easy to produce and save task materials.  
4. Troubles in computers and programs occurred frequently during the m-learning class.  
5. It was easy to get a help when computers made troubles during the m-learning class.  
6. It was easy to get a help when software made troubles during the m-learning class. |
| 3            | Efficacy (learning) | 1. I studied better than the others in the m-learning class.  
2. I was able to understand most of the things I had to study in the m-learning class.  
3. I was more excellent than the others in the m-learning class. |
| 2            | Efficacy (IT) | 1. I can use software used in the m-learning class better than others.  
2. I can operate fluently the computer used in the m-learning class. |
| 2            | confidence & locus of control | 1. I became to accommodate well when having opinion conflict during m-learning.  
2. I performed learning tasks well due to my diligence during m-learning. |
| 2            | endurance | 1. I disliked difficult assignments/tasks in m-learning.  
2. I gave up if learning content and tasks were difficult. |
1) Document analysis of participating school’s project proposal, 1st year interim report, the next year proposals, 5-weeks lesson plans, designed instructional and activity material, learning outcomes.

2) Interviews of teachers (class teachers, colleagues, and research leaders), students, parents, principals, and the APPLE Korea staff, in order to find out various dimensions levels from diverse data sources.

3) Observation to discover if the lesson plans are implemented as planned, how students perform their activities, how Mac laptops work in classroom setting, and how teachers perform inside and out of classroom and how school leadership and culture functions.

Data was recorded by audiotapes, videotapes, and camera. This information was analyzed through triangulation (cross-checking of four research team members; and multiple information sources of transcription/audios/videos/pictures). The various information was reviewed and analyzed through the combination of coding, chart making, Critical Incident Techniques, and Analytic Induction.

<table>
<thead>
<tr>
<th>Date</th>
<th>Location</th>
<th>Purpose/Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oct. 2nd</td>
<td>KERIS</td>
<td>First meeting with school teachers</td>
</tr>
<tr>
<td>Nov. 6th</td>
<td>KERIS</td>
<td>Second meeting with school teachers</td>
</tr>
<tr>
<td>Nov. 9th</td>
<td>Apple Korea</td>
<td>Visit and Software workshop</td>
</tr>
<tr>
<td>Nov. 20th</td>
<td>S Elementary</td>
<td>School visit: Interview &amp; observation</td>
</tr>
<tr>
<td>Dec. 6th - 19th</td>
<td>S Elementary</td>
<td>5 teachers, principal, &amp; 2 students</td>
</tr>
</tbody>
</table>

4. Analyzes and Findings

4.1. Research Question 1

Research results from comparing pre- and post-test scores in order to evaluate learning achievement showed, in general, that S School experienced very positive learning enhancement after five weeks. There were highly significant differences between pre- and post-tests for the total scores of Korean Language and Social Studies in S elementary school. Post-test scores are significantly higher than pre-test scores (p<.001) as indicated in Table 4. The same pattern was evident in the comparison of pre- and post-tests for Korean language (p<.01) and Social Studies (p<.001) independently.

<table>
<thead>
<tr>
<th>Results</th>
<th>Means</th>
<th>Cases</th>
<th>SD</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-test</td>
<td>74.08</td>
<td>78</td>
<td>17.313</td>
<td>-7.352</td>
<td>.000***</td>
</tr>
<tr>
<td>Pro-test</td>
<td>81.40</td>
<td>78</td>
<td>16.885</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

There were no significant differences between females and males for pre-tests for the total scores of Korean language and Social Studies. It means both genders were identical in terms of their learning readiness before five weeks learning experiences. After the mobile laptop computer based learning activities, both genders approved significant different post-test scores from pre-test for both subject areas. Post-test scores are significantly higher than pre-test scores (p<.001).
4.2. Research Question 2

The questions measuring the level of satisfaction, self-efficacy and motivation also revealed the positive impact of Mac-integrated activities in general (a total M=3.66; satisfaction M=3.73; self-efficacy and motivation M=3.46). However, there were several items with apparently low scores as follows:

