ICCE 2011

The 19th International Conference on Computers in Education

28 November - 2 December • Chiang Mai, Thailand

# Workshop Proceedings: Supplimentary Proceedings of the 19th International Conference on Computers in Education: ICCE 2011


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APSCE

NECTEC

a member of NSTDA

TCU

THAILAND CYBER UNIVERSITY

MAEJO UNIVERSITY

# Chapter 6

## Technology-Transformed Learning: Going Beyond the One-to-One Model?

# Preface

The advancement of personal computing devices, from personal computers to mobile devices, has been gradually changing the landscape of the technology-transformed learning. This facilitates the incorporation of one-to-one computing into education and opens up endless possibilities of the design and enactment of innovative teaching and learning models (or the enhancement of pre-existing models), such as perpetual and ubiquitous learning, personalized learning, authentic and contextualized learning, seamless learning, digital classroom, rapid knowledge co-construction, among others. This leads to the further empowerment of the learners in deciding what, where, when, and how they would learn, and whom they would learn with/from. After the initial hype, however, there have been voices within the researcher community to reassess the notion of one-to-one computing in classroom and informal learning, such as whether and how one-to-one settings may impact peer collaboration and teachers' roles, the issues of student, teacher, school and social readiness, as well as the explorations of alternative or hybrid settings of many-to-one, one-to-many, many-to-many, and one-to-one configurations.

This workshop deals with the fundamental concerns and challenges in adopting one-to-one computing in either or both classroom and informal learning settings. The collection of paper will serve as an international forum for researchers and practitioners to exchange their thoughts and contributions and set future directions in one-to-one technology-transformed learning.

Organizers
Lung-Hsiang Wong, *National Institute of Education, Singapore*
Hiroaki Ogata, *University of Tokushima, Japan*

Mohd Ayub A. F. et al. (Eds.) (2011). Workshop Proceedings of the 19th International Conference on Computers in Education. ChiangMai, Thailand: Asia-Pacific Society for Computers in Education.

# Effects of Video Caption Modes on English Listening Comprehension and Vocabulary Acquisitions Using Handheld Devices

**Ching-Kun Hsu[a], Gwo-Jen Hwang[b], Yu-Tzu Chang[a], Chih-Kai Chang[a]**
[a]*Department of Information and Learning Technology, National University of Tainan, Taiwan*
[b]*Graduate Institute of Digital Learning and Education, National Taiwan University of Science and Technology, Taiwan*
gjhwang.academic@gmail.com

**Abstract:** This study used different display modes of video captions in mobile devices, including non-caption, full-caption, and target-words, for English comprehension and vocabulary acquisition of fifth graders. During the one-month experiment, the students' English listening comprehension and vocabulary acquisition status was evaluated per week. From the experimental results, it was found that the English target-word group had as satisfactory learning achievement as the full-caption group in terms of vocabulary acquisition, and both groups outperformed the non-caption group. Moreover, the visual style students in the English target-word group and full-caption group had better learning effectiveness in terms of vocabulary acquisition than those in the non-caption group. Furthermore, in terms of listening comprehension, the students in the three groups all made remarkable progress without significant difference.

**Keywords:** listening comprehension, vocabulary acquisition, captions, learning styles

## 1. Background and Objectives

English has been recognized as being an important international language for decades. Many non-native English countries have developed and utilized various computer systems to support those English as Foreign Language (EFL) learners. Most non-native English countries intend to have their people learn English as early as possible; therefore, the Ministry of Education in Taiwan extended regular English instruction down to the third grader in the elementary school. In the next decade, regular English instruction is considered to be extended down to the first grader in the elementary school. The policies of government in the nations whose mother tongue is not English, such as Taiwan and Korea show the importance of English instruction. Foreign language learning is often categorized into four parts which are listening, speaking, reading, and writing. Listening is an initial important aspect in social interaction to receive message or information from outside. Accordingly, Ministry of Education in Taiwan indicated that elementary schools should put emphasis on English listening first, and then reading or writing. Moreover, most of the English certifications today includes the listening proficiency examine. Due to these requirements and reasons, this study applied mobile and multimedia technologies to the learning activities of English listening for elementary school students. It is expected that such an approach can enrich the daily life input stimulus of listening opportunities in the non-English countries and environment as Taiwan.

With the advance of mobile technologies and multimedia, the instructional materials which can be used for English listening training are not restricted in school and presented in diverse forms. For example, many people have the habit of bringing an MP3 player so that they can learn via listening at anywhere. As for seeing videos, they can both have visual and aural input, such as YouTube videos and TED talks. Owing to the popular of mobile devices and the wireless network such as Wi-Fi and Wi-Max, it is convenient for most of students to do individual and independent learning by means of mobility aids. Therefore, it can be foreseen that students will eventually be equipped with a mobile device installed with proper leaning tools, systems, or materials so that they can have their own learning progress, and may set the difficulty degree of their learning content to meet their proficiency. Previous studies have shown that videos embedded with captions are helpful for students to learning second language reading [2] and listening [6]. Hsu and Chang (2010) have further reported that hiding part of the easier foreign vocabularies and showing only the more difficult words in the captions can contribute to undergraduates' listening comprehension [14]. Those selected vocabularies are presented when the students press the "pause" button of the video player during the process of listening to the foreign language courses; on the other hand, full captions are provided when the videos are played.

Accordingly, this study tries to provide different display modes of captions in the mobile devices for students to learn English via listening. A video without any caption of English and Chinese subtitle is used for the students in the control group one because previous studies indicated that no caption or subtitle help student get adaptive to various pronunciation appearances, such as reduced forms, assimilation, elision, and resyllabification [26]. On the other hand, a video with full English captions and Chinese subtitles of target vocabulary is used for the students in the control group two because a previous study showed such setting is helpful to training listening proficiency and comprehension, and confirmed that full Chinese subtitle is not needed [14]. Another video with both English caption of target vocabulary and Chinese subtitle of target vocabulary is used for the students in the experimental group.

The study aims at exploring whether different display modes of caption and subtitle result in different effectiveness on listening comprehension and vocabulary acquisition of elementary school students. Moreover, this study also investigates the learning performance of different learning style students in learning with different caption modes. The learning performance will be assessed by a test including listening comprehension and vocabulary acquisition examination in each week.

## 2. Related Literature

*Subtitles* are the on-screen text in the students' native language combined with a second language soundtrack in the video. *Captions* are the on-screen text in a given language combined with a soundtrack in the same language [21]. In this study, subtitles refer to the on-screen Chinese text combined with an English soundtrack, and captions refer to the on-screen English text combined with an English soundtrack. In addition, *bilingual subtitling* refers to the on-screen texts in both students' native and target languages combined with the target language soundtrack [15]. For example, in this study, *bilingual subtitling* refers to the English audio with simultaneous appearance of English and Chinese texts on the screen. These clear definitions of terms are helpful in the following description of the study instrument. The definition of *target-word* in the study refers to the new or key vocabulary which the learners need to know well in the new lesson or unit of the listening instructional material or video.

### *2.1 Caption and English Listening Comprehension*

Krashen (1985) indicated that students need to receive a great quantity of comprehensible input so as to achieve the objective of language learning when they learn foreign or second language [19][20]. When students watch videos with foreign language, the contribution of comprehending and connecting foreign learning and its meaning is limited while students cannot understand what they heard at all. Therefore, using caption and subtitle to assist listening comprehension is helpful for learners to reserve more effectiveness after learning. Scholars confirmed that combining captions with audio-visual materials is an effective instructional method to enhance listening and reading comprehension of second language [1][6]. Captions visualize the information of foreign language which learners heard in the video [6]. Videos with captions facilitate listening comprehension [5][21]. On the contrary, another scholar stated that providing native subtitle for learners will obstruct their listening familiarity of pronunciations [26]. Therefore, the study designed control group one as a both non-caption and non-subtitle group, and control group two as the full caption and target-word subtitle group while the study design the experimental group as the target-word caption and target-word subtitle group. The study observed the effects of different display modes of caption and subtitle on listening comprehension and vocabulary acquisition of elementary school students.

### *2.2 Learning style*

Learning style refers to individual preference way of learning, which affects how individuals accept stimulus, memories, thinking, and problem-solving. There are many different scholars proposing diverse categories of learning styles [7][9][10][11][13][16][17][18][22][24][25]. If teachers realize the difference of learning styles among learners and design appropriate instructional methods or media, learners will possibly be benefited.

This study utilized the scales of learning style proposed by Felder and Soloman (1991) who developed the Index of Learning Style (i.e., ILS) based on Felder and Silverman (1988) [7][8]. The ILS consists of 4 dimensions (i.e., active/reflective, sensing/intuitive, visual/verbal and sequential/global), each of which has 11 items. This study employed the visual/verbal dimension to evaluate the learning styles of the participants since this dimension is highly relevant to the use of videos in training the listening competence or vocabulary acquisition of foreign language.

## 3. Method

### *3.1.Participants*

The experiments were conducted in an elementary school in an Asia country. The people there learn English as foreign language. There were nine classes of fifth graders in the elementary school. The fifth graders consisting of 11-year old students on average in the school were divided into three levels, A, B, and C, based on their English proficiency in the school. There were three classes in each level. The study selected the three classes which were the same level and are all the lowest level C among the nine classes. Therefore, totally eighty-one low-achievement fifth graders in English participated in the learning activity. The number of the students in the three classes was 26, 27, and 28 respectively. The study did not adjust the original number of students in each class. One class in which there are 27 students, including 16 males and 11 females, is called the control group one, one class in which there are 28 students, including 12 males and 16 females, is named the experimental group one, and the last one class in which there are 26 students, including 15 males and 11 females, is called the experimental group two. Each group had different treatments which will be explained in the following section.

*3.2. Research design*

The participants used PDA to play the instructional video related to the lesson they study each week. Each student was equipped with one PDA. After watching the video, the students immediately took a test for evaluating their listening comprehension proficiency and vocabulary acquisition. The experiment was conducted for a month as shown in Figure 1.

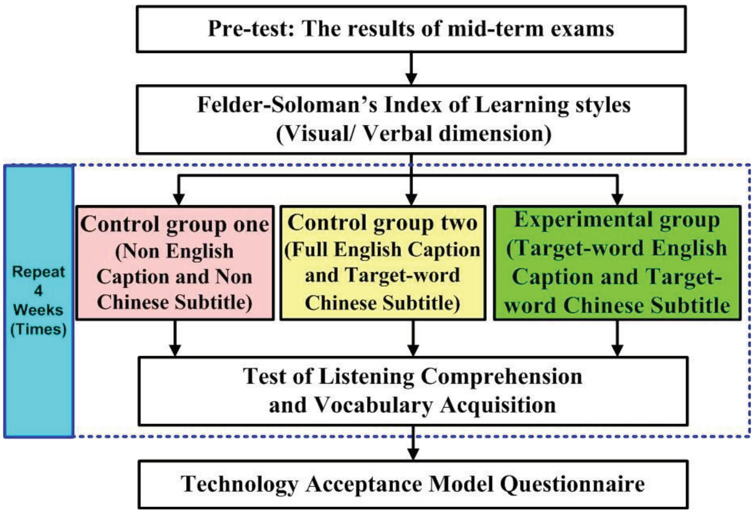

Figure 1. Experimental procedure

The videos for the three groups had the same content with different caption modes. No caption was provided for control group one, while full English caption and Chinese target words were provided to control group two, and English and Chinese target words were provided to the experimental group. Figure 2 shows an example of the caption modes for control group two (left) and the experimental group (right).

Figure 2. The playing interfaces of control group two (left) and the experimental group (right)

Researchers have indicated that, for the students to get used to the tempo of usual conversation, there is no need to provide the fast forward or slow play function; instead, the function of play, pause, and replay is necessary for listening training [12]. In order to meet the practice of mobile assisted listening training, students in each group can use a stylus to operate the function of play, pause, and replay to listen in the limited time.

### *3.3. Research tool*

The measuring tool of learning styles used in this study is the visual/verbal dimension of Felder-Soloman's Index of Learning styles [8].The visual/verbal dimension contains 11 items to evaluate the learning styles of the students. Its Cronbach's alpha value is 0.76.

As for the test items in each week, all the questions and items are verified by two English teachers so as to have similar difficulty degree. Each test of listening comprehension has five multiple-choice questions broadcasted from audio. The students are asked to listen to the questions and fill out the answers in the answer sheet. In addition, there are five multiple-chose questions for testing their vocabularies learned in the lesson. Both the perfect scores of the listening comprehension test and the vocabulary test are 100.

## 4. Results and Discussions

### *4.1. Analysis of pre-test and post-test*

The study used the mid-term test conducted one week before the experiment as the pre-test, which was used to evaluate the students' listening comprehension and vocabulary proficiency. The ANOVA analysis results of the pre-test among the three groups are not significant difference (p=0.94 >.05); that is, the three groups of the students had equivalent prior knowledge before the learning activity.

After using mobile devices with the three different caption modes to learn, the students in the three groups all made remarkable progress in comparison with their pre-test results during one month. Figure 3 shows the students' progress in listening comprehension and vocabulary acquisition. It was found that both experimental group and control group two had significantly better learning effectiveness than control group one, especially after the third week; moreover, experimental group had similar learning effectiveness in comparison with control group two.

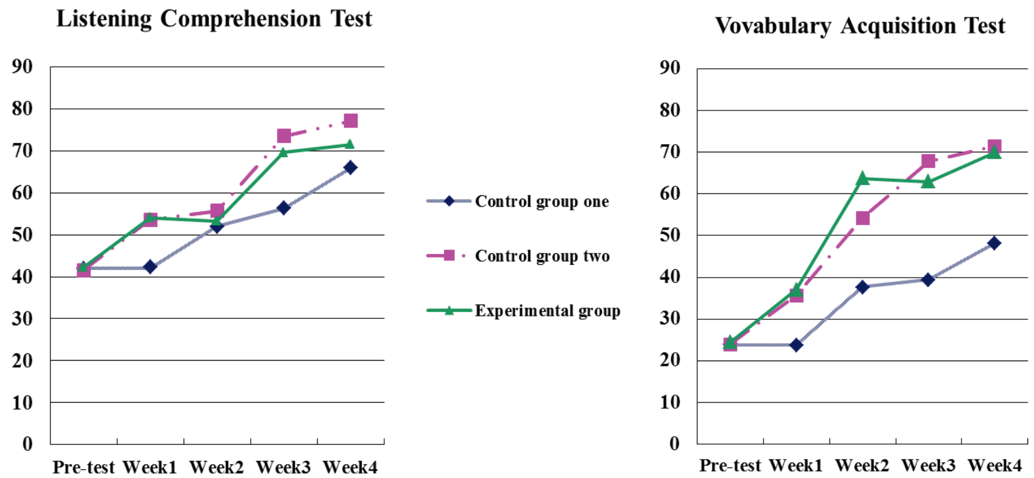


Figure 3. The improvement progress of listening comprehension (left) and vocabulary acquisition (right)

By employing ANCOVA on the post-test scores of the three groups no significant difference was found between the listening comprehension scores of the three groups. On the other hand, the ANCOVA analysis on vocabulary acquisition showed significant differences between the experimental group and the control group one as well as the two control groups, as shown in Table 1. That is, the students who watched to the videos with captions (no matter Full English caption or only English target words with Chinese target words) revealed significantly better learning achievements in English vocabularies than those who learned without captions.

Table 1. ANCOVA analysis results of vocabulary acquisition tests

| Group | N | Mean | SD | Adjusted Mean | F | Pairwise comparisons |
|---|---|---|---|---|---|---|
| Control group one (a) | 27 | 48.15 | 24.34 | 51.10 | 3.71* | (b)> (a)* (c)> (a)* |
| Control group two (b) | 28 | 71.43 | 26.35 | 68.81 | | |
| Experimental group (c) | 26 | 70.00 | 33.11 | 67.17 | | |

*p<.05

### *4.2. Analysis of learning style*

This study further compared the learning achievement of the verbal style and visual style students in the three groups. In terms of listening comprehension, no significant difference was found. Therefore, the listening comprehension of the students in the target-word group had similar performance with the listening comprehension of the students in the full-caption group. As a result, it is no need to provide full-caption for the purpose of training students to have more opportunities of practicing various pronunciation appearances, such as reduced forms, assimilation, elision, and resyllabification. Because the listening materials of the elementary school students is relatively easier, such pronunciation attributes were rare happened in the video used in the study, resulting unremarkable difference influence between the full-caption group and the target-word group on the effectiveness .

As for vocabulary acquisition for visual style students, a significant difference was found between the experimental group and control group one, and between the control group two and control group one, as shown in Table 2. On the other hand, no significant difference was found between the three groups of verbal style students. Therefore, the students with visual learning style in the target-word group performed as good as the students with visual learning style in full-caption group in the vocabulary acquisition, and both the target-word group and full-caption group outperform the non-caption group. As a result, for visual style students, it is suggested to provide both English and Chinese target words to them; in particular, for those low-achievement students.

Table 2. ANCOVA analysis of vocabulary acquisition of different learning style students

| Learning style | Group | N | Mean | SD | Adjusted Mean | F | Pairwise comparisons |
|---|---|---|---|---|---|---|---|
| Verbal (L) | Control group one(L1) | 8 | 50.00 | 26.19 | 50.17 | 0.89 | |
| | Control group two(L2) | 9 | 73.33 | 33.17 | 68.64 | | |
| | Experimental group(L3) | 9 | 62.22 | 38.01 | 66.39 | | |
| Visual (V) | Control group one(V1) | 19 | 47.37 | 24.23 | 51.55 | 3.23* | (V1)<(V3)* (V1)<(V2)* |
| | Control group two(V2) | 19 | 70.53 | 23.45 | 68.71 | | |
| | Experimental group(V3) | 17 | 74.12 | 30.63 | 70.30 | | |

*p<.05

## 5. Discussions and Conclusions

This study found that the target-word strategies have better effects on vocabulary acquisition rather than on listening comprehension for low-achievement elementary school students. As those low-achievement elementary school students in non-English speaking countries do not know enough English words, they especially need the assistance of the target words when watching the videos for vocabulary acquisition. On the other hand, the results concerning listening comprehension are different from those of previous study carried out in the universities since undergraduates have learned the frequently-used 2200 English vocabularies while elementary school students have only learned few of the words; therefore, the undergraduates benefited (Hsu, & Chang, 2010). Therefore, this study suggests that the partial hidden mechanisms of captions can be used in an adaptive way that presents the selected vocabularies with different difficulty degrees based on the learning level of the students.

