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Developing a sustainable education innovation for seamless learning

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Abstract

Mobile computing technologies are suitable for one-to-one and seamless learning (learning anywhere and anytime). However, there has been little research on how to develop a sustainable innovation for seamless learning to transform school teaching and learning practices. We embarked on a three-year research study to fill in such a gap by doing design research in a primary school in Singapore. Our analysis showed strong school leadership and administrative supports, epistemological changes in the knowledge and beliefs of teachers and students, available curriculum materials to work with the technologies, and convincing assessments are needed to lead to sustainable innovation like ours.

Keywords: Seamless learning, mobile learning, sustainability, primary science

1. Introduction

Mobile computing technologies are becoming more and more pervasive and affordable in our daily lives (Looi, Seow, Zhang, So, & Chen, 2009). Such technologies are suitable for one-to-one and seamless learning, which enables learning anywhere and anytime (Chan et al., 2006). The premises for expanding personal, social, and technological spaces for learning include:

a. Making learning more authentic because students are able to learn on the move so that their learning can be context-based. For example, in science education, when they learn the topic of plants, they might be able to also go for a field trip to seek contextualized understanding of the habitats of plants; understanding the kinds of environment the plant thrives could lead to knowing why the plant has certain characteristics. Such learning is more engaging and motivating because students see the relevance of what they learn to their daily lives. Because of the relevance, it might be easier for students to transfer the process and skills to learning new topics.

b. Making learning more personal and meaningful because seamless learning refers to student-centered learning. With the availability of mobile technologies, students are able to collect data, analyze data, and make conclusions to answer questions of their own with evidence. Students have to think on their own, take initiatives, monitor their own progress, solving problems, and be more aware of the complexity of how their new knowledge is constructed and represented; such experience should develop their competence in self-directed learning and lifelong learning.

c. Learning by collaboration. In the information age, the division of job tasks is becoming more and more specialized. Using mobile technologies enables students to search and make judgment of information, seek help
through communicating with more knowledgeable others through emails, chatting, and other means in a timely manner; mobile technology allows students to create their own artifacts and share what they have with others easily. When learning tasks are inquiry-based and authentic, they can be complex and collaborative in nature.

We are already in the 21st century. There have been debates on what 21st century knowledge and skills are, where the balance between 21st century knowledge and skills is, and how the current social, cultural, as well political systems are ready to accommodate the needs for fostering 21st century knowledge and skills. We argue that the seamless learning innovation we are developing has the potential to foster 21st century knowledge and skills. However, there is little research on how to develop a sustainable innovation for seamless learning to transform school teaching and learning as new routines. We embarked on a three-year research study to explore how to develop a sustainable seamless (mobile) learning pedagogy in a primary school. We worked with one primary three experimental and mixed ability class (3X) since 2009 (Looi et al., 2010; Zhang, et al.,2010). With a team of five faculty researchers and an average of four full-time equivalent researchers, we have been exploring how to best integrate mobile technologies to enable students to learn not only in classroom in a planned manner but also self-directed learning in an emerging manner in both formal and informal settings to form “new habits of mind”.

We intend to provide answers to the following questions:

- What is seamless learning and why it is an innovation?
- How mobile technology enables the creation of seamless learning environment?
- What are the strategies to make the innovation to be sustainable?
- What is the effectiveness of the innovation?

Given the limited space, this paper might only provide an overview of our efforts towards the answers to the questions above without going to the details. The paper contributes to the literature by describing our efforts in designing, refining a seamless (mobile) learning innovation and some initial findings of our current analysis following a design research tradition. It also points to some directions for our further work.

2. Background

In this section we briefly review the literature related to the focus of our study in developing an education innovation for seamless learning.

2.1. Seamless (Mobile) learning

In general, researchers tend to define “formal learning” to be the learning as being “planned” and happen in “formal” settings (mainly “classroom”). The formality is indicated in national or local syllabi. In schools, there are documents to define the sequence of teaching, the assigned textbooks, student workbooks, and other curriculum materials. “Informal learning”, on the other hand, refers to learning that might be unplanned and incidental without school and teacher intervention and happens out of formal settings. On the other hand, unplanned and incidental learning can happen in formal settings, such as school, while “informal learning” may happen to be “planned” (but not by school and teacher) and “purposeful” for students. Seamless learning bridges formal and informal learning (Chan, et al., 2006; Looi, et al., 2009). We discuss “the seamlessness” of learning from the perspective of learners. When learners can bring technologies that are mobile and are able to learn beyond what their school and teachers have planned for them, which will be seamless that may or may not be in connection to their school work. In our project, we held the belief that the development of seamless learning competence and new “habits of mind” need to be purposefully designed in formal learning. Such an understanding was not only a belief change, but also based on the empirical studies that we have conducted over years. For example, our early studies started from how we could make use of the affordances of mobile technologies and how students might receive such learning opportunities. Students went to field trips with pocket PCs and other devices. The activities were adds-on to their school curriculum (Chen, Tan, Looi, Zhang, & Seow, 2008; Zhang et al., 2006).
2.2. Innovation and sustainable education change