- I felt easy to understand class materials during m-learning class. (learning content satisfaction)
- The programs used in the m-learning helped me learn. (learning program satisfaction)
- I became to feel more interested in school life since the m-learning class has begun. (learning outcome satisfaction)
- It was easy to get a help when computers made troubles during the m-learning class. (computer satisfaction)
- I performed learning tasks well due to my diligence during m-learning. (confidence/locus of control)

In terms of the level of satisfaction, self-efficacy and motivation, there were no significant differences between genders; but some differences among classes (F=5.095, p<.001). Post-hoc analysis demonstrated Class 2 (Ms. Hong’s Class & Social Studies) scores were significantly higher than Class 1 (Korean Language) & Class 4 (Social Studies). There is no difference between Class 1 & Class 4.

4.3. Research Question 3

In the qualitative field study, the positive and negative factors affecting the operation and result of mobile learning activities are derived from four areas: organization, teaching, learning and technology infrastructure.

4.3.1 Organization-administration: “Open Space and Open Leadership”

- **Positive factors:** Principal’s proactive understanding and encouragement, public expression of interest; principal’s participative leadership; Teacher colleagues support and encouragement; school stakeholders’ (teachers, students, parents) interest and pride in participating in the m-learning project; and school location in areas of economic stability
- **Negative factors:** Approach of experimenting with the different student members each year

4.3.2 Teaching/teacher: “We, S School, have no classes of students who are difficult to handle at all.”

- **Positive factors:** Positive attitude of class teachers (toward m-learning and their students); class teachers’ challenge concerning new instructional methods and educational utilization of IT; class teachers’ curiosity and specialties in IT; class teachers’ fluent teaching skills; technology support teachers’ IT competencies; learning-teaching models appropriate to m-learning: self-directed, participatory, and cooperative/collaborative; subject areas suitable to m-learning activities; physical arrangement appropriate to m-learning and related learning models; selecting software responding to individual learners’ preference; and instruction process of clear learner roles
4.3.3 Learning/learners: “I think our relationship with friends is getting better since wireless laptop computers have been used in class.”

- **Positive factors:** Learners’ high motivation to m-learning; active learning attitude; high proficiency concerning m-learning; attitude to apply what has been learning within the class to outside; and high communication and time management skills
- **Negative factor:** Low competencies of using software

4.3.4 Technology infra: “Hope we have more reliable and stable IT system and IT support.”

- **Positive factors:** Stable computer system; easy access to hardware; m-technology use based on school needs, conditions and learning goals; IT training in advance to m-learning implementation; customized IT consultation during m-learning implementation; and quick repairs
- **Negative factors:** Unstable system and frequent program errors; frequent laptop software and hardware troubles and lack of in-time repairs; absence of continuous and needs-specific training on Apple computer; lack of Korean manuals; and low accessibility and compatibility (short battery duration, sharing computers with multi-classes, no wireless connection outside school)

Conclusions

The current research proved the potential power of the Mac-wireless computer integrated instruction/learning approach regardless subject, class, and gender. Furthermore, the current research enables to learn following issues for the successful use of portable technologies within elementary schools: Organizationally, the principle’s sincere interest and support and appreciation of the organization-administration, colleagues’ active concerns and support, coherent operation of classes, and students’ economic stability are very important factors.

There are various critical support factors for teachers: positive attitudes toward students and technology, posting challenges toward mobile learning and IT application, curiosity and competency concerning IT, several years of teaching, selecting of subject areas appropriate to mobile technology, classroom operation implementing instructional design considering mobile learning and technology features, and classroom settings and environment appropriate to mobile learning and technology.

In students there should exist students’ high motivation, an active attitude, and advanced skills concerning mobile learning and technology; willingness to use learned information and skills; time management skills; communication skills.

Lastly, of technology infrastructure, there are stable computer and network systems, error-free programs, easy access to hardware(computer), specialized/customized operations fitting to specific schools, selective uses of software and functions appropriate to learning goals; IT training sessions provided before actual classroom implementation, IT consulting and prompt A/S, internal competencies in fixing devices.

References