Furthermore, in terms of English vocabulary acquisition for visual style students, it was found that the students in the full caption and the target-word groups had significantly better learning achievement than those in the non-caption group one, while no significant difference was found between the three groups of verbal style students. Therefore, it is suggested that, for visual style students with low learning achievement, the provision of both English and Chinese target words are needed.

From the interview results, we have several interesting findings. For example, the students in the control group two (the full English caption group) indicated that it was not necessary to provide full English captions to them; moreover, they stated that showing full captions interfere with their listening to the learning materials. They believed that providing only target words were sufficient to assist them in improving listening comprehension, which conforms to the results of the perception investigation toward using the system in learning English listening. In addition, some students said that they would like to learn from watching videos and playing computer games related to the topics of their textbooks.

In the future, we plan to conduct more experiments from three perspectives. The first is the longer broadcasting time of videos and not limited to use in the classroom. The present study only applied short-term videos in an elementary school. It is suitable to elementary school students with low learning achievement, but may not be appropriate to advanced learners. Therefore, secondly, the study suggests future researchers can set and show the target words and hide the other words in the caption of different video length for the learners in different ages. Thirdly, English listening proficiency needs learners to spend more time on exercising and training so as to make remarkable progress easier. Therefore, in the future, we plan to extend the experiment in a seamless learning environment to accelerate the listening proficiency of learners. It is inferred that the extended time of self-learning may have contributions to listening proficiency.

## Acknowledgement

This study is supported in part by the National Science Council of the Republic of China under contract numbers: NSC 99-2511-S-011-011-MY3 and NSC 99-2631-S-011-002.

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Mohd Ayub A. F. et al. (Eds.) (2011). Workshop Proceedings of the 19th International Conference on Computers in Education. ChiangMai, Thailand: Asia-Pacific Society for Computers in Education.

# Teacher Attitude and Preparation for Technology Innovation: A Case Study of 1:1 Laptop Initiative

**Ding Jie[a], Yu Shengquan[b]**
[a b]*Beijing Normal University*
[a] arbingee@gmail.com,
[b] toyusq@gmail.com

**Abstract:** The success of one-to-one laptop learning initiative in a school largely depends on support and acceptance by teachers. Teacher's technological skills also play an important role in the implementation of one-to-one laptop learning initiative. This research, conducted in a middle school located in Beijing, China, investigated teacher attitude and technology preparation for the upcoming one-to-one laptop learning initiative. Research data were collected by interviews and surveys during the training before the commencement of the initiative. According to the data, most teachers acknowledged the effectiveness of laptop to teaching and learning, and showed great enthusiasm toward the technology innovation. Meanwhile, some doubts were expressed toward new pedagogy and class management strategies. And there existed attitude difference between different subject teachers. Based on the surveys, most teachers were familiar with only one specific operating system and can use PC proficiently. The findings of this research provide valuable planning framework and suggestions for the schools and educators that want to launch one-to-one laptop learning initiative.
**Keywords:** Teacher Attitude, Technology Innovation, One-to-one Laptop Initiatives, Classroom teaching

## 1. Introduction

Due to the development and diffusion of information and communication technologies, we have witnessed the greatest change in the domain of education. Ubiquitous computing and mobile technology make it possible that every student can have one laptop for his/her own use with 24-7 internet access. Not surprisingly, over the last ten years the emergence of one-to-one programs has grown increasingly in popularity. More and more schools around the worlds are implementing one-to-one programs as a means for increasing student achievement and performance. There is no doubt that one-to-one laptop initiatives have the potential to significantly impact education, especially classroom instruction. More importantly, we have to confront another question: are teachers prepared for the upcoming changes and able to handle all the technological challenges. From traditional teacher-lecturing-and-student-listening classroom to laptop and Internet supported learning environment, teaching styles are changing. Concerns of change by a teacher will definitely influence the integrating use of technology into the classroom.

## 2. Factors influencing 1:1 laptop learning initiative

Based on Ely's research on technology integration and a review of existing literature, he proposed eight conditions that facilitate the implementation of educational technology innovations: dissatisfaction with the status quo, knowledge and skills, adequate resources, time, rewards or incentives, participation, commitment, and leadership (Ely, 1990, 1999). These conditions can greatly influence the effect of technology innovation and even decide whether the innovation is likely to succeed or not based on the number of conditions present. We know from prior research on innovation adoption that successful implementation is deeply rooted in an understanding of the concerns of the individuals delivering the innovation (Hall&Hord, 2001). Obstacles to change such as inadequate educational resources, not enough training time, and lack of leadership support have been excuses for not implementing new technology in schools.

When it comes to 1:1 laptop initiatives, many researches showed wide range of factors that can affect the success of this type of technology innovation. Those factors include both school- and teacher level ones, such as professional development, availability of resources and technical support, teacher readiness to integrate technology, and teacher beliefs and attitudes (Inan, Lowther, 2010).

## 3. Conceptual framework

All teachers cannot be expected to be excited about laptop initiatives. Although some teachers might be enthusiastic about the creative use of laptop in teaching, others might be reluctant because they might not have the confidence in using the laptop in classroom teaching. The Technological Pedagogical Content Knowledge approach proposed by Misha and Koehler (2003a, 2003b) showed that teachers connect technology with content and knowledge. The Figure 1 demonstrates the complex knowledge system that teachers have to possess for the successful technology integration.

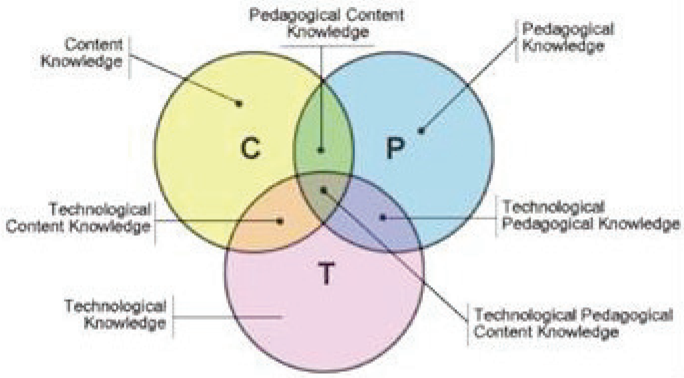


Figure 1. TPCK (Mishra & Koehler, 2003a, 2003b).

According to TPCK, it is very important to provide teachers who will participate in the technology innovation programs with exposure to educational technology professional development and require them to attend sessions. Sufficient pre-program preparations for teachers' confidence and self-efficacy with technology can greatly affect the result of technology programs in school. Getting teachers started in their use of technology and establishing an expectation of applying integration strategies may be all that most teachers need (Yost, 2007). However, teacher competency in using specific hardware and software used to be the focus of former educational technology professional development. More and more researches supported the professional models that can expand teachers' knowledge, skill and confidence in integrating use of technology in their classroom teaching activities (Borthwick & Pierson, 2008).

Hence, we think effective training and appropriate professional development are the important factors to promote teachers' attitude and preparation, which meanwhile can be the crucial factor to the success of technology innovation in schools. The following research will carry on under that conceptual framework (shown in figure 2).

Figure 2. The research conceptual framework

## 4. Method

### *4.1 Participants*

The participants are 18 teachers from The High School Affiliated to Renmin University of China (abbreviated to RDFZ) Xishan School in Beijing, China. RDFZ Xishan School is a public middle school with many educational reform thoughts. The one-to-one laptop initiative was enthusiastically propelled by the school leaders. The initial implementation planned to begin at September, 2010 including 70 students at the 7th grade and 18 teachers of several subjects, such as Chinese language, mathematics, English, history, biology, art, geography, psychology. A two-day training was carried out by the researchers in the school with specifically designed courses. All the program teachers participated in the training in August, 2010. All the teachers can PC for daily work, but none of them had experience of teaching in 1:1 laptop classroom. The laptop for the program is Apple MacBook, which was completely unfamiliar to all the teachers. 2 of the teachers had taken a laptop computer skill training from the technology company 4 months before the pre-program training.

### *4.2 Data collection*

A mixed method was applied to collect teachers' attitude and concerns of 1:1 laptop initiatives. The researcher interviewed 5 teachers during the break time of the training, including one teacher who had taken new laptop technology training before. A questionnaire was designed based on the result of teacher interviews. Five teachers took the interview during the training while the survey was conducted at the end of the training for all the program teachers.
The interview outline was composed of following questions:

- How do you think about the technology innovation in the school?
- How would you expect the integrating use of laptop will influence your pedagogy?
- Do you have any ideas of how to implement laptop integrating use in classroom?
- What is your biggest concern of the 1:1 laptop initiative in the school?
- How do you think of your laptop computer skills? Can you use laptop expertly?
- Are you familiar with the new type of laptop and new software?
- Are you comfort with the scenarios of one student with one laptop?
- Do you think you are technically ready for the 1:1 laptop initiative?

During the interview session, teachers responded to these open-ended questions. Teachers' responses were written down by the researchers.The questionnaire includes 16 items about teachers' attitude toward the effect of laptop using in the classroom teaching.

## 5. Results

After reading and analyzing interview transcriptions, data analyses resulted in the following themes: great enthusiasm of the forthcoming program, excitement of the new pedagogy, concern about the classroom management, anxiety of different laptop computer.

The interview was conducted after the first day training lectures. The training lectures were about digital instructional design and new teaching models for 1:1 laptop class. Teachers were very excited about the new program. Some of the teachers described the laptop use could become an opportunity for fulfilling their 21st century education ideal. Some teachers talked about using laptop to foster students' 21st century skills, showing great active, embracing attitude about technology innovation. Several teachers however were more conservative about the laptop use in classroom. These teachers would like to stick to their conventional teaching method. They admitted the advantages of laptop for students, but they were very uncertain about the new pedagogy for 1:1 laptop classroom. Almost 5 teachers, including the one had learned how to use Apple MacBook laptop said they were very unfamiliar with the new laptop. One teacher even insisted that school should use PC instead of Mac. All the interviewed teachers said they would feel very confident about their computer skills if the program laptop were PC.

14 items of the questionnaire use 4-range answers to show teachers' attitude of laptop use in class. The results are shown in table 1. According to the results, all the 18 teachers confirmed the positive influence of laptop use on 5 items, which are: effect of teaching and learning, teaching efficiency, students' learning motivation, involvement in learning, and knowledge extent. This result showed all program teachers' great optimism and confidence of the laptop initiative.

The other positive influence teachers would like see are test scores, communications between students and teachers in classroom, understand of learning content. The percentage of teachers to support these influence is 92.8%. And 71.4% teachers thought positively about the knowledge sustain by laptop use in class.

Among the negative influences, the most concerned issue is teachers' workload. 64.3% teachers thought laptop will increase their workload. Teachers said that they would spend more time on instructional design, preparing the learning resources. But there are still 21.4% of teachers thought laptop can make their teaching much easier because of the teaching assisted software. We can see that technology competence is the factor that effect teachers' attitude.

Another issue teachers are worried about is students' attention. 14.3% teachers thought laptop would become a distraction in class. But 85.7% teachers thought they can use more interesting learning tasks and classroom management strategies to "draw back" students from non-learning related activities.

| Items | Increase | Decrease | No Influence | Uncertain |
|---|---|---|---|---|
| *Effect of classroom teaching & learning | 100% | 0 | 0 | 0 |

| | | | | |
|---|---|---|---|---|
| Students' standardized test score | 92.8% | 7.2% | 0 | 0 |
| Teachers workload | 64.3% | 21.4% | 7.1% | 7.1% |
| *Teaching efficiency | 100% | 0 | 0 | 0 |
| Teaching pace | 64.3% | 0 | 28.6% | 7.1% |
| Communication between teacher &students | 92.8% | 7.2% | 0 | 0 |
| *Students' learning motivation | 100% | 0 | 0 | 0 |
| Students' attention | 85.7% | 14.3% | 0 | 0 |
| Students' understanding of the learning content | 92.8% | 0 | 7.2% | 0 |
| Students' knowledge sustain | 71.4% | 0 | 28.6% | 0 |
| *Students' involvement in learning | 100% | 0 | 0 | 0 |
| *Broadening knowledge extent | 100% | 0 | 0 | 0 |
| Students' enrollment rate to high school | 71.5% | 7.2% | 7.2% | 14.1% |

Table 1. teachers' attitude of laptop use in class

Generally speaking, program teachers from RDFZ, Xishan School hold a very positive attitude toward the up-coming 1:1 laptop initiative. Besides of support of school leaders, the pre-program training would be thought as another essential reason. After the interview, the researchers adjusted the form of training. Simulating-classroom teaching workshop took place the original lectures. Teachers were asked to practice what they have learned in the previous lectures. Digital instructional design and new teaching models were the focus of all program teachers. They implemented the new design methods and teaching models during the workshop session, and discussed the effectiveness of the instructional design and teaching models. The adjustment of the training course was friendly accepted and thought highly helpful by all the program teachers.

Chart 1 shows that teachers of different subjects use laptop in their teaching with different frequencies. Only 28.6% teachers thought laptop use is very frequent for the subjects they teach. While there are still 28.5% teachers who thought other teachers of the subject rarely use laptop in class. 35.7% teachers think laptop use is an occasional activity for their subject teaching. The explanation for this result could be the features of different subjects will be taken into great consideration when it comes to laptop use in class.

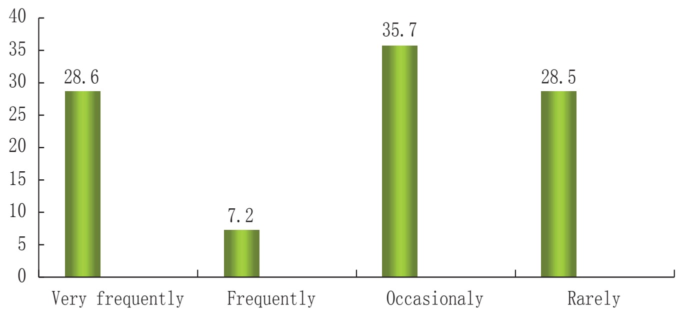


Chart 1. Teacher perception of the laptop integrating use in the subject teaching

According to the survey result (shown in chart 2), teachers planned to use laptop in their classroom for different amount of time. Only 7.2% teachers would like let students use laptop for a whole class. Over 70% of the program teachers would not use laptop more than half of class time. The result brings a very key question: will it be necessary for students to use laptop for the whole class? Another question worthy of further discussion is: what kind of teaching and learning activities we employ in the laptop classroom.

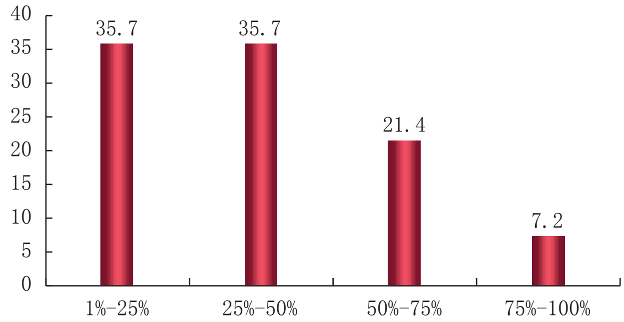


Chart 2. The amount of time that teachers plan to carry out laptop learning in class

## 6. Discussion

Implementing 1:1 laptop initiatives in schools is a huge step in bridging the digital gap. The excitement of this kind of technology innovation needs to be appreciated by all the teachers because they are not only the crucial factor of successful implementation, but also an important part of the technology innovation in education. As long as teachers feel they are embraced by the innovation programs, they can completely engage in their everyday teaching with technology. The first stage of programs should improve teacher attitude and gain their support. Teachers not only need technology skills, but also should attain advice and help about the pedagogy and beliefs toward technology innovation. Before the commencement of 1:1 laptop initiatives, teacher training must be carefully planned and conducted. The content of the training should be designed specifically, including all the technology skills based on teachers' need and the professional development plans. Teachers will feel confident about teaching in a 1:1 laptop classroom with tacit

In this study, the researchers proposed an experiential training framework for the pre-program teachers, showed in Figure 3. The training takes on the form of a three-step-circle workshop. First step is watching. Teachers will be organized to watch and discuss some successful laptop teaching class videos. Secondly, after taking training course of technology and pedagogy, teachers will try to practice the teaching strategies and experiences they learned in their own class. Thirdly, teachers will write reflection of their teaching practice in the workshop and obtain advice and help from experts and program researchers.

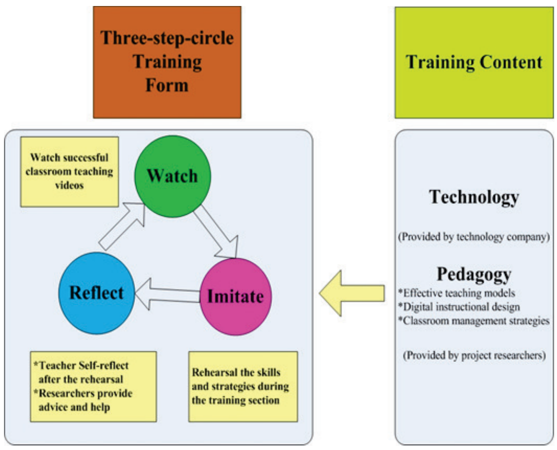


Figure 3. pre-program teacher training framework

Educational technology professional development also plays an important role in the implementation of technology innovation. Only pre-program training is far from enough to motivate teachers' support and passion toward technology innovation. High-quality professional development, no matter small or large, may have different goals, but all should be planned to convince teachers to involve, learn, and then constantly use technology and instructional strategies in their daily work. Professional development also can be achieved in many different ways. Training (pedagogy and technology), workshop, school-based researches are some examples of commonly recognized professional development forms, and not all of them are equally suitable for every school. Therefore, schools that want to start 1:1 laptop initiatives must find the most appropriate professional development of their own.

According to the interview and survey results, we designed a systematic professional development 3-year-plan (shown in Table 2) for the program teachers of RDFZ Xishan School. The plan includes six sections with the different sub-goals for every section. The six sections have covered six aspects of teachers' concerns of the 1:1 laptop initiatives while the forms are flexible. The plan will be carried out through the whole process of the 1:1 laptop initiative, assuring teachers will reach out help and advice any time they need them.

| Section | Content |
|---|---|
| Understanding the Program | ● Plan Goal, Vision of the Program |
| Constructing Digital Learning Environment | ● Laptop computer skills<br>● Teaching and Learning Software<br>● Web-based educational platform<br>● Multimedia information technology |
| Digital Pedagogy | ● Instructional design for 1:1 laptop learning<br>● 5-step innovation teaching model for middle school<br>● Learning resources design<br>● Evaluation and reflection |
| Information Technology Integrating Use | ● Theory of information technology integration<br>● Case study of classes with successful information technology integration<br>● Problem-based learning in 1:1 laptop scenario |
| Teaching and Learning In 1:1 Environment | ● Classroom management strategies and cultures for 1:1 laptop learning<br>● Fostering students' 21st century literacy<br>● Nursing students' creative thinking skills<br>● Bridging the digital gap between students |

| | |
|---|---|
| Thinking and Working Like A Researcher | • 21st century teacher professional development<br>• Introduction of educational research<br>• How to conduct research and write research papers |

Table 2. Professional development plan

## 7. Conclusion

Successful implementation of one-to-one project is deeply rooted in an understanding of teachers. Obstacles such as inadequate technology skills, not enough training time, and lack of new pedagogical support have been causes for one-to-one project failures. Hence, the design and practice of professional development plan must maintain consistency with teachers' needs in a very specific school.