Starting from 2008, the project team received a one million-dollar grant to continue working with school N, a neighborhood primary school in Singapore, to embark on designing an innovation for seamless learning. We call our intervention an innovation because seamless (mobile) learning was not in the school’s repertoires for teaching and learning. Considering seamless learning as an innovation is aligned with the definition of Rogers’ in terms of being a practice that is perceived as new by educators of adoption (Rogers, 1983). Furthermore, we did not simply plan to introduce a mobile device for students to use, we came in to explore how we might promote systematic change in developing a mobile technology integrated curriculum, preparing teachers to be able to teach the curriculum, using multiple assessment to facilitate student learning and convincing stake holders that seamless learning is a worthwhile learning model. We hope the innovation to be “sustainable” so that even when researchers withdraw from the school and teachers were still able to continue the seamless learning practice (Sabelli & Dede, n.a.).

3. The development of the innovation

3.1. Methods

For such a school-based research project for sustainable education change, we had to take a holistic and systematic approach. We followed a design research tradition (Brown, 1992; Collective, 2003) when developing our innovation. We acknowledge that the innovation requires iterative and continuous evolvement. As mentioned before, our collaboration with the school in fact started from 2006. Below we provide an overview of our three-year journey. There was one principal investigator and four co-principal investigators who have been spending part-time on the project. Two full-time researchers ran the day to day operation since the beginning of the project. They coordinate the curriculum development, professional development (PD), and serve as on-site supporters and field researchers. They spent most of their time in the school except for time to have weekly whole team and sub-group (there is a “formal” sub-group and an “informal” sub-group) meetings in our institute. The school suggested that we worked with primary three sciences (3 periods per week) because primary science syllabus was recently revised and the school also need help to develop resources for teaching the subject. The innovation fits well the needs for student-centered and inquiry-based learning. From Table 1 we can see that the collaboration was intensive and demanding for both the teacher and researchers. The teacher had to teach all subjects and she was not trained in teaching primary science. Researchers and teachers co-designed the “mobilized” curriculum, which was also considered as part of teacher PD for sustainability.

Table 1. Brief description of project major progress for the “formal” sub-group

<table>
<thead>
<tr>
<th>Year</th>
<th>Major Research Activities</th>
<th>Remarks</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>Recruit researchers; Select teachers; Understand the setting; Designing and implementing pilot lessons; Teacher PD; Curriculum development in primary three (P3) science and research design</td>
<td>2 full-time researchers</td>
</tr>
<tr>
<td>2</td>
<td>1st year of one Primary three class 3X; Curriculum development, PD, enactment of developed P4 curriculum materials; collect data and formative assessment to inform design and PD</td>
<td>3 full-time researchers</td>
</tr>
<tr>
<td>3</td>
<td>2nd year, 4X; added 4Y as an experimental class and 2 control classes; continued curriculum development, teacher PD, curriculum enactment, data collection and analysis; more publications</td>
<td>3 full-time researchers and a part-time HoD science</td>
</tr>
</tbody>
</table>
3.1.1. Context and participants

The school we collaborate with has strong commitment in translating theories into practices; it has set up a first school-based research center to collaborate with outside researchers. The experimental class 3X was a mixed ability class with 39 students. The teacher Jean had taught in the school as her first teaching position for more than three years. Each student in 3X was given a smart phone with unlimited Internet access, data plan and some educational software tools. The class has just finished their second year with us as class 4X. Fig. 1 shows a simplified “school administrative structure. The arrows indicate the interaction and “power” strength in the “hierarchy”. The dotted arrow means less “power” or priority. For example, we could see that principal and Vice-Principal (VP) would have more decision power than a Head of Department (HoD) ICT (ICT stands for Information and Communication Technology). The Researchers could influence the teacher at “equal” status because the teacher enacted the co-designed curriculum. Although researchers had opportunities talked to the principal and VP, our collaboration had to ensure school’s priority in teaching and satisfy parents, and the like. It should also be noted that we had international collaborators and they have been able to influence both school and teachers, and researchers by visiting the school and providing interaction and professional development sessions.

3.1.2. Data and analysis

We audio taped and/or videotaped our weekly teacher-researcher meetings when we were discussing ideas about seamless learning, and co-designed a “mobilized” science curriculum that ran for two years. Data on class videos of most science classes, debriefing sessions with the teacher Jean, student artifacts, and minutes of researcher weekly meetings, student surveys, focus group interviews, and other related documents comprised our data collection. The current data has accumulated to be two terabytes. The data analysis is still on-going. Since we had both quantities and qualitative data and the field researchers were interested in ethnographic study, our data allowed us to reflect many aspects of our design and the effectiveness of our design. In the next section, we will illustrate how we have addressed some of the major aspects of our design process of the innovation with either conference or journal papers as further references.