This research, conducted in a middle school located in Beijing, China, investigated teacher attitude and technology preparation for the upcoming one-to-one laptop learning initiative. Research data were collected by interviews and surveys during the training before the commencement of the initiative. According to the surveys and interviews, teachers of program school hold a very positive attitude toward the up-coming 1:1 laptop initiative. This result will become a positive factor for the implementation of the project. Otherwise, additional work should be carried out to promote teachers' attitude. Teacher training should be innovative, flexible and updated according to the teachers feedback of pre-program training. After analyzing the data, the researchers proposed an experiential training framework for teachers and a designed a systematic professional development 3-year-plan. This professional development should be altered to meet different schools concrete requirement.

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# Using Shared Display Mind Tools for Facilitating One-to-one Collaborative Learning

**Chen-Wei CHUNG[a*], Chih-Chung LEE[b], Chen-Chung LIU[b]**
[a] Digital Education Institute, Institute for Information Industry, Taiwan
[b] Graduate Institute of Network Learning Technology, National Central University, Taiwan
*jerryjong@gmail.com

**Abstract:** Most collaborative mind tools are applied in asynchronous learning contexts. In other words, these tools can support students in joint construction of knowledge through the Internet. However, face-to-face collaborative learning may pose new challenges for the design of collaborative mind tools. For example, without a proper arrangement of learning devices, the control of a mind tool may be limited to a single member and this may reduce willingness on the part of other students to share their personal opinions and this may in turn impede the group learning process. This study has adopted a shared display mind tool combining shared display with a one-to-one learning environment to help students engage in collaborative mind activities. The participants were nine graduate students who enrolled in the course “Learning, Collaboration and Creativity" in a middle-sized university in Taiwan. By analyzing activity logs and video, it was found that the shared display mind tool could facilitate information exchange and sharing. This tool can also help students establish shared visual focus and attract the attention of group members. In addition, it elicits ideas from each individual and inspires new search directions, thus enhancing the elaboration of knowledge for new understanding.

**Keywords:** One-to-one collaborative learning, shared display, collaborative mind tool, peer interaction analysis

## 1. Introduction

Computer mind tools have been widely applied in supporting teaching and learning [6][8]. It has been shown that mind tools such as CmapTools [5] and Knowledge Forum [13] can help students to organize, judge and link information and knowledge and thus are helpful in improving high order abilities such as critical thinking and problem solving [16]. When such mind tools are applied in collaborative learning, they can promote the externalization of knowledge by facilitating students in judging, linking, and negotiating their own knowledge in a way which develops new understanding of knowledge.

Most collaborative mind tools are applied in asynchronous learning contexts. In other words, these tools can support students in jointly constructing knowledge in non-realtime through the Internet. For instance, Knowledge Forum [13] can facilitate students to exchange resources and ideas in support of collaborative knowledge construction. However, face-to-face collaborative learning may pose new challenges for the design of collaborative mind tools. For example, without the proper arrangement of learning devices, control of a mind tool may be limited to a single member and this may reduce willingness on the part of other students to share their personal opinions, which may in turn impede the group learning process [1]. Furthermore, collaborative learning involves both individual and group activities and would also include rapid transitions between the two activities [10]. For instance, students need to collect and organize information individually and then use the collected information in group discussion to advance their understanding. If the mind tool is used in a shared computer setting where all group members share only a single computer, individual students do not have the opportunity to conduct work independently and develop their own ideas. Therefore, in a face-to-face collaborative learning activity, individual workspaces are needed to support learning autonomy in order that students can generate their own ideas separately and then contribute those ideas in group activities [3].

One-to-one learning environments, which refer to the 1:1 ratio of computing devices and students in educational settings, can potentially address the above-mentioned issues. In such learning environments, each student can use the collaborative mind tool through his/her own computing device. For instance, Zurita & Nussbaum [17] and Manlove, Lazonder, & Jong [11] applied handheld devices in assisting students to perform collaborative learning activities. With the help of the personal computing devices, the group could be more productive due to better communication and interaction. However, individual work and group work taking place during collaboration often occur in parallel. This may impede collaborative learning due to a decrease in activity awareness [14]. More specifically, as each student works only with his/her personal computing device, some group members may not be aware of the learning activities of their partners because of the lack of a visual workspace in a collaborative activity [9].

Shared displays may be used to provide a shared visual workspace in the one-to-one learning environment. The groupware used with shared displays [4, 5] can facilitate collaboration by promoting shared understanding of the workspace and an increasing awareness of partner action, as participants can get close to one another's centre of visual focus with the shared display [14]. At the current development stage, shared displays are applied increasingly to support cooperative work. However, it is still not clear that how these collaborative mind tools, incorporating shared displays in a one-to-one learning environment, may influence collaborative activity.

In response, we conducted a study to investigate student interaction and discourse in the use of collaborative mind tools with the shared displays and personal handheld devices. In order to get a better understanding of student interaction, both verbal and non-verbal communications were analyzed. The former can reveal the detailed processes involved in shared cognition while the latter play an important role in face-to-face communication. For example, eye contact is commonly used as an expression of intention to transmit information to another person and hand-pointing behaviors indicate the direction of attention during human communication [7]. These non-verbal cues are important factors in understanding how students interact when exchanging knowledge [12]. Therefore, this study aims to explore the effect of shared displays and personal handheld devices on face-to-face collaborative learning by answering the research questions below:

1. How may the shared displays facilitate information sharing during collaborative learning in one-to-one learning environments?

2. What role do the shared displays play in non-verbal interaction among group members?

3. How do the shared displays affect verbal interaction among group members?

## 2. Method

### *2.1 Participants and the collaborative activity involved*

The participants were nine graduate students enrolled in the course "Learning, Collaboration and Creativity" in a middle sized university in Taiwan. Because one of the major goals of the course was to develop collaborative skills in students, they were required to solve open-ended problems collaboratively. To achieve this goal, they were to search the Web and collaborate with each other in forming their individual perspectives of the problem in order to advance their understanding of the problems. During collaboration, students were required to explore all possible solutions to the assigned problems and then to discuss them with each other to achieve a shared understanding. Therefore, sharing information found on the Web and exchanging perspectives with peers were essential during their collaboration.

The nine students were divided into three groups of three, each of which had to generate a perspective on some open-ended problems. The three groups each took part in two collaborative activities. In one of these, the student group used a collaborative mind tool without shared displays (Non-SD) (described later) to explore an open-ended problem: "constructivist approach toward mathematics in Taiwan." In the other collaborative activity, the students utilized a shared display collaborative mind tool (SD) (described later) to investigate another open-ended problem: "low-price computers for education in emerging markets." The students were to explore possible issues and solutions by accessing resources on the Internet. Neither of the two problems has a well-known answer at present. Therefore, an analysis of student interactions during the two collaborative activities could help obtain a better understanding of the effect of the two collaborative mind tools.

Each collaborative activity took 3.5 hours including 0.5 hour for introducing the problem's background and the learning activities. During the collaborative activities, students used their own laptop computers to work on the problems, on which were installed the collaborative mind tools. For instance, group members used their laptop computers to search the Web for material related to the given problem. At the same time they could exchange and share search results with each other using the group mind tools. All collaborative activities and discussions were videotaped by three video cameras on the ceiling for subsequent analysis.

*2.2 Collaborative mind tools*

To achieve a better understanding of the roles played by the shared displays and handheld devices in collaborative mind tools, this study investigated student interaction assisted by two such tools: one designed based on the shared display (SD) and the other which did not provide a shared display (Non-SD). Both designs used handheld devices as an individual workspace to participate in the learning activity enabled by the collaborative mind tools.

In this study, the collaborative mind tools were used to support exploration activities on the Web. Therefore, they had to assist students in exchanging and sharing search results so that those students could join together to reflect upon the information they had found on the Web. To achieve this goal, this study developed two collaborative mind tools based on mind maps to facilitate such collaboration activities. The mind maps were applied because the use of knowledge maps can improve the quality of argumentation among participants in collaborative learning environments [15]. More specifically, the mind maps functioned as the main workspace in which all participants could amalgamate web search results to reflect upon their own understandings of the problems.

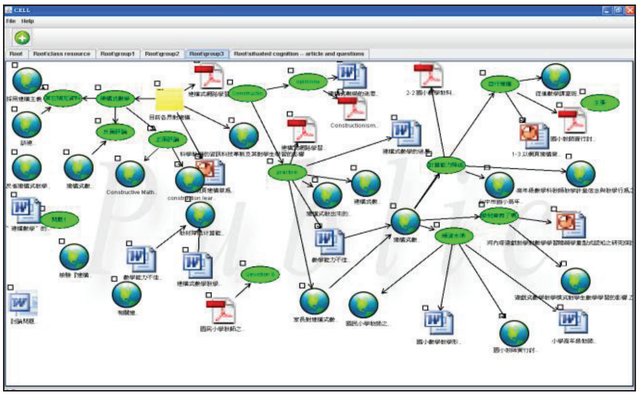

Figure 1. Diverse nodes on the group mind map

Both the Non-SD and SD collaborative mind tools were client/server groupware applications. Figure 1 displays the collaborative mind map constructed by a student group during the collaborative activity. The two mind tools enable students to work individually and collaboratively in the following ways:

- Individual search: Each student can search the Web freely using a personal laptop computer and can contribute any type of web search results as reference nodes to the collaborative mind map. The reference node may include web pages (shown as earth icons), and any type of document files (such as MS Word, MS PowerPoint, and PDF). Each student drags the web search result nodes from his/her laptop computer onto the group mind map.
- Exchange of web search results: Students can easily exchange and share web search results with their peers. They access the shared web search results through their personal mobile computers by double-clicking the web search result nodes on the group mind map.
- Integration and reflection: Students can organize and integrate information collaboratively by performing group mind mapping activities. When they read the web

search results, they can propose an issue, position or argument node (shown as an oval icon) on the group mind map to decompose the exploration topic. Students could also propose ideas on specific web search results by adding a comment node (shown as a square icon) on the collaborative mind map, or propose diverse ideas on a comment node added by others, which led them to further develop a shared understanding, refine a concept, or generate a new idea. In the meantime, students can clarify the relationship between these resources (i.e. web search results, concepts, and comments) on the group mind map by linking these resource nodes.

The Non-SD and SD collaborative mind tools have a different design in terms of the usage of the shared display. Therefore, a comparison of the interaction between students can be made to explore the influence of shared displays on collaborative learning. More specifically, the Non-SD collaborative mind tools allowed the students to perform mind mapping activities only on their own laptops. In contrast, the SD collaborative mind tool contained a shared display with which students could work together on their mind maps while also individually editing the mind map with their own laptop computers. Each group took part in the exploration activities with both the Non-SD and SD collaborative mind tools, therefore, a total of six collaborative mind maps were generated by the three groups. Their mind mapping behaviors with the collaborative mind tool were logged. The log files and the mind maps were analyzed to reveal the effect of shared displays on collaborative learning.

## 3. Results and discussion

### *3.1 The effect of students' visual focus*

We were interested in how eye contact affected collaborative learning. This study analyzed video and activity logs generated during collaborative learning. It was found that group members discussed their teamwork in depth though the shared display. At the same time, group members modified the content of their proposed nodes and uploaded new search results on the shared display. For example, figure 2 shows that all group members looked at the shared display to discuss their group work. Such discussion demonstrated that they were elaborating their understanding of the problem. It also found that members B and C viewed position nodes 2 times and proposed 2 argument nodes which they then modified 4 times. The result reveals that shared visual focus in the discussion was helpful in eliciting the ideas of each individual.

*[1] C: (gazing on the shared display) the difficulty/problem of teacher is that the quality of teaching skills which literally affected the learning effectiveness of students. Therefore, the competence of teachers should be raised up in order to promote 12-year compulsory education.*
*[2] A: (gazing on the shared display) I believe that the teaching skill is not only focus on their education level but should include the professional proficiency as well.*
*[3] B: (gazing on the shared display) the level of teaching skills.*
*[4] B: (gazing on the shared display)(hand pointing at the shared display) Yes, exactly, taking education background for instance, the qualification for being a teaching is just passing the examination to acquire the teaching certificate, thus, some of campuses have staff teaching subjects they are not qualified to teach. For example, Math was the subject most commonly taught by teachers not fully qualified in the area, followed by information technology, computer science, psychology and languages. That is because of a shortage of secondary teachers, schools often had little choice but to assign staff to teach areas they had not studied; therefore, I think, teachers should generally qualify for the role by having strong professional credentials and formal training rather than a teaching certificates.*
*[5] A: (gazing on the shared display) because one of important point is .....*
*[6] B: (gazing on the shared display) accordingly, teaching skill is the most imperative essence in the teaching education.*
*[7]A: (gazing on the shared display): the teaching skills are including professional proficiency as well as their education background.*

Figure 2. The students' conversation is elaborative knowledge

To get better understanding of how Non-SD and the SD environments affected the eye contact of group members, this study analyzed the activity video and counted the number of eye contacts within a group. The result is shown in Figure 3. In Figure 3, each circle represents a group member and the number on the solid arrow represents eye contact frequency between one member and another. The number on the dotted arrow represents the frequency with which one member watched another member's laptop computer. For example, in Figure 3a, member A engaged in eye contact with member B 68 times and looked at member C's laptop computer 71 times.

It was found that the shared display promoted eye contact between group members. For instance, the total eye contact frequency count in the SD environment (500 times in Figure 2d and 663 times in Figure 3e) was significantly higher than that of the Non-SD environment (301 times in Figure 3a and 418 times in Figure 3b). Previous studies pointed out that an instance of eye contact is commonly used as an expression of intention (Gomez, 1996), especially when eye contact functions as an important confirmation cue in face-to-face collaborative learning. The result showed that the shared display increased the instance of confirmation in face-to-face learning. It was supposed that when group members discuss group work on the shared display, they often confirmed the intention of others through eye contact. It was also found that the shared display promoted exchange of information by enabling members to watch each other's computers. The number of instances of watching the computers of others and the shared display under the SD environment (318, 149 and 217 times, respectively) was higher than that of the Non-SD environment (290, 49 and 172 times, respectively). Notably, instead of watching computers of other members, the three groups watched the shared display more frequently (229, 88 and 208 times, respectively). The result shows that the shared display can help to establish shared visual focus and further promote confirmation between group members in achieving exchange of information. Such exchange of information can explain why shared visual focus could help to elicit ideas from each individual and inspire new search directions.

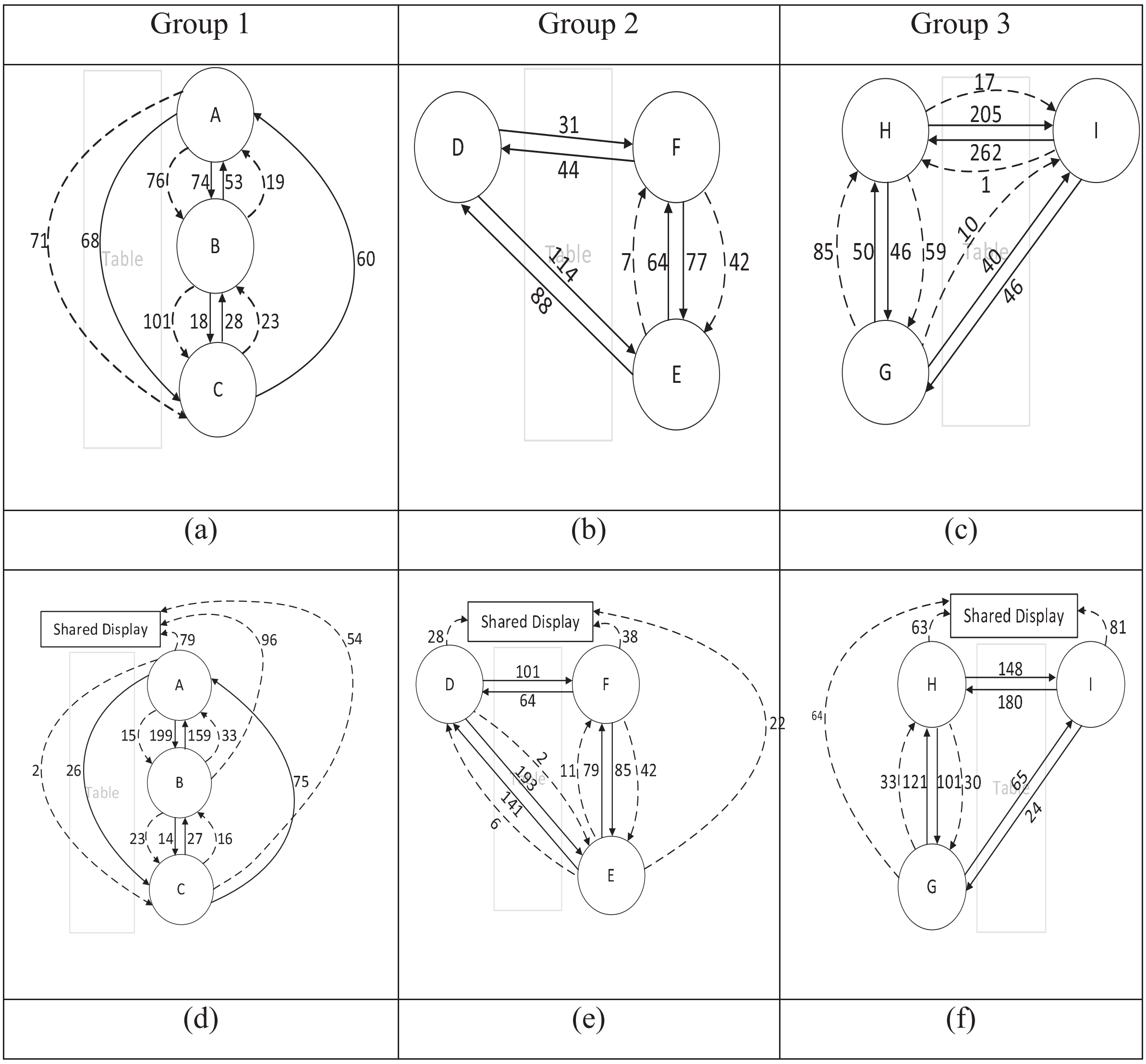


Figure 3. Students' eye contact in Non-SD (a-c) and SD (d-f) environments

Watch group member

Watch shared display or device

This study also analyzed the activity video and counted the number of hand-pointing occurrences within each group in order to understand how the Non-SD and the SD environments affected hand-pointing behavior. The result is shown in Figure 4. The number on the solid arrow represents the frequency of hand-pointing between one member and another. The number on the dotted arrow represented the frequency with which one member pointed at another member's laptop computer. For example, in Figure 4a, member A pointed at member B 2 times and pointed at member C's laptop computer 5 times.

The hand-pointing frequency of individual devices under the Non-SD environment was 32, 0 and 70 respectively (Figure 4a-c) and that of the SD environment was 45, 15 and 48, respectively (Figure 4d-f). It did not show a significant difference between the two environments. Interestingly, it was found that the hand-pointing behavior shifted from pointing at one another or pointing at another's laptop computer to pointing at the shared display. The result showed that group members tended to use the shared display to discuss and organize group work instead of working on their personal devices. It also revealed a change of attention during collaborative activities. Hand-pointing represents the direction of attention during human communication [7]. Within the SD environment, students often focused on the shared display rather than interacting with each other via their personal devices. Our study showed that the SD environment can shift attention to group work, which is helpful in improving group performance.

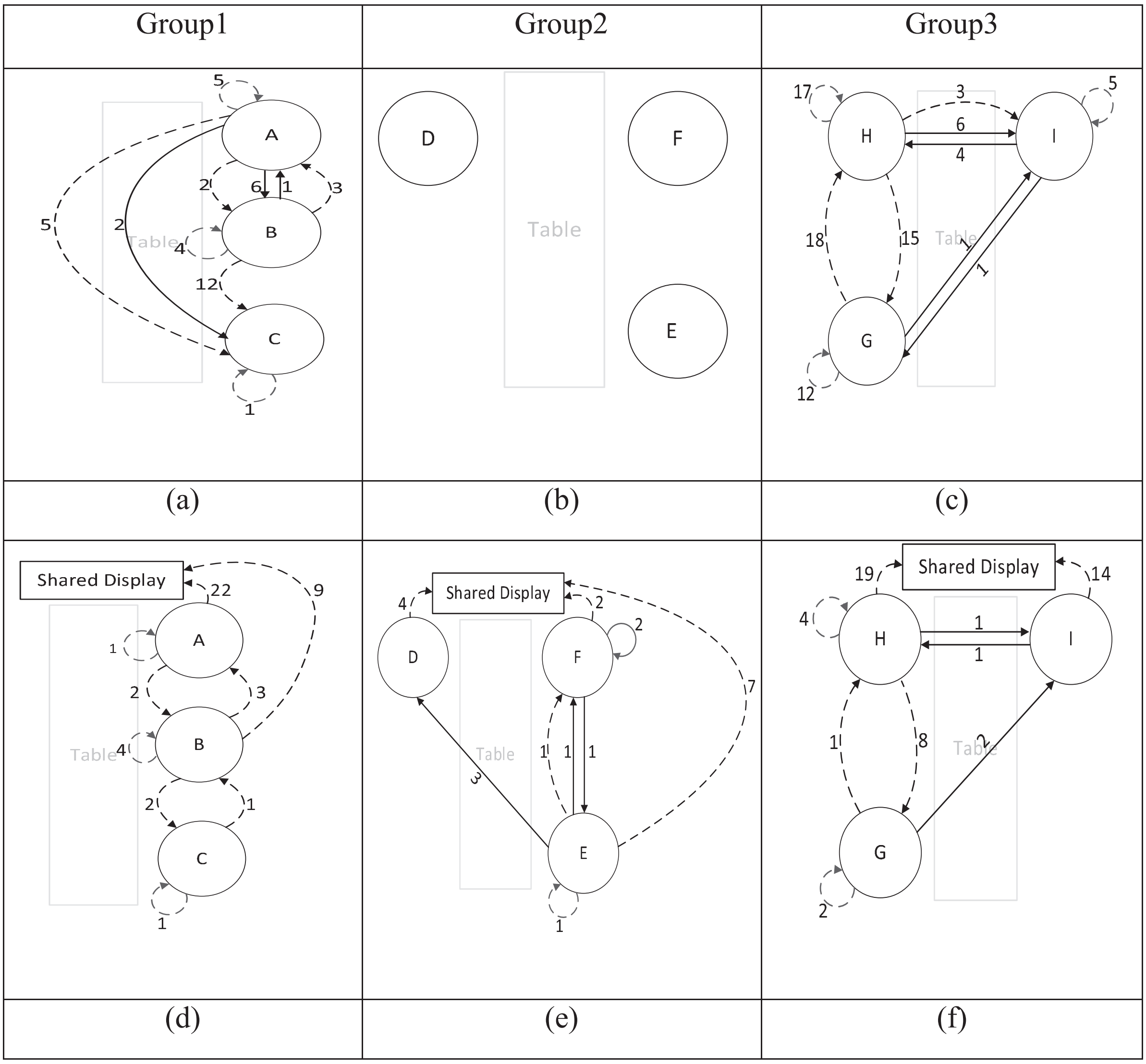


Figure 4. Students' hand-pointing behaviors in the Non-SD (a-c) and SD environments (d-f)

Point at group member

Point at screen

Table 1. The counts of students' conversation utterances under the Non-SD and SD environments

| | Procedure discussion | Searching | Document explanation | Group argument | Group decision-making | Total |
|---|---|---|---|---|---|---|
| Non-SD | 307(24%) | 97(8%) | 169(16%) | 510(40%) | 153(12%) | 1236 |
| SDG | 159(12%) | 28(2%) | 158(12%) | 803(59%) | 210(15%) | 1358 |

Besides investigating the effect of a shared display upon computer-mediated communication and non-verbal interactions, we also tried to analyze students' conversational utterances to reveal how group members developed collaborative strategies. In the activity video, we found five main types of conversational utterances during collaboration. Table 1 shows the counts these. There was no significant difference between totals of conversational utterances within the Non-SD and SD environments (1236 and 1358, respectively). However, there were clear differences in the character of conversational utterances between these two environments. Group members produced more instances of procedural discussion and searching within the Non-SD environment (307 and 97, respectively) than those in the SD environment (159 and 28, respectively). However, they produced fewer instances of group argument in the Non-SD environment (510) than in the SD environment (803). The result shows that group members often questioned procedure and search results during activities rather than focusing on group arguments within the Non-SD environment. This suggests that the shared display can enhance activity awareness and thus reduce the number of conversational utterances dealing with procedure discussion and searching. This finding is consistent with the eye contact and hand-pointing analysis. The shared display shifted more attention to group work during the discussion, so members spent less time describing their work status and search results and more pursuing group argument and elaborating knowledge interactively.

## 4. Conclusion and Implications

Many researchers contend that mind tools can improve high order thinking in students and improve the acquisition of new understanding of knowledge. Therefore, this study adopts the shared display mind tool, combining a shared display with a one-to-one learning environment to help students engage in collaborative mind activities. By analyzing the activity log and video, it was found that the shared display mind tool can facilitate information exchange and sharing. The shared display mind tool can also help students to establish shared visual focus and to attract the attention of group members. It further elicits ideas from each individual and draws out new search directions to enhance the elaboration of knowledge for new understanding.

The results of this study show that the shared display mind tool can help students conduct collaborative mind activities, but due to the limited number of available devices, only nine subjects were enrolled in the experiment. A future study will involve a large number of subjects to confirm the effect of shared display upon collaborative mind activities. The current subjects were graduate students. Future studies should use students with different knowledge levels to reveal how the shared display mind tool can provide assistance to a wider range of collaborative mind activities. In addition, the shared display may also be applied to other fields of knowledge. These new findings can also be provided to the designers of learning systems to aid them in improving their current design of collaborative mind tools and curriculum design in the classroom.

## Acknowledgements

This research was partially funded by the National Science Foundation under NSC98-2511-S-008-004-MY3, NSC 100-2631-S-008-001 and NSC100-2631-S-008-004. This research was also conducted under the "Digital Convergence Service Open Platform" of the Institute for Information Industry which is subsidized by the Ministry of Economy Affairs of the Republic of China.

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Mohd Ayub A. F. et al. (Eds.) (2011). Workshop Proceedings of the 19th International Conference on Computers in Education. ChiangMai, Thailand: Asia-Pacific Society for Computers in Education.

# Designing with mobile technologies for enacting the learning of geometry

**Håkan SOLLERVALL*, Didac GIL DE LA IGLESIA, Marcelo MILRAD, Aihui PENG, Oskar PETTERSSON, Sadaf SALAVATI, Jane YAU**
*School of Computer Science, Physics and Mathematics, Linnaeus University, Sweden*
*hakan.sollervall@lnu.se

**Abstract:** Guided by the methodology of design research and the notion of seamless learning we develop a mobile learning activity for an outdoor context, where groups of 12 year old students are asked to coordinate themselves physically in terms of given distances with respect to both given and peer-defined points. Our learning activity consists of three connected tasks of successively increasing complexity, implemented at separate occasions over a period of 6 months. By participating in the activity, the students are offered opportunities to experience geometrical constructions in full-sized space. Specifically, they are stimulated to make use of their orientation ability, which differs cognitively from the visualization ability which is more commonly used to solve similar tasks in school. The outdoor explorations, the use of mobile technologies, and the distribution of the activity across time and locations, pose didactical as well as technological challenges which call for careful considerations regarding the design of the activity. In this paper, we account for the design process and its pedagogical grounding in ancient mathematics and modern psychology. Furthermore, we suggest to systematically combining the theory of instrumental genesis together with scenario-based design, within the methodological framework of design research, to guide the development of seamless mobile learning activities which provide a learning progression over time.

**Keywords:** Design research, geometry, instrumental genesis, seamless learning, scenario-based design, mobile technologies, technology-enhanced learning

## 1. Introduction

This paper reports on the design of a technology-enhanced learning (TEL) activity developed in collaboration between researchers in mathematics education and media technology. The activity emerged as an idea during a meeting where a selection of available mobile technologies and their didactical potential for the learning of mathematics were discussed. Several members of the current research team have previously collaborated in projects involving outdoor mathematics supported by mobile technologies and interactive visualization techniques [8,9,11]. These efforts have been inspired by Cobb, Confrey, diSessa, Lehrer, and Schauble [3], who formulate a mission for research in mathematics education as striving to develop, test and revise learning activities which are designed in order to support envisioned learning processes.

Research in mobile learning (m-learning) relates to a variety of subjects including school mathematics. An example of such an m-learning activity is MobileMath [13], designed as an outdoor activity for teams of students to compete against each other by constructing squares, rectangles, and parallelograms to cover as much area as possible while negotiating obstacles such as houses. The students define the vertices of the shapes by walking to chosen positions and clicking on a mobile device supporting GPS technology.

The device provides visual feedback to the students. As being a one-off activity, the game involves mathematics but it remains to exploit and research its potential for learning [13].

In this paper, we discuss the development and pedagogical grounding of a connected learning activity, whose three tasks have been initially tested with students. To achieve the specific learning objectives for the activity, we involve mobile technologies in an outdoor context. The development of learning activities for outdoor contexts is in itself a complex task, which becomes even more complex when attempting to support advanced mathematical learning objectives by making use of mobile technologies. In the next section, we account for the theoretical and methodological foundations that serve as a basis to support and guide our design efforts. In the last section, we suggest how to further strengthen the methodological approach in our future efforts. Moreover, the implemented tasks have to be negotiated with teachers and students. We address this latter issue of pragmatic roots in relation to dimensions of mobile-assisted seamless learning [14], and argue for using these dimensions as guiding principles for future work in educational design research.

## 2. Design research, scenario-based design, instrumental genesis, seamless learning

Two key aspects of design research are the central position of the design of learning activities and the cyclic character that allows their adjustment and improvement. One design cycle consists of three natural phases; the preliminary design phase, the teaching/learning experiment phase, and the phase of retrospective analysis [5]. The preliminary phase for design of a learning activity involves the negotiation between a) the design of a proposed activity, and b) a prospective analysis with focus on hypothetical learning trajectories [3], where the intended mathematical learning objectives guide the choice of trajectories. In our case, which concerns a learning activity with three connected tasks, the classical design cycle (Fig. 1, left pane) is naturally extended to involve three connected cycles (Fig. 1, right pane). This latter model involves transitions between designs (preparatory stage) as well as transitions between tasks (students in action).

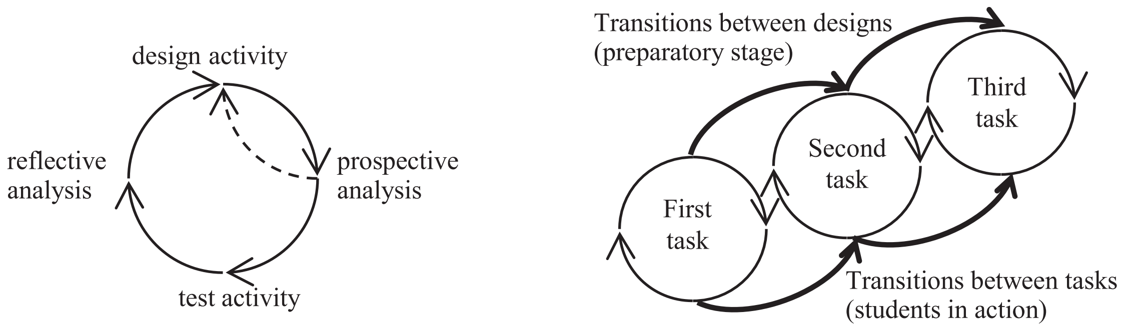



**Figure 1: Design cycle (left pane) and connected design cycles (right pane)**

In the current project, as well as in our previous efforts related to design research [8,9,11], the learning activities are highly self-regulated and stimulate collaboration in the sense that the students need to engage in a coordinated effort to solve tasks within the activity [4]. From a didactical point of view, we negotiate the design of a specific learning activity with prospective analysis in a local cycle and simultaneously negotiate technological requirements of the mobile applications with the technological domain experts. These discussions and negotiations are guided by scenario-based design (SBD) which enables “rapid communication about usage possibilities and concerns among many different stakeholders” [10] by providing narratives about the students’ possible actions and interactions during a proposed learning activity. The scenarios make it possible to communicate about learning trajectories without having to engage deeply in specific subject matters.

The implementation of any learning activity, and particularly an activity that makes use of mobile technologies, has to include a phase where the students try out and learn to use the available tools. The process of turning a tool into an instrument (in our case, an instrument for learning) is summarized by the notion of instrumental genesis [12]. The theory of instrumental genesis makes a distinction between the tool as an object and the instrument, as a cognitive construct, emerging when the user interacts with the tool. A central feature within the current activity is a customized mobile application to be used in an outdoor context. The design considerations regarding the students' instrumental genesis could fortunately be limited to the first task, as the functionality of the application was changed just slightly from the first to the second and third tasks. As a consequence, the students' cognitive efforts during the latter tasks could be focused on the mathematical challenges.

Our three tasks being distributed across time and locations make them fulfill two of the ten dimensions (MSL3 and MSL4) characterizing mobile-assisted seamless learning (MSL), as recently suggested by [14]. The tasks were implemented at four different occasions beginning in December 2010 and ending in June 2011. Each task involved an indoor preparatory session combined with a self-directed group effort in an outdoor setting. We will discuss the dimensions of MSL in further detail in the last section.

Our general design approach can be characterized by the use of design research to develop learning activities which support specific learning trajectories. The prospective analysis is based on narratives, which account for the students' hypothetical action (and learning) trajectories. These narratives guide the pedagogical design as well as the technical implementations throughout our work. The reflective analysis in this contribution is limited to a concluding discussion in relation to the dimensions of MSL.

## 3. Grounding of the activity in ancient mathematics and modern psychology

Our activity offers the participating students enacted experiences of school geometry which are not commonly offered in school contexts. The activity, which will be described in the next section, was initiated during a team meeting where a selection of available mobile technologies and applications were introduced and implemented by researchers from media technology. The research team promptly agreed, influenced by the didactical opportunities offered by one of the mobile applications, to design an activity involving outdoor constructions of large-scale triangles. We now proceed to account for the theories and research findings which were identified and used to guide the design process in order to refine and support specific hypothetical learning trajectories within the activity.

From a mathematical perspective, the activity may be interpreted as the construction of a triangle with three given sides. A while after the task was proposed we felt confident that such a geometric construction must have been considered by Euclid (~300 BC). Indeed, we found such a proposition in Book 1 in Euclid's Elements [6]. The construction can be regarded as a traditional school task related to geometrical constructions, problem solving and visualization. Students may readily solve the task on a piece of paper by using a compass and a ruler. In that case, they make use of a spatial ability which is sometimes referred to as *object manipulation*. This ability includes abilities for spatial visualization and spatial relations and concerns manipulation of spatial forms from a fixed perspective, involving an object-to-object representational system [7]. Within the psychometric research tradition, spatial visualization and spatial relations are contrasted with a third spatial ability, namely spatial *orientation*, which involves "movement of the egocentric frame of reference" [7, p. 745] and a self-to-object representational system. The self-to-object system activates another part of the brain than does the object-to-object system [7], which implies that object manipulation and spatial orientation should be considered as separate spatial abilities.

Steering documents for compulsory school in Sweden have a one-sided focus on object manipulation and consider spatial orientation explicitly only in pre-school. This fact may be contrasted with the claim by Bishop [1, p. 260] that "insofar as we are concerned with spatial ideas in mathematics as opposed to just visual ideas, we must attend to large, full-sized space, as well as to space as it is represented in models, and in drawings on paper". Activities taking place in full-sized space may be related to Bruner's [2] enactive mode of action and corresponding mode of thinking, as one out of three modes – enactive, iconic, symbolic – characterizing an individual's interaction with the world. We find it reasonable to claim that these different modes, which Bruner considers as emphases (rather than stages) in a child's development [2, p. 28], may be fruitful to draw on during learning activities also for older children, especially with respect to learning subject matter of abstract nature, such as mathematics.