3.2. Systematic consideration for promoting sustainable changes

According to the school-based research experience of the PI and co-PIs, we proposed our research design based on the assumption that we had to develop school infrastructure, human capacity, as well as promoting knowledge and beliefs change as indicated in Figure 2. We elaborate some of the consideration and empirical experience in the different aspects in turn. The two direction arrow demonstrates the evolving and interactive nature of the design.
process. For example, when we took student artifacts as formative assessment, we address student learning difficulties in both our curriculum design and teacher professional development. We put the squares in dashed line for “informal learning” because we report mainly the “formal learning” part of the project. Mobile technology became an integral part of our curriculum design, assessment, and teacher PD.

![Diagram of formal, informal, and seamless learning](image)

**Figure 2. How to “engineer” seamless learning spaces**

3.2.1. “Mobilized” curriculum development

The most intensive and challenging part of the project in regard to serving the school needs was curriculum development. Conventional teaching materials may not prepare students to learn the inquiry way and to become self-directed and social learners who could learn seamlessly using mobile technologies. It is a process of transformation when we integrate the affordances of mobile technologies into the P3 and P4 science curriculum hoping to foster new teaching and learning routine. The design guidelines, co-design process and some changes in students and teachers were reported in a journal paper from our first year’s work (Zhang et al., 2010).

3.2.2. Multiple assessment strategies

As mentioned above, we had multiple data sources to assess the effectiveness of our design as well as student learning. The process data include classroom videos, student artifacts, their worksheets, assignment submitted to an online learning manage system, and log files of student smart phone use (Boticki & So, 2010). The outcome data include student semester examinations, pre- and post-tests of some topics, interviews, and surveys such as measurement of their self-directed learning and epistemology of science and science learning. Our first year results show that among the six mixed-ability classes in primary (Grade) 3 in the school, the experimental class performed better than other classes as measured by traditional assessments in the science subject. With mobilized lessons, students were found to learn science in personal, deep, and engaging ways as well as developed positive attitudes towards mobile learning (Looi, et al., 2010). Further analysis of the results from P4 is still on-going.

3.2.3. Intensive and just-in-time teacher professional development

We had audio taped and/or videotaped all sessions of teacher-researcher meetings. Teacher professional development has been on-going on daily base because the teacher could come to talk to the two researchers almost every day. The two researchers have been based on the school to be involved in almost every aspects of teaching primary three and four science. It is evident that the teacher has transformed her knowledge, beliefs, and practices to be aligned with seamless learning pedagogy (Looi, et al., 2010; Zhang, et al., 2010).
3.2.4. Technology development

Our methods are aligned with design research tradition; we found it necessary to capture some “process” data about how students used the smart phone as the “hub” of their seamless learning. Therefore, in order to capture the evidence of the ways students utilize mobile devices in their formal and informal learning pursuits, a quiet data capture program was designed and pilot-tested. It is used to capture both quantitative and qualitative data about device use, to track user generated data and artefacts persistent across time and to generate and render aggregated reports identifying usage patterns. It is supposed to serve as a mechanism of identifying affordances of mobile devices within the landscape of seamless learning. Some preliminary findings led to further questions and sharpened our research lenses in designing the innovation for education change (Boticki & So, 2010).

Furthermore, our overall analysis also shows that strong school administrative support, epistemological changes in teacher and student knowledge and beliefs, available curriculum materials to work with the technologies, and convincing assessments are all necessary to lead to sustainable innovation like ours.

4. Discussion and implications

We have described briefly the different aspects of our project that concerns the development of an innovation for seamless learning to promote education change in a Singapore school. The innovation is not simply to introduce mobile technology to students and teachers. The innovation includes a package of designed curriculum materials, assessment instruments, teacher professional development plan, suite of software tools, school administrative and technology infrastructure, and ways to promote the desired education change. Our further work includes an analysis of how the innovation has been substantiated with taking into account of subject characteristics; detailed analysis about how we have addressed teacher capacity building, and environmental, cultural, institutional, technical, and other educational challenges. Based on our current work, we will explore how to sustain and scale up our seamless innovation.

In summary, we have provided an overview of how we have been developing the innovation. It is our intention to make the innovation sustainable with systematic consideration of how a school system might adopt the innovation. Our future direction of research will lead us to further scale-up of the innovation to all classes within one level, to more teachers and more levels of classes. (*The authors thank Mr. Peter Seow for his comments and feedback)

References


Sabelli, N., & Dede, C. (n.a.). Reconceptualizing the goals and process of educational research funding: Interconnecting scholarship and practice.