Our ambition has been to design a learning activity that stimulates students' enactive mode of action by putting special focus on spatial orientation while minimizing features related to spatial visualization. We argue that this singular activity may serve as a general frame of reference regarding students' future geometric constructions on paper, using compass and ruler, where the outdoor activity may provide a connection between iconic constructions on paper and constructions imagined to be enacted in an outdoor setting.

## 4. Design and implementation of our learning activity

The current learning activity draws on the use of GPS technology available in a mobile device. The research team has developed a mobile application, which allows a student to measure distances between her own device and mobile devices held by other students. Based on this feature, we have designed a learning activity providing opportunities for students to experience spatial self-orientation in full-sized space. The activity was tried out by twelve students in grade 6 (13-14 years old) at a school located in a rural area in southern Sweden. The students worked with three tasks within the activity during a number of sessions that took place during the period December 2010 - June 2011.

### *4.1. The first task of the learning activity*

In the first task, implemented in December 2010 on a field covered in snow, the students worked in pairs. They were asked to use one mobile device to coordinate themselves with respect to two given distances measured against two fixed points, which were respectively marked on the field by a triangle and a square (Figures 2&4).

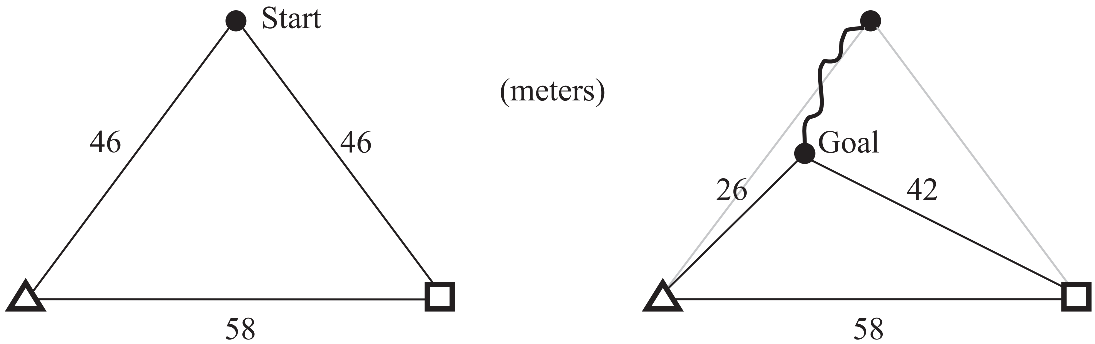
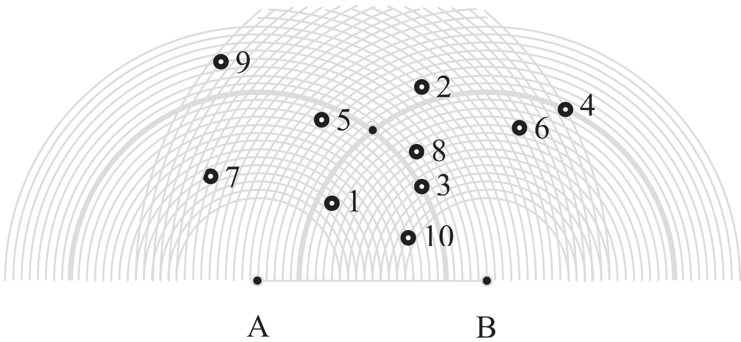



**Figure 2: Visual representation of the first subtask.**

The standing markers were placed 58 meters apart and could be readily identified from a large distance (Fig. 4). The starting point was marked with a pole and located 46 meters from each of the markers, as indicated in Fig. 2 (left pane). We chose to design ten subtasks, based on a diagram of level curves used to secure variation between longer and shorter distances (Fig. 4). The goal point for the first subtask, involving the students coordinating themselves with respect to the distances 26 m and 42 m, is indicated in Fig. 2 (right pane).




| Point | A | B |
|---|---|---|
| 1 | 26 | 42 |
| 2 | 62 | 50 |
| 3 | 46 | 28 |
| 4 | 86 | 46 |
| 5 | 42 | 56 |
| 6 | 74 | 38 |
| 7 | 28 | 72 |
| 8 | 50 | 36 |
| 9 | 54 | 84 |
| 10 | 38 | 22 |

**Figure 3: Distribution of points for the tasks (unit: meter).**

The rather large distances, 22-86 meters, were chosen for two reasons. Firstly, we wanted the students to move substantially (and reasonably far) within the chosen field. Secondly, inaccuracy of the GPS values resulted in an error for the computed distances. The research team tested both these aspects outdoors and found that a tolerance of two meters was enough to compensate for the inherent inaccuracies of the GPS technology. At the final stage of implementation (December 2010), the students were randomly organized into six groups. They worked simultaneously with the activity on the same field, which was covered with 20 cm snow. To avoid having the groups follow each other (in order to complete their ten tasks) six variations of the initial sequence of points were constructed based on symmetry (interchanging distances for A and B) and taking the ten points (Fig. 3) in different order (1-10, reverse order 10-1, and 3-10 followed by 1-2). A reference point was marked on the field with the two starting distances 46, 46 (meters). Between the points A and B, we provided distance markers for 5 and 10 meters which the students could use as references either before or during the activity. In order to put focus on the spatial orientation ability, we decided not to provide visual references on the mobile device although this was technically possible (such as maps with marked attempts). They were instructed in the classroom about the activity and the functionality of the mobile application. To promote students' reflections during the activity, their new distances were shown on the display of the mobile device only when so prompted by the students (Fig. 4, right pane).

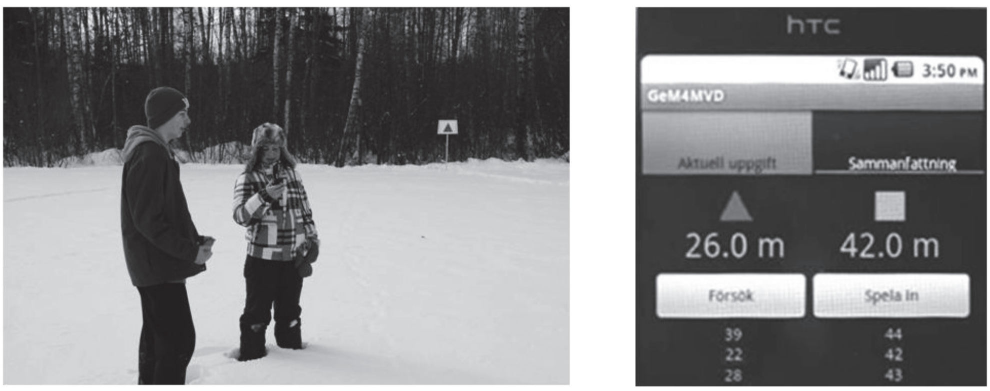



**Figure 4: Picture from the outdoor activity. The display of the mobile device.**

They were instructed to try to minimize the number of prompts/tries for each task and were also asked to record audio messages (on the same device) to be used for reflection in the classroom. The activity took less than one hour to complete by the six groups, despite the snow, cold weather, and humidity in the students' clothes.

### *4.2 The second task of the learning activity*

The first part of the activity was followed by a more complex activity, implemented in early February 2011 involving a task where the students had to handle repeated coordination of distances. The new requirement for the mobile application was that distances had to be measured with respect to moving targets as the initial reference points A and B (triangle and square) had to be replaced by the other students as new reference points for the measuring of distances. Hence, each group needed three GPS enabled mobile phones which were running a customized application, so that relative distances between the students were measured. The activity was supposed to be tried out by three groups, one with four students and the two remaining groups with three students each (due to two students being absent on the day of the activity). The students who were chosen had all participated in the first part of the activity and were familiar with the functionality of the mobile application.

The groups prepared for the outdoor activity in the classroom. They were presented with maps (size A4) of a construction presented on a neutral white background and with marked distances on each edge (Fig. 5, left pane). They were asked to find the goal point, indicated with a circle in Fig. 5. Before attempting the constructions outdoors, they were asked to discuss possible strategies for approximately 15 minutes and to decide on a strategy for reaching the goal point before engaging in the outdoor activity.

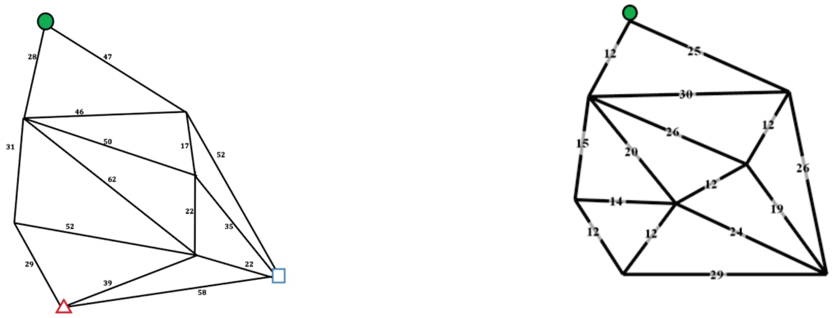



**Figure 5: Maps used in February 2011 (left pane) and in April 2011 (right pane).**

During the first implementation of the task, in February 2011, some incidents appeared that made us implement a re-designed version of this construction (Fig. 5, right pane) before the third and final task was implemented. These incidents concerned the students' preparation of strategies and the scaffolding of their outdoor communication. First, the students did not engage sufficiently in their indoor preparations of strategies for solving the task. Their insufficient strategies made them insecure and caused confusion when they tried to solve the task outdoors. Their confusion was amplified by communication problems due to the large distances in the construction and the strong winds on the day of implementation. For these reasons, the second task was redesigned with a technologically supported indoor session for preparing strategies. Furthermore, the distances in the construction were halved with the starting distance shortened from 58 m to 29 m in order to facilitate communication. This second iteration of the task worked out well when implemented in April 2011.

### *4.3 The third task of the learning activity*

The last task of the activity, implemented in early June 2011, involved each of the three groups making a similar construction from different starting points (Fig. 6, left pane) by using the map above (Fig. 5, right pane). When all three groups had identified their different goal points (Fig. 6, left pane) they were instructed to collaborate in a jig-saw construction to construct the center of mass for the triangle (Fig. 6, right pane). The instructions did not mention "center of mass" which was an unknown and possibly distracting concept for the students. Instead, the goal points were named A, B, C, a form of notation they were already familiar with. The midpoints on the line segments AB, AC, BC were named D, E, F, respectively. The students were instructed to find the (final goal) point where the line segments AF, BE, CD intersect each other (Fig. 6, right pane).

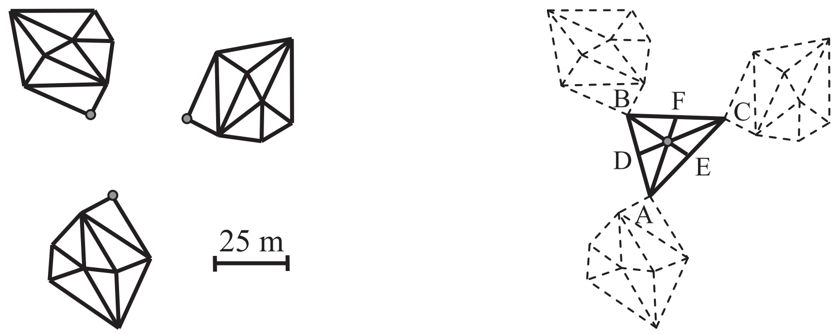



**Figure 6: First phase (left pane) and the second phase (right pane) of the third task.**

Our observations indicate that the students have been deeply engaged and motivated in solving the tasks, particularly when enacting the constructions in the outdoor contexts.

## 5. Lessons learned and future efforts

Based on the experiences from the first iteration, we plan to more systematically collect data during a second implementation of the activity with new groups of students. We plan to evaluate the outcomes based on a comparison of two groups of students, one which will do the tasks and one that will make similar constructions by solving standard tasks in textbooks. The students' ability to make geometrical constructions will be tested by letting them solve tasks with varying mathematical representations and modes of action.

As already mentioned, our activity obviously involves the two dimensions MSL3 and MSL4 (distribution across time and location) out of the ten dimensions for mobile-assisted seamless learning [14]. The tasks also encompass personalized and particularly social learning, (MSL2), they involve physical and digital worlds, (MSL6), and combined use of multiple device types – digital as well as traditional, (MSL7). Furthermore, the activity involves seamless switching between multiple learning tasks (MSL8) as individual students' roles in particularly the second and third tasks were changed frequently as they solved the tasks. Finally, managing the tasks in the connected activity requires a combination of prior and new knowledge (MSL9) as each new task builds on the previous tasks and each task involves both strategic planning and application of problem solving skills.

Although the participating researchers have been collaborating for several years in similar projects, there remains a need for a deeper understanding of both the didactical intentions of the activity and the functionality of the supporting technological applications in order to improve the design and realize the learning objectives for the students. In the current research effort, the ten-dimensional model for mobile-assisted seamless learning [14] has been used mainly for assessment purposes and has not been explicitly used in the design process, although some of the researchers are familiar with the model. Similarly, the methodology of scenario-based design has been used only implicitly. In our future efforts, we will attempt to make more systematic use of the dimensions of MSL as guiding design principles and apply the SBD methodology explicitly to further enhance the communication within the research team and to improve the quality of the design process.

Although our activity is designed for and implemented in a school context, we argue that it contains several features with strong impact for broadening students' learning experiences beyond both the activity itself and also beyond the formal school context. In a formal school context, the flow of learning is controlled and supported by the teacher, while the learner herself becomes primarily responsible for her learning in informal contexts. As noted by Wong and Looi [14], the "learners need to be engaged in an enculturation process to transform their existing epistemological beliefs, attitudes, and methods of learning". In our activity, we contribute to some extent to the learners' enculturation but even more to the enculturation of the teachers who are involved in the design process. By targeting teachers and transforming their attitudes and methods in the direction of seamless learning, we indirectly target their students and other teachers (and their students). The acceptance of our approach is underpinned by current steering documents for Swedish compulsory school, that highlight the development of general abilities (problem solving, communication, reasoning, representation, choosing and evaluating methods) which naturally encompass both formal and informal contexts, before specific content knowledge (arithmetic, algebra, functions, etc) which is more closely associated with the formal school context. By offering activities that are highly self-regulated and involve collaboration and communication with peers, we contribute to preparing the students for a future which requires them to take initiatives, be creative, take informed decisions, and puts high demand on their social skills.

A didactically relevant challenge for the future design improvements of our seamless learning activity would be to continue optimizing the hypothetical learning trajectories, aiming at specific mathematical learning objectives, while simultaneously attempting to incorporate additional dimensions of MSL in the activity.

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# PACALL: Passive Capture for Ubiquitous Learning Log Using SenseCam

**Bin HOU [a*], Hiroaki OGATA [a], Toma KUNITA [a], Mengmeng LI [a], Noriko UOSAKI [a] & Yoneo YANO [a]**

[a] *The University of Tokushima, Japan*

*hou-bin@iss.tokushima-u.ac.jp

**Abstract:** In our previous works, we developed a system named SCROLL in order to log, organize, recall and evaluate the learning log. However up to now, we just use an active mode to record logs. This means that a learner must take a capture of learned contents consciously and most of learning chances be lost unconsciously. In order to solve this problem, we started a project named PACALL (Passive Capture for Learning Log) in order to have a passive capture using SenseCam. With the help of SenseCam, learner's activity can be captured as a series of images. We also developed a system to help a learner find the important images by analyzing sensor data and images processing technology. Finally, the selected images will be uploaded to the current SCROLL system as ubiquitous learning logs. This research suggests that SenseCam can be used to do passive capture of learning experiences and workload of reflection can be reduced by analyzing sensor data of SenseCam.

**Keywords:** passive capture, learning log, life log, sensor data, SenseCam, ubiquitous learning

## Introduction

Learning Log was originally designed for children as a personalized learning resource [6]. It was set by teachers to help their students record their thinking and learning. In this learning log, the logs were usually visually written notes of learning journals. We defined a ubiquitous learning log as a digital record of what a learner has learned in the daily life using ubiquitous technologies. We developed a system SCROLL (System for Capturing and Reminding Of Learning Log) [10] that helps learners collect their learning experiences as ubiquitous learning objects (ULLOs). Also, all of the collected ULLOs are organized, shared in this system, and the learning effect can be enhanced. The model of a learning process is shown in Figure 1 and we call it LORE [10].

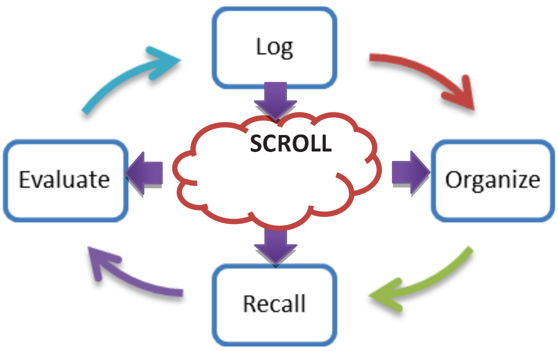


Figure 1. LORE Model in SCROLL

However, in the current SCROLL ULLOs are created by learners manually. It means that learners must record their learning experiences in the form of photo, video or other formats consciously. It is evident that learners cannot record all of the learning experiences in the system and most of them will be lost and forgotten.
In order to solve this problem, we attempt to introduce the concept of life log into this system. The notion of life log can be tracked back at least 60 years [1]. It means to capture a person's entire life or large portions of life. It usually uses digital devices to record life log such as wearable cameras or video recorders. For example, in the early 1980s Steve Mann captured his life using wearable computer and streaming video and even his everyday life 24 hours a day in order to see what he was looking at [7]. The life log brings us the data of whole life of not only learning but also other activities. However, if there is any way that we can extract the learning part from it, the learning log will be more significant and more sufficient. Besides, our system captures the learning log beyond their consciousness and learners' burden will also be reduced.
Microsoft's SenseCam [4] is an effective way to capture the life log. It is a wearable camera equipped with a number of sensors. The SenseCam is proposed to record a series of images and capturing a log of sensor data.
In this paper, we propose a system named PACALL (PAssive CApture for Learning Log) to capture the learning log passively using Microsoft's SenseCam. With the help of analyzing sensor data and image processing technology, it extracts the meaningful images for learning from life log and helps learners upload the learning content easily. In addition, we also conducted an initial experiment and analyzed the result.

## 1. Related Works

### *1.1 MyLifeBits*

MyLifeBits [9] is a Microsoft's project. The aim of this project is to implement Bush's Memex model [1] that proposed to store everything that you saw and you heard.
MyLifeBits has a large amount of storage that can store email messages, web pages, books, photos, sounds, videos, etc. It also has a full-text search function to supply users with searching text, audio annotations and hyperlinks.
In addition, the MyLifeBits project team is also using SenseCam to have the passive capture of life log and upload the sensor information along with the photos to the MyLifeBits repository [3].
We have learned a lot from this system. In our previous works, we had made it possible to store the learned material such as photos, sounds, videos and pdf files into the system repository. Besides, we have also implemented recall functions that use quizzes and contextual information to help learners to remember what they have learned. However, all works that we have done are using active logging mode, not passive logging mode. It means that learners must record their learning experiences as learning material by themselves. Comparing to the passive mode, in the active mode we are more likely to lose learning experiences since we are not necessarily able to record what we have learned or sometimes we just forget to record it. Therefore, we planned to introduce passive capture in our project with SenseCam.

### *1.2 JAMIOLAS*

JAMIOLAS [11] is Japanese mimicry and onomatopoeia learning assistant system. This system uses sensor to get the context information from real world such as temperature, light and sound level and use these data to support learning Japanese mimicry and onomatopoeia words. Because most of these words are just Japanese feelings, this system simulates the feeling of human beings with sensors, and generates proper word to help non-Japanese learners learning mimicry and onomatopoeia words. Each word has relationships with a number of sensors. Sensor data types are attributes of the word. For example, "hiyahiya" means cold in Japanese, so this word has a relationship with temperature sensor, and the temperature data is an attribute of "hiyahiya". The threshold is set by native Japanese speakers. In the second generation of JAMIOLAS [8], sensor network was introduced into this system, and in the third generation [5] this system also used online sensor data and supported learning mimicry and onomatopoeia with multimedia materials.
In the PACALL, we also use the sensor data to analyze the situation of an image file. When sensor data is collected by combined sensors, we need to analyze the sensor data, evaluate it as a situation and all the information will be added to each photo as properties.

### *1.3 Collaborative Reflection with SensorCam*

Fleck and Fitzpatrick [2] used SensorCam to support collaborative reflection. In their research, the students were asked to wear SenseCam when they played arcade games. After that, they did a reflection on their learning experiences. They found that SenseCam images were not only used to support memory aids but also can be used as resources for supporting the collaborative reflective discussion. The research also suggests SenseCam has potential to support reflection and that it is more appropriate in learning situation than videos.

## 2. SenseCam

SenseCam is a prototype device under the development of Microsoft Research [4]. It is a small digital camera that is combined with a number of sensors to help to capture a series of images of the wearer's whole daily life at the proper time and it can be worn around the neck (Figure 2). Actually this device is designed for memory aid.

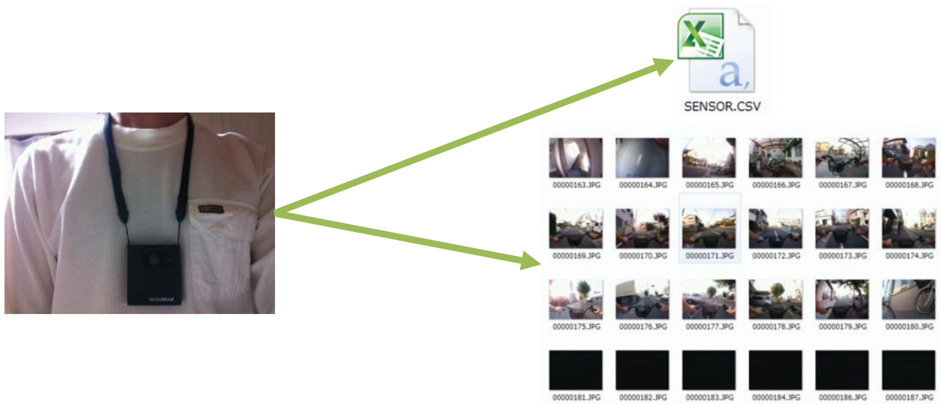


Figure 2. SenseCam and the record data

The SenseCam uses sensors as triggers to capture images along with a time trigger. As it is shown in Figure 2, when using the SenseCam all actions are saved into a single file named SENSOR.CSV including sensor data and the names of photos. Once the SenseCam is connected to computer, all the photos and the SENSOR.CSV file will be imported automatically.

```
CAM,2010/09/16 11:43:57,00000115.JPG,P
ACC,2010/09/16 11:44:20,00.037,00.940,-0.231
TMP,2010/09/16 11:44:20,0032.0
CLR,2010/09/16 11:44:20,00132
PIR,2010/09/16 11:44:20,1
BAT,2010/09/16 11:44:20,40992
MAG,2010/09/16 11:44:20,-374,892,-1924
```

Figure 3. Example of SENSOR.CSV

Figure 3 is an example of SENSOR.CSV. Each line starts with a flag (e.g. CAM, ACC) and a timestamp. Meanings of some flags that we are using in this research are shown in Table 1.

Table 1. Flags in SENSOR.CSV

| Flag | Sensor/Meaning | Data Interpretation |
|---|---|---|
| CAM | Image capture | Image filename, capture reason (P: PIR, T: Timer, M: Manual, L: Light level change) |
| PIR | Passive infrared detector | 1: the PIR is triggered, 0: not triggered |
| CLR | Color light sensor | Value for 'white' light |
| TMP | Temperature sensor | Temperature |
| ACC | Accelerometer | Acceleration values in x, y and z axis |
| MAG | Magnetic sensor | Magnetic values in x, y and z axis |

The SenseCam itself has an algorithm for capturing images by a time trigger and other triggers that use sensor data. However, because SenseCam is designed for memory aid, it takes photos continuously even if it is dark or the situation is not been changed. The result is that there are so many photos that are duplicated or blurred or dark.
In this research, we focus on filtering the images with sensor data in order to help learners to select proper photos in a short time.

## 3. Research Design

### *3.1 Learning Process*

This research is a sub-item of Ubiquitous Learning Log, and we named it as PACALL. It means a passive capture for learning log. The whole process of passive capture happens unconsciously. However it is no doubt that the simple photo capture is not the whole process of learning. It is necessary for learners to look through the captured photos and find the learning contents with the help of system. After entering the information of the image such as title and description, this learning content will be saved into SCROLL system as a ULLO. Of course, the saved ULLOs need to be recalled to help learners to remember, but this is the feature of SCROLL. That is to say, a process of passive capture includes capture, reflect and store. Such process is called a PACALL frame.

- Capture: Capture a series of photos for life log in daily life. This log is assumed that it includes all what learner has seen. Besides, massive redundant contents are also included in this log. We use SenseCam in the process of capture. SenseCam is already introduced in section 2.

- Reflect: After capturing life log, a learner needs to have a reflection of what he has learned. In this process, since there are so many photos, we provide a system to filter the redundant photos by analyzing sensor data or image processing technology. The analysis of sensor data is described in section 3.2.
- Store: When a learner finds an important learned content, the content must be stored into SCROLL. During this process, he also needs to enter the information of learned content such as title, description or tags.

### *3.2 Photo Classification and Sensor Data*

In PACALL, we use SenseCam to have a passive capture of learner's daily life. However, since this device takes photos continuously, more than 200 photos will be taken in one hour, and more than 1500 photos in one day. Therefore, we propose a method to classify these photos by sensor data.
All photos are divided into 5 levels based on importance – manual, normal, duplicate, shake and dark.

- Manual: Manual means the photo is taken by pressing manual button consciously. When a learner takes a photo manually, it means that this photo must be important from his point of view. Manual photos are selected by the sensor data with flag CAM and the capture reason "M" (manual capture).
- Normal: Normal means the photo is clear and can be used as learning log object. After excluding the duplicates, shake and dark, left photos are judged as normal.
- Duplicate: Duplicate means the photos are duplicated. Duplicated photos usually have same conditions. We use CLR, TMP, ACC, MAG and timestamp of photo to detect photos that are taken under the same conditions and pick out them as duplicated photos.
- Shake: Shake means the photo is blurred. It usually happens when the light level is low and the camera shakes. The sensor data CLR help us detect light level and ACC help us detect camera shake.
- Dark: Dark means the photo is taken with insufficient light and the photo is dark. It can be detected by CLR data.

Figure 4 shows the process of photo classification.

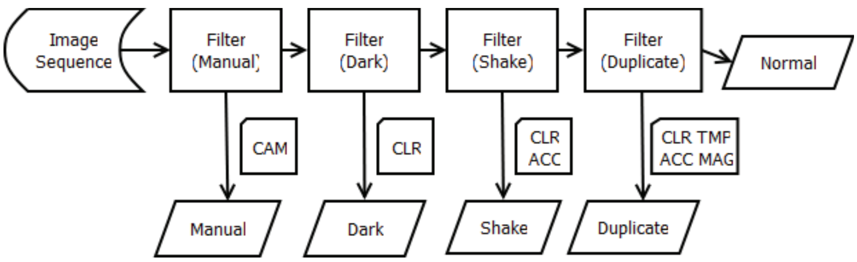


Figure 4. Process of Photo Classification

## 4. Implementation and Initial Evaluation

### *4.1 System Architecture*

In this research, the SenseCam that we are using is produced by Vicon Revue [12]. When the SenseCam is connected to the computer, if the software Vicon Revue Desktop is already installed, all photos will be imported into computer. The location of SenseCam repository is in the user's document folder and the name is Vicon Revue Data.
This system is programmed using Java and runs in Tomcat as a B/S system. When using this system, Tomcat accesses the repository of SensorCam photos directly and shows them in web browser.

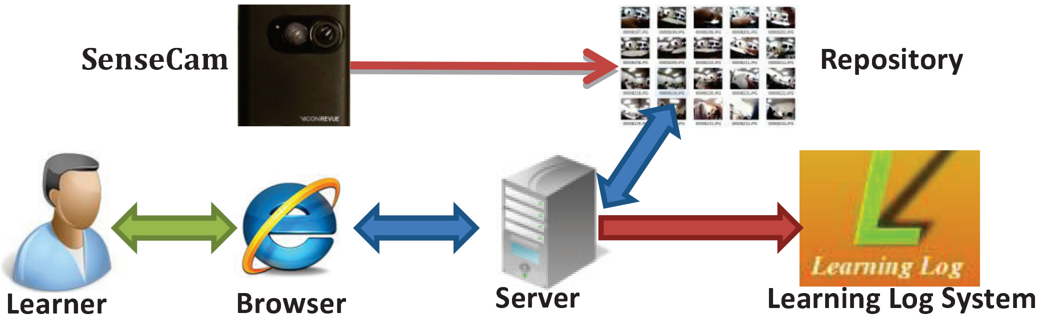


Figure 5. System Architecture

Figure 5 shows the system architecture. All the photos captured by SenseCam and sensor data are imported into repository. When a learner uses this system through browser, server accesses repository and analyzes the photos by sensor data, then returns the classified photos to learner. Then he selects proper photos and uploads them to learning log system through the server. We have a plan to use image processing technology to detect the photos which contains faces or texts.

### *4.2 User Interface*

When the learner starts this system, s/he is required to enter the username and password as the same as SCROLL system. If this is the first time that learner logs in, system will ask learner input the location of sensor data path. This setting can be changed at any time by the setting page. The sensor data path must contain the sensor data file (data_v3.sql), and since the security issues, learner cannot choose the folder directly by file select dialog. For the Vicon Revue SenseCam, this folder is usually named "Vicon Revue Data" and located at user's documents folder. When the SenseCam connects to the computer, all the data will be import into this folder automatically.
After that, life-log picture folders will be shown to them including the name of the folder, picture number and last updated time. Each folder contains photos for a PACALL frame. Here, the name will be used to locate the folder directly in file explorer. Sometimes, if a SenseCam has no picture and is connected to a computer, a life-log picture folder will be also created with no data. Picture number makes it clear, and save the time when the learner selects life-log picture folder.
When the learner selects a new folder, the system will analyze the file SENSOR.CSV in this folder. Because in this file, the sensor data is record as event flow, we need to analyze it and get the sensor information of each picture. At the end of this process, the information of each picture will be saved into database and the life-log picture browser page will be shown (Figure 6 left). On the top of this page, classifications are shown like menus including ALL, MANUAL, NORMAL, DUPLICATE, SHAKE and DARK. The numbers of pictures in each classification are shown on the side of classification. There is also a function that let users change the lines of pictures per page. It is very useful when user wants to view all of the pictures or do not want to drag the scroll bar.

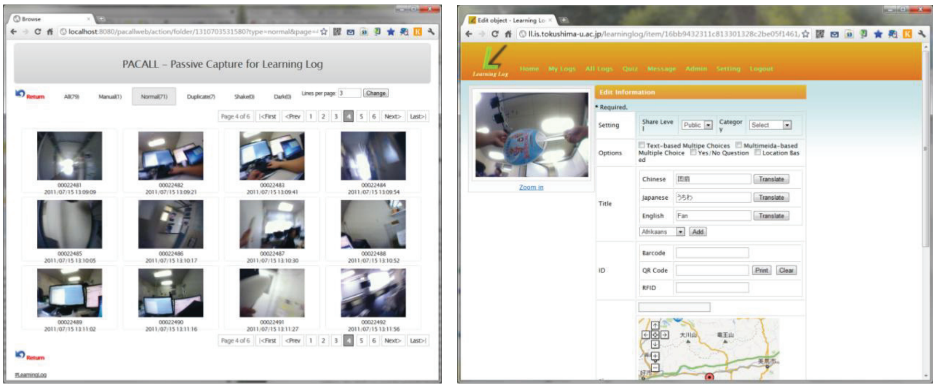


Figure 6. Interface

Once the learner clicks a picture, the system will show a page to view the large picture and help learner upload the picture to SCROLL. Currently, this page is very simple, and there are two buttons – “Upload it” and “Close” and one picture on it. However, in the future, we plan to expand this page and show the similar pictures from remote server on it.
If leaner decides to upload this picture to the server, s/he can click the “Upload it” button. Then the picture will be uploaded to the SCROLL system directly and the page will jump to the learning log registration page (Figure 6 right). On the learning log registration page, learner is required to input the title of the picture. The title is usually the name of the object in this picture. Location and other options are also supported on this page. When an object is registered to the system, SCROLL system will use “organize”, “recall” and “evaluate” model to help learner remember uploaded objects and vocabularies. For example, system will remind learner this vocabulary by quizzes.

### *4.3 Initial Evaluation*

This is an initial evaluation experiment. We have conducted this experiment on computer and the target is to see the effect of analyzing sensor data.
Firstly, we use SenseCam to capture daily life. Then using PACALL to classify the photos and review the accuracy rate. This process has been conducted for three times. Table 2 shows the result of this experiment.

Table 2. Result of Evaluation Experiment

| No. | Capture time | Total number | Normal (correct/total) | Duplicate (correct/total) | Shake (correct/total) | Dark (correct/total) |
|---|---|---|---|---|---|---|
| 1 | 2.5h | 683 | 544/579 | 1/1 | 26/28 | 41/73 |
| 2 | 4.8h | 1089 | 377/434 | 383/383 | 8/16 | 166/253 |
| 3 | 24h | 2467 | 46/86 | 1800/1800 | 0/5 | 568/568 |

No.1 was captured in a common daily life, and no.2 was captured in a conference, and the no.3 was captured when we left SenseCam on the table during 24hrs. From this table, we learned that duplicate has the highest accuracy rate. It means in duplicate tab, all of photos are duplicated. But the results of shake and dark were not sufficient enough. After analyzing data manually, we have noticed that value from color light sensor is not changed immediately upon the light change but photo is usually taken at that time.
On the whole, this system is helpful for reducing the workload enough and usable for reflection. In the future, we will also use image processing technology to improve this system.

## 5. Conclusion and Future Work

In this paper, we introduced a project named PACALL that supports passive capture for learning log using SenseCam. We have designed a model of learning process in passive capture mode including capture, reflect, store. The PACALL system has been also developed in order to support reflection and reduce the workload of reviewing photos. During this research, we found that the SenseCam that originally designed for memory aid can be also used to capture learning log for passive mode. However, it usually takes too many photos, and many of them are duplicated or dark. Therefore, we must introduce other technology to help learners find out important photos. Currently, we are using sensor data to help us do it. In the future, we also use images processing technology to detect the contents of photos. Besides, current algorithm and user interface also need improvement. In addition, we plan to conduct a full evaluation experiment and invite students to use this system in the near future.

## Acknowledge

This research work was supported by Japan Science and Technology Agency, PRESTO, and the Grant-in-Aid for Scientific Research No.21650225 from the Ministry of Education, Science, Sports, and Culture in Japan.

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Mohd Ayub A. F. et al. (Eds.) (2011). Workshop Proceedings of the 19th International Conference on Computers in Education. ChiangMai, Thailand: Asia-Pacific Society for Computers in Education.

# Development of Personalized and Context-aware Model in Learning Log System

**Mengmeng Li[a], Hiroaki Ogata[a], Bin Hou[a], Noriko Uosaki [a], Yoneo Yano [a]**
[a]*Graduate School of Advanced Technology and Science, University of Tokushima, Japan*
lemonrian99@gmail.com

**Abstract:** In this paper, we describe a personalization and context-awareness model based on learning log system. It is able to notify the learners of the location-based knowledge surrounding him in accordance with both their needs and context, detect learners' learning styles using their context history and recommend learning objects for them regarding their learning styles. What's more, by monitoring learners' reaction on the recommendation message, the model can improve its prediction. We also conduct a preliminary experiment to observe what kind of benefits it can bring to learners. The results reveal most of the learners benefit from the context-based notification and learning-style based recommendation.

**Keywords:** personalized learning, learning log, context-aware learning, language learning

## Introduction

Since many years ago mobile technology has been believed holding out great promise for learning [1]. However, some of its limitations such as the small screen size, the high cost of 3G network and so on stopped the technology from growing as fast as we expect. Until the last few years, a real great revolution is occurring in the mobile device world with the release of the new generation smartphones represented by iPhone launched by Apple Inc. and the open sourced Mobile OS Android released by Google. Since the new generation smartphones accommodate users with many advanced functions such as the multi-touch interface, full browser, GPS, millions of applications and so on, the number of smartphones users is increasing very sharply recently. Another key feature of smartphones is that they are equipped with a range of sensors such as the accelerometer, ambient light sensor, GPS, microphone, camera, compass and so on. Several years ago, researchers forecasted that the mass of mobile smartphones equipped with sensors could be turned into a giant distributed sensing system, allowing users to benefit from information gathered via other phones and users [2].

Yet, in our research we intend to primarily investigate the capabilities of the sensors of smartphones in context-aware and personalized mobile learning. Precisely speaking, we propose a personalization and context-awareness model which can monitor and analyze learners' activities and context and recommend learning objects for learners taking into account both their learning needs and their context. Meanwhile, the model can track their contextual data as context history when they study and catch their personal learning styles through analyzing their context history. Finally, it will utilize their learning styles to support individual learners' learning. In this paper we will put our main emphasis on introducing the details of this model.

Furthermore, our research model is based on a system called learning log system which allows learners to log their learning experiences with photos, audios, videos, location, QR-code, RFID tag, and sensor data and so on, and share and reuse them with others [3].

The ambitious goals of this system are lying in helping users to easily record their learning experiences, reminding them to recall what they have learned based on the context, recommending others' learning experiences for them, finding out individuals' learning styles and supporting their learning in accordance with personal learning style. The model we propose is responsible for the latter four goals. In section 2, we will highlight the main functions of the system in detail.

The rest of the paper is constructed as follows. In section 2, we introduce the Learning Log system and a primary scenario of its use. In section 3, the personalized learning and context-aware model is presented in terms of its three dimensions. Besides, the workflow of the model is explained as well. Section 4 shows a preliminary experiment on the model and the future work derived from the participators' comments. At last, conclusions are given.

## 1. Learning Log system

With the evolution of the mobile devices, our lives are changing gradually. For example, usually we take memos or notes (such as schedules, planners or task lists) in our pocketbooks. But now more and more People prefer to record these messages with their cell phones. Obviously, it is a simpler way, since the information can be contained in much more ways like texts, photos, audios and videos. Many researches have focused on facilitating this kind of "informal note taking", such as [4], [5]. However, besides informal notes we also take formal notes. For example, most of the language learners have a vocabulary notebook as shown in Figure 1. We call these kinds of notes as formal notes. In this paper, formal note is defined as a recorded form of knowledge or learning experience acquired in our daily lives and this kind of notes serves as memory storage for notable or important knowledge to review, to remind and to reflect. Learning log system is a system proposed for supporting such formal notes taking and the "learning log" is defined as the electronic record of these notes organized in the form defined by the system.

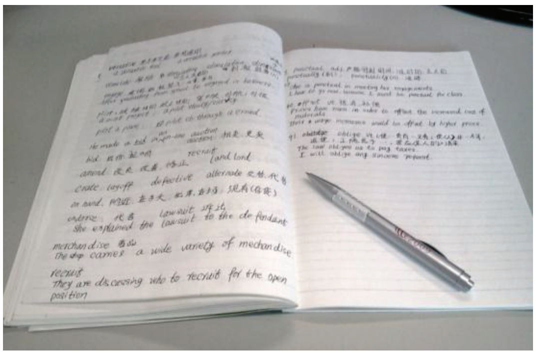


**Figure 1: Language learning notes**

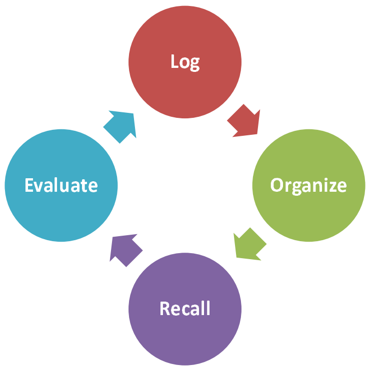



**Figure 2: LORE model**

Learning log system is constructed based on a LORE model which is shown in Figure 2. It aims to aid users to simply capture what they learn, review and reflect their past learning logs, reuse the knowledge when in need, be reminded at right time at right place and be recommended others' learning logs. It adopts an approach of user created content to share knowledge among users. The following parts list several basic functions of the system and describe a typical scenario of its use.

### *1.1 Log what we have learned*

This function provides an easy way for the learners to upload their learning logs to the server whenever and wherever they learn. A well-organized form of learning logs is defined. It includes four basic elements to illustrate a learning log, which are the time when the learning occurred (when), the knowledge (what), the sequence recorded in texts, photos, audios or videos that the learning should comply (how), and the location where the learning occurred (where). Besides, the logs can be organized by tag and category. Figure 3(1) is the interface of adding a new learning log and Figure 3(2) is an example of learning log. One more property we need to explain is whether a learning log is location based or not. The purpose of this is to remind learners with the location context. This is because the place where we learned usually can remind us what we have learned there. For example, if we learned the Japanese names of vegetables in a supermarket, when we enter the supermarket next time some of what we have learned may come into our mind again.

### *1.2 Recall what we have learned*

Learning log system is also designed to help learners remember what they have learned. Compared with only viewing what we have learned, being asked in quizzes is thought to have a greater impact on confirming whether learners have mastered the knowledge or not. For this reason, the system is proposed to provide users with quizzes after they learned something. Three types of quizzes can be generated automatically by the system, which are yes/no quiz, text multiple-choice quiz and image multiple-choice quiz. Figure 3(3) shows an image multiple-choice quiz generated based on the meta-data of learning logs.

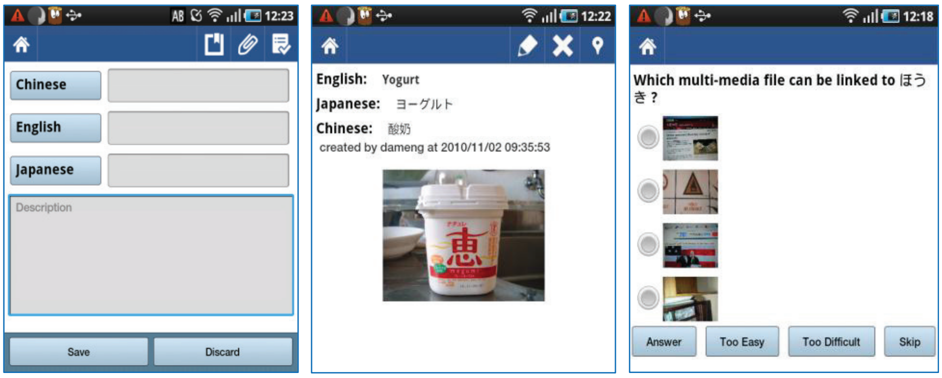
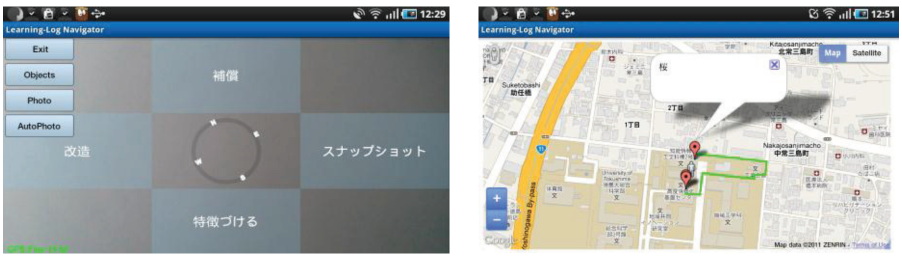



**Figure 3: (1) Add ULLO (2) A learning log (3) Quiz**




**(4) Navigator (5) A path to learning logs**

### *1.3 Location based knowledge awareness*

Another function of Learning Log system is LL navigator. It is a function built on mobile augmented reality allowing the learner to navigate through the learning logs. It provides the learner with a live direct view of the physical real-world environment augmented by a real time contextual awareness of the surrounding objects. While a learner is moving with his mobile phone, the system sends an alert on the phone as soon as entering the region of learning logs according to the GPS data. This view is augmented, associated with a visual compass, and overlapped by the nearest objects in the four cardinal directions (Figure 3(4)). Also, it offers the learners a list of all surrounding objects. When the learner selects one or more of these objects, the Google map will be retrieved, and marked with the learner's current location and the selected objects. Moreover, the system shows a path (route) for the learner to reach to the objects locations (Figure 3(5)). This assists the learner to acquire the location-based knowledge around him/her and to recall his/her past learning logs.

### *1.4 The Scenario of Using Learning Log System*

Up to now, the learning log system mainly focuses on language learning field. One typical scenario of its use is to assist foreign students learning Japanese in Japan. In this case, Japanese learners, who face rich learning contexts every day, can gain abundant of knowledge from their daily lives in different kinds of situations, such as shopping in the market, seeing doctor in the hospital, having a haircut in a barbershop, visiting the museum and so on. As mentioned, one objective of learning log system is to support learning in these contexts. Besides, lots of these learners have their personal learning styles, such as studying Japanese on the commuting train, or studying Japanese before they sleep. Learning log system is also responsible for aiding these kinds of learning styles. This paper is based on the case study under this scenario.

## 2. Personalization and Context-awareness model

As mentioned in the beginning of the paper, we propose a model for personalized and context-aware learning with two objectives:

(1) The system can be aware of learner's current context and after analyzing the context it can determine whether to notify him the location-based knowledge he have learned near his current location or the surrounding knowledge uploaded by others which may interest him.

(2) The system can catch individual learner's learning style by making use of the context data obtained when the learner studies. If a learner's learning style exists, the system can persuade him/her to study based on the learning style.

In a word, this model aims to help learners recall their past knowledge by quizzes at a proper time in a related context, recommend suitable knowledge for them based on their current context and their needs and prompt them to learn when the context is including their favorite learning styles. Furthermore, this model consists of three dimensions, which are learners' current context information, learners' preferred learning styles and the attributes of learning material. The followed sections we will introduce theses three dimensions respectively in detail and finally we will talk about the flow of this model.

### *2.1 Learners' context*

A lot of study on context-aware computing can be found in the literature. Here we want to highlight some of them. For example, [6] has developed a location-aware system called commotion that link users' personal information to their locations in daily lives. [7] presents a system to deliver dynamical message to users according to their schedule, location and so on. [8] describes a similar system using the context information involving time, place and more sophisticated pieces of context. From the above projects, it is easy to find that lots of context-aware computing researches employ the location and time to sensor users' state but some other contextual information are rarely used and the context history which is also believed to be useful has not been fully utilized [9]. For these two reasons we proposed our model. We divide the context into three parts:

(1) Learner's activity: Learner's activity involves their motion (e.g. walking, running, travelling on the train or bus or keeping stationary) and what they do with the devices (e.g. listening to the music through earphone, surfing on the internet, and doing learning with the learning system and so on).
(2) The status of device: The status of device includes the battery, the Internet connection (3G, Wi-Fi or no connection), and the model of the ringtone (vibrate status or ringtone).
(3) The environment. The environment involves the location, time, temperature, weather and so on.

Based on the above information, we firstly analyze whether the context is appropriate to draw the users' attention. For example, whether the battery is enough, whether the Internet is connected, whether it is too late for the users and whether the user is moving in a high speed. If these conditions are satisfied, the system then will notify the users their surrounding knowledge and remind them their past knowledge if these learning objects are existed based on their location context. Finally, the system will check whether the notification is responded. If responded, the contextual information will be recorded as context history. Such kind of information will be reused for analyzing the learners' learning styles. We will introduce this part in the next section.

### *2.2 Learners' Personal Learning Styles and Preferences*

What are the learning styles? Harold Pashler defines this term as that individuals differ in regard to what mode of instruction or study is most effective for them [10]. A variety of learning styles have been supported by many systems. For example, [11] developed an English learning recommender system capable of proving ESL students with reading lessons that suit their different interests to increase their motivation. [12] presents a personalized mobile English vocabulary learning system, which recommends appropriate English vocabulary for learners according to individual learner vocabulary ability and memory cycle. In our model, these personal attributes are also included, such as learners' memory cycle, learners' ability and learners' interests and so on. For instance, the respective learner's ability and interests can be retrieved based on the content analyzing method. In other words, the system monitors each learner's action such as what kind of knowledge s/he recorded recently, what kind of other learners' knowledge s/he looked through, what kind of quizzes s/he corrected or mistook and so on. By analyzing these data, learner's learning preferences including his/her capability and learning interests can be achieved.

However, besides these kinds of learning styles that is usually supported by many systems, we think some more personal learning styles that can only be detected by mobile learning and ubiquitous learning should be supported. These learning styles involve where a learner usually studies (such as home, school or fast-food restaurants), whether a learner has a habit of studying on the commuting train and when a learner prefers to study (e.g. after waking up in the morning or before sleeping at night) and so on. In our opinion, these kinds of learning styles play a very important role on our learning because usually they are related to learners' daily customs and habits. What's more important, these learning styles can be easily obtained by analyzing the context histories, which are thought to be important but rarely be used [9]. For example, the system can make use of the contextual data including the speed and the time to detect whether a learner commutes by train or bus and whether s/he would like to study when commuting. Besides, the system can also find the learners' preferred studying places and time phases by analyzing the GPS information and the time of studying. After achieved the learners' learning styles, the system can recommend the messages to the learners when they entered those environments and by checking the learners' response rate the system can also modify its prediction.

### *2.3 Learning Contents*

In this study, learning contents are referred to the learning logs stored in the system. For one learner, the learning objects can be separated into three types: his/her own learning logs, the ones that s/he has looked through and the ones recommended by the system. Regarding the former two types, systems will provide quizzes for learners to recall them. But for the last type, the system should tailor the contents to suit individual learners' needs according to the difficulty of them. We use a dynamical way to adjust a learner's ability level and the difficulty level of the learning materials which refers from the [13]. Both learners' ability level and the difficulty level of the quizzes are affected by the correct rate. As the multiple-choice quizzes are generated from the learning logs the learners have learned, the selected wrong choices are also calculated. The system manages to match the difficulty level of the learning contents with the learners' ability level.

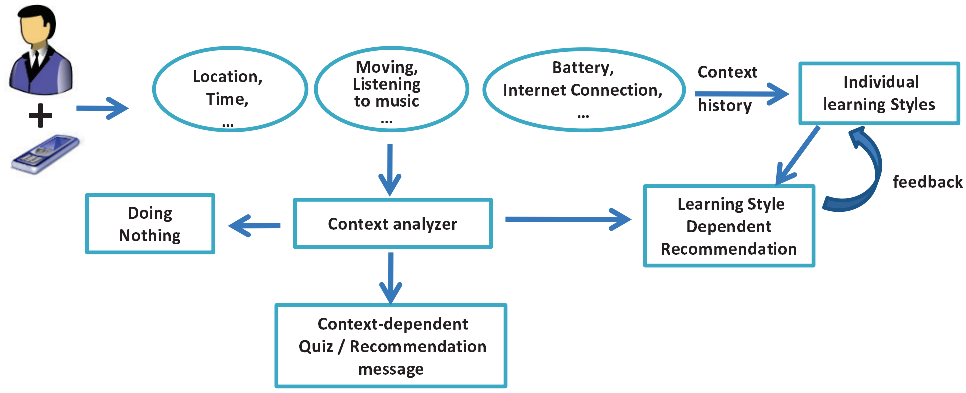



**Figure 4: The workflow of the personalization and context-awareness model**

### *2.4 The Workflow of the Model*

Figure 4 demonstrates the whole processing flow of the personalization and context-awareness model. It follows the below steps:

(1) The model collects a learner's context information from three parts: his/her activity, the status of device and the environment.

(2) The model analyzes the context and check status of the device: for example, how much battery is left and whether the internet is connected. If the availability is low, the system will do nothing.

(3) If the device has a high availability, the system will check whether there is location-based knowledge surrounding the learner. If existing, the system will provide location-dependent quizzes or recommendation messages for him/her.

(4) If there is no location-based knowledge for the learner, the model will examine if the learner is in his/her preferred learning context. If so, the model will show messages to persuade him/her to study.

(5) All the data of the context is remained as context history to approach individual learner' learning styles. Finally the learner's response to the learning style based recommendation is used to improve the learning style detecting method.

## 3. Evaluation and Future Works

In order to evaluate our model, we conducted a preliminary experiment. Through this experiment, firstly we intend to investigate whether the learners can retain what they have learned by linking the context to their past learning logs and whether others' learning logs are meaningful for them by notifying them the context-based learning logs. Secondly, we hope to make it clear whether the system can find out each learner's individual learning styles and support them well. Finally, we are eager to know what kinds of other benefits the model can bring for learners and what kinds of improvement are demanded.

In this experiment, we organized ten foreign students to use the learning log system for two weeks. The participators are from China (3), Taiwan (1) and Korea (6). The device adopted is Galaxy Tab SC-01C produced by Samsung. Before the experiment started, they were given one week to get used to the smartphones and the system. Then, they spent two weeks to use the system and after that we interviewed them one by one. We expect to acquire the results from the interviews and the statistical analysis on the learners' data of using the system. Here we pick up the typical messages including the positive and the negative:

- When I am free at home, sometimes I receive recommendations of reviewing what I have learned. It is very suitable and helpful.
- It is very useful to use it on bus.
- It was suitable to be recommended in the past. But I suggest you to consider more parameters, because it is not easy to catch the real context with few aspects.
- It is not good enough, since sometimes I am alarmed when I am very busy.
- Because the Galaxy Tab is a little big, I seldom take it out. So it is meaningless for me.
- It is not so useful the People who do not usually take the devices out.

Besides the messages, they also evaluated the learning-style based recommendation function and the score is 3.8 (A five-point Likert-scale is used, the responses to which were coded as 1 = strongly disagree through to 5 = strongly agree.). From the messages and the score, we can infer that most of the learners who have personal learning styles can benefit from the recommendation messages from the system and while part of them have a low opinion of the function, for the judgment of the system on the learners' context is not appropriate. This is a problem to solve in the future. As for the context-based notification function, the result can be gained from the users' reaction on the recommendation messages. During the two weeks, the system sent 7 pieces of messages for the learners and 4 of them have been responded. The high response rate surpassing 57% is very encouraging. Through the interview, we also received a lot of advices on the functions they demand and we list all of them:

- It will be very helpful if I can get support from the system when I go to hospital, supermarket, and barbershop and so on. Moreover, we need not only the words, but also some daily sentences.
- I need Japanese support when I have lunch in the restaurant or go shopping.
- For example, when I see something such as exercise machines and computer, the function that teaches me how to use them is very useful for me.

These comments reveal that these learners are eager to get help instantly in lots of situations of their daily lives. It points out one of our future work on the context-based recommendation that the model can recommend the learning objects based on a similar context. For example, if one learner learned how to express headache in a hospital, when he go to another one the system can also send him/her a message to review the way of speaking headache. Another function posed by the learner is to help them a real work in daily life such as to demonstrate how to change a toner cartridge for a printer. This is another issue we will explore soon.

## 4. Conclusion

In this paper, we introduced a personalization and context-awareness model on the basis of learning log system. This model aims to assist learners to review what they have learned and recommend others' learning experience for them by utilizing the context. Also, it can detect learners' learning styles by analyzing their context history and prompt them to review past knowledge according to their learning styles. Finally, the attributes of the learning objects are also considered in the model. We conduct a preliminary experiment to examine our model and the results illustrate learners can benefit rom our model well both from the context-based notification and the learning-style based recommendation.

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Mohd Ayub A. F. et al. (Eds.) (2011). Workshop Proceedings of the 19th International Conference on Computers in Education. ChiangMai, Thailand: Asia-Pacific Society for Computers in Education.

# Supporting English Course with Mobile Devices: How Can We Learn Vocabulary Seamlessly?

**Noriko UOSAKI*, Hiroaki OGATA, Taro SUGIMOTO, Bin HOU, Mengmeng LI, and Yoneo YANO**
*Dept. of Information Science and Intelligent Systems*
*Faculty of Engineering, The University of Tokushima, Japan*
*n.uosaki@gmail.com

**Abstract:** We proposed SMALL system as a blue print seeking for seamless language learning in our previous study. In this paper, we describe how far we have developed the system for the realization of intertwining in-class formal learning with outside-class self-learning. As our first step, the target has been English vocabulary learning, since vocabulary learning is one of the fundamental aspects of language learning. We also aim to create a knowledge-aware virtual learning community to promote P2P interaction in our seamless learning environment.

**Keywords:** Mobile Assisted Language Learning (MALL), Seamless Learning, Vocabulary Learning, Learning Log, EFL, TESOL

## Introduction

English has been a dominant language in the world [1]. Therefore EFL (English as a Foreign Language) education is pivotal for non-English speaking countries including Japan. However, Japan is facing a serious problem in terms of English proficiency. "… it is rare to find a Japanese student who, after six years of English, is able to engage in even a marginal dialogue with a speaker of English" [2]. Japan ranked 3rd worst out of 30 Asian countries in TOEFL test (Test of English as a Foreign Language) [3]. One of the factors which have caused this disappointing situation is lack of learning time of English at school [4]. If time to study in class is limited, there is no other way but to learn outside class. Here our basic issue is to establish an effective method to carry out outside-class learning as well as to entwine in-class learning with outside-class learning. Along with the shortage problem, it has been long pointed out that Japanese EFL learners are in lack of vocabulary. Since it is an essential component in language as is often cited, "Without grammar, very little can be conveyed. Without vocabulary, nothing can be conveyed" [5], it is pivotal to build up vocabulary to improve one's language skill. Besides, vocabulary learning is often considered boring [6]. One solution of these problems may lie in mobile assisted language learning, which has been gaining global attention in recent years. Since mobile phones are most popularly used in Japan, the idea is realistic. So our aim is to provide EFL learners with a seamless vocabulary learning support system, namely SMALL system.

## 1. Theoretical Background

### *1.1 Seamless Learning*

Recent progress of mobile and wireless technologies offers us a new learning environment, namely “seamless learning”. “Seamless learning” is used to describe the situations where students can learn whenever they want to in a variety of scenarios and that they can switch from one scenario to another easily and quickly using one device or more per student (“one-to-one”) as a mediator [7]. In this paper, however, by seamless learning, we mean learning which occurs with smooth and seamless transitions between in-class and out-class learning as “American College Personnel Association (1994) stresses the importance of linking students’ in-class and out-of-class experiences to create seamless learning and academic success.” [8]. Seamless learning can be depicted in a two-dimensional way 1) in-class and out-class learning and 2) planned and unplanned learning. Thus there are four types of learning accordingly: in-class planned learning, in-class unplanned learning, out-class planned learning and out-class unplanned learning [9]. And if the technology could help these four types of learning interact with one another and help them to be incorporated into one continuous learning beyond time and space, learning could be very successful.

In addition, we need to consider that we usually have only one instructor per class, small or large. What the teacher can do through these four types of learning is limited. So peer-to-peer (P2P) collaboration is necessary for successful seamless learning. How we can adopt P2P collaboration effectively in a seamless learning is another key issue. We aim to create a knowledge-aware virtual learning community to promote P2P interaction in our seamless learning environment.

### *1.2 Mobile Assisted Vocabulary Learning*

Vocabulary is one of the most important components of a language. But living in Japan, students rarely have exposure to English outside the classroom. Since incidental learning is not highly expected, they should be encouraged to learn vocabulary outside-classroom on an autonomous basis. Then here come the questions: What is effective vocabulary learning? How should learners learn vocabulary? Unfortunately, researches on vocabulary learning strategies are in a lack of theoretical underpinning up to now [10]. However, along with recent development of studies on technology enhanced learning, there have been considerable studies on mobile assisted vocabulary learning such as *Vocab Tutor* [11], *Moodle for Mobile* [12], *m-iLexicon* [13] including commercial products such as *Eigo Duke* (*English Training: Have Fun Improving Your Skills!*) [14]. However, most of these vocabulary learning systems are ready-made closed vocabulary learning systems which often specialize the textbook vocabulary or chosen vocabulary of say, basic 3000 word-level. Learners cannot customize their own want-to-learn vocabulary. Besides, many of them are aiming for self-vocabulary learning, outside the classroom. There are few which challenged to entwine in-class planned vocabulary learning with out-class open vocabulary learning. Therefore our main purpose is to develop the system which links what students have learned outside-class with what they have learned inside-class, and also with what other students have learned.

### *1.3 Importance of Link*

Why is it important to link? We learn words from the context [15]. The whole (contexts) precedes the part (words) in language acquisition [16]. Therefore we need the contexts where the words are used in order to learn vocabulary. For instance, for many Japanese learners of English, it is difficult to grasp the meaning of 'subject to' unless they encounter this phrase repeatedly in different contexts as below:

- All visitors and packages are subject to electronic scan.
- This Agreement shall be subject to the laws of Japan.
- The terms of your account are subject to change

Therefore by linking the one context to another, the system let them learn how the words are used in different contexts. It is reported that frequency of occurrence encourages incidental vocabulary learning and that reappearance of a word reinforces the form-meaning connection in the learner's mental lexicon [17]. These facts endorse the importance of linking.

## 2. System Design

### *2.1 SMALL System*

Based upon the above ideas, we designed the following Seamless Mobile-Assisted Language Learning Support System (hereafter we call it SMALL System) (Figure 1) in our previous study [18].

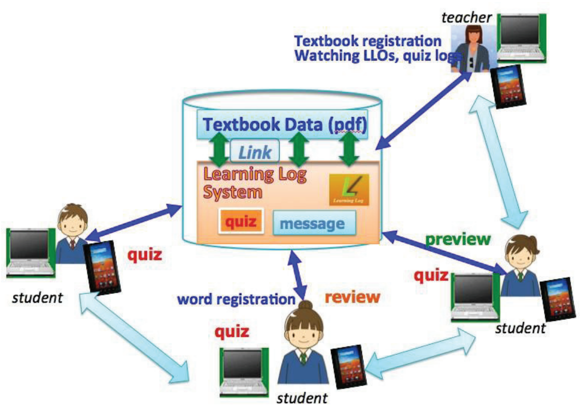


Figure 1. SMALL System (Seamless Mobile-Assisted Language Learning Support System : http://ll.is.tokushima-u.ac.jp/ecourse/)

#### *2.1.1 Textbook Data*

Texbook Data in Figure 1 consists of the whole units of the textbook to be learned through one semester. This system is available for any textbooks if they have Pdf versions. Instructors upload Pdf file textbook data to the system (Figure 2). They can add and delete files anytime.


Figure 2. Textbook data uploading interface

#### *2.1.2 Learning Log System*

Learning Log System, SCROLL is a system developed by our team. Users register what they have learned, which we call "learning log objects (LLO)" to the system and view LLOs uploaded by themselves and others, then it supports recalling of their learning logs by giving them quizzes [19].

#### *2.1.3 Quiz*

Students register textbook target words and their newly acquired words during their self-learning and the system gives them quizzes. It generates quizzes automatically based on the LLOs registered and viewed by the students. The aim of the quiz is to help the students retain their vocabulary. Quizzes will be generated until they give them correct answers. And after a certain interval, the system gives them quizzes which they have answered correctly to make sure if they are retaining their acquired vocabulary. That way it is expected that their short-term memory will be reinforced into long-term memory. Logs of all the quizzes done by the students are stored to be analyzed and evaluated. Wrong answer rates reflect the quiz generation and if the users click "too easy" or "too difficult", it also reflects quiz generation and difficulty level adjustment is made so that it facilitates their learning processes.

#### *2.1.4 Message*

Users are able to send massages to other users in this system. In "All Logs" page, it shows the names of the users who registered the objects. When a viewer clicks the nickname, new window will be popped up and can send a message to him. This function will promote the students' interaction or discussion and will lead to collaborative learning which will be inevitable where the teacher in not there outside-class self-learning.

### *2.2 The scenario*

The scenario using this system is as follows.

#### *2.2.1 Preview (mobile-based out-class planned/unplanned learning)*

Students resiger textbook target words instructed by the teacher and read the text for preview and take target word quizzes. They answer multiple-choice quizzes. Quizzes will be generated until they make correct answers. They can read texts and answer quizzes at any time and at any location using mobile devices.

#### *2.2.2 Lessons (PC-based in-class planned/unplanned learning)*

In the electronic textbook, student registered words are hyperlinked and when the teacher clicks them, a side bar will appear and it shows the names of the students who registered them so that the teacher will be able to know how many students and who have learned them. (Figure 3).

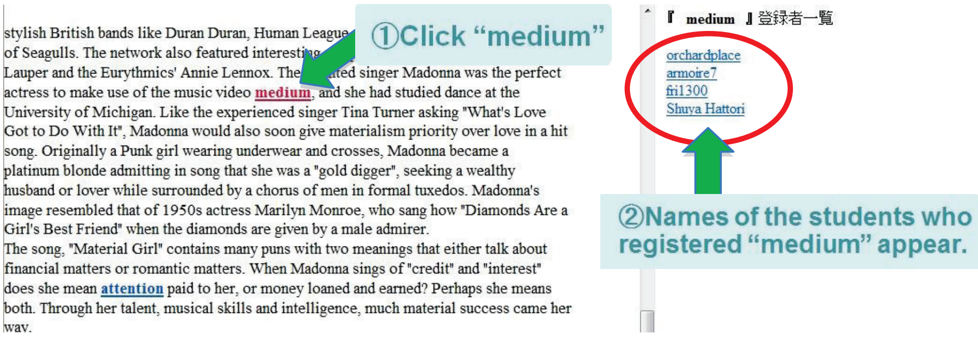

Figure 3. textbook interface

*2.2.3 Review (mobile-based out-class planned/unplanned learning)*

Students read the text for review and take target word quizzes. The quiz logs show the results with most frequently mistaken words and the teacher will review these words in the next class. So the learning occurs continuously.

*2.2.4 Expanded Self-learning (mobile-based out-class unplanned learning):How can we entwine formal learning with informal learning?*

Students are assigned to do self-learning and register new words to the system. Each student is supposed to present in-class in turn what he/she has learned through his/her out-class self-learning so that the teacher can incorporate students' unplanned self-learning into classroom activities. They are encouraged to collaborate with other students who have the same interests.

This system aims to entwine outside-class learning with in-class learning. It also entwines a students's self-learning with that of another. Figure 4 shows how in-class vocabulary learning and out-class vocabulary learning are linked. When a student, Yusuke, registers new word, "including", which he already learned in the textbook, then the system shows him the textbook context where it appears. This linking function is pivotal for two reasons. For one reason, students need to encounter as many contexts as possible to learn words. For another, generally people are likely to forget what they have learned. Therefore even though he felt " including" was totally new to him, the system let him know that he has learned it before in the textbook. If Yusuke and registered the same word, "inspire" that Miwa has already registered, then it shows Yusuke that Miwa did it too, which is expected to lead some interaction between them. It is also expected to add some fun factor in vocabulary learning to know that another classmate is learning the same word.

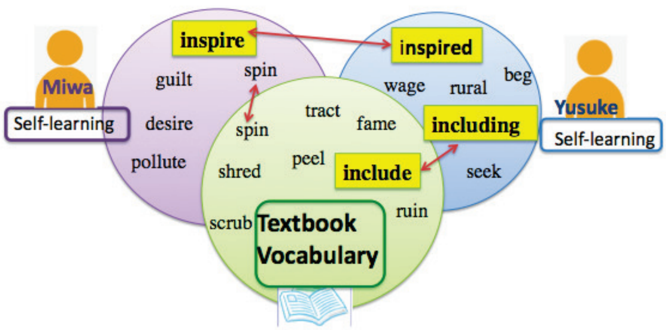

Figure 4. Link between in-class learning and outside learning

In order to motivate them to learn more, the System shows each student his degree of advancement by counting his correct answers out of total number of target words.
With the help from the system, students can be aware of what they have learned before, and what other students are learning, and the teacher can grasp what the students are learning outside-class and incorporate students' unplanned self-learning into classroom activities so that close link between in-class and out-class learning will be realized.
Generally, English education at the university level is arbitrary and leaves to the discretion of the instructors. Therefore it is easy to run the class described above. But Japanese secondary education is subject to the guidelines issued by the Ministry of Education, Culture, Sports, Science and Technology. Therefore in order to introduce students' out-class learning into $7^{th}$-$12^{th}$ class, we need a fundamental reform of the curriculum. A high-level discussion on this issue in the Ministry is strongly desired.
In order to measure how out-class vocabulary learning is linked with in-class one, we propose *link rate* which should be caliculated as follows:

$$\text{link rate} = \frac{\text{n. of registered words}}{\text{n. of words in one chapter} - (\text{n. of words learned during } 7^{th} \text{ grade} + \alpha)}$$

This equation shows the rate of overlapped vocabulary learned in- and out-class learning. The average number of words in one chapter of the textbook was 913 words. The number of words learned during 7th grade was 398 words.  The 7th grade is the first year of learning English. So they are very easy, fundamental words. We excluded these words plus a few more words because collage undergraduates were most unlikely to register such words to the system. "A few more words"  described as 'α' in the above equation was judged by an experienced English teacher. This notion is still in progress and we are far from being sure whether this rate shows the effectiveness rate of vocabulary learning. Further exploration would be necessary.

## 3. Method

Upon the completion of the system, the following experiment will be conducted.

### *3.1 Experiment*

Forty university students will be divided into two groups with the equal English proficiency according to the pre-test result. The test consists of target words to be learned in the textbook. Each group will be engaged in learning vocabulary, where Group A will use SMALL System, while Group B will learn vocabulary with Mircosoft Excel files to make their own vocabulary lists using home PCs and classroom PCs. Evaluation will be carried out over a period of six weeks. At the end of the phase, the subjects will undergo two kinds of post-tests: the same vocabulary test as the pre-test (Post-test 1) and a vocabulary test containing self-learned words gained through unplanned learning (Post-test 2). As for Group A, Post-test 2 will be created by the System which identifies what they have learned through self-learning. As for Group B, it will be created based on each student's word list by Excel files. Both post-tests will be designed to translate the target words into Japanese. The students will also be given questionnaires. Further data will be collected from the subjects of Group A by means of the log data contained in the server.

### *3.2 Pilot*

Before the actual classroom use, 6 university graduate students and 1 undergraduate were asked to give a trial use of the system to see if any serious problem exists to carry out the above mentioned experiment. The subjects were asked to register 5 recommended words with their contexts, to click the words they registered in the textbook pages to learn other contexts and to send messages to other users. In the end of the experiment, they were surveyed by the questionnaire. Table 1 shows the result of the questionnaire.

Table 1 Questionnaire Results (five-point-scale)

| Questions | M | SD |
|---|---|---|
| Did you like it when the system let you know that you can find your self acquired vocabulary in the textbook? | 4.57 | 0.49 |
| Did you like it when the system let you know that your self-acquired vocabulary is also registered by other users? | 4 | 1.07 |
| Was it useful for your vocabulary learning to read textbook contexts where your registered words appeared? | 4.57 | 0.49 |
| Was it useful for your vocabulary learning to read other contexts of your self-acquired words which were registered by other users? | 4.43 | 0.73 |
| Was the message system useful for collaborative work? | 3.71 | 1.16 |

**Open Comments**

- It would be better if I can see the meaning and contexts of the word registered by others at the same time (by one click).
- The letter size and space between lines of the textbook were small. it would be more convenient if I could see the meaning of the words not by clicking but by just positioning the cursor.
- Color coding of the words in the textbook was helpful for me to know if those are my registered words or those by others. Linking my newly registered words with textbook page would be more convenient.
- The textbook interface and layout were not user-friendly. I wanted to see the illustrations in the web textbook just like its paper textbook version.
- I could not check if I could send the message successfully.
- If I clicked the words in the textbook, it showed the names of the learners who registered the word, but I'd like to know the contexts rather than the authors.
- Word registration in this system helped me retaining the word in my memory.

Unfortunately there was no time to do some collaboration in this pilot. In order to let them do some collaborative work, longer-term experiment is necessary. We are planning to conduct a long-term experiment during the second semester 2011.

## 4. Early Insight and Future Works

Upon the above questionnaire results, we have found that we need to improve textbook interface and linking function of registered words and textbook contexts. We have not acquired any data on the classroom use, but possible advantages of the System that we expect are: 1) In-class and out-class vocabulary learning are closely linked so that what they learn in-class will be reinforced in out-class learning and vice versa. 2) Since we learn words from contexts, its linking function can lead to effective vocabulary learning. 3) It encourages out-class self-learning, which is expected to compensate the lack of learning time in class. 4) Linking between the students who registered the same word or who read the same contents could trigger peer-to-peer interactive learning, which is expected to add some fun factor to vocabulary learning which is reported to be monotonous. The disadvantage of this system is that it may be unfair for the students who do not own smart phones unless the project team could provide them.

As our further future work, improvement of the system's capability of identifying related words or derived lexical items will be needed so that when the students register related words, it will be able to successfully make links. That way one's unplanned self-learning will be entwined with that of other students more deeply.

## Acknowledgements

This research work was supported by Japan Science and Technology Agency, PRESTO, and the Grant-in-Aid for Scientific Research No.21650225 from the Ministry of Education, Science, Sports, and Culture in Japan.

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Mohd Ayub A. F. et al. (Eds.) (2011). Workshop Proceedings of the 19th International Conference on Computers in Education. ChiangMai, Thailand: Asia-Pacific Society for Computers in Education.

# Utilizing the HTML5 to Build a Classroom Response System

**Yoshiyuki Tabata[1], Chengjiu Yin[*1], Amy Yu-Fen Chen[2]**
[1]*Research Institute for Information Technology, Kyushu University, Fukuoka, Japan*
[2] *Dept. of Computer Science Information Engineering, National Central University, Taiwan*
**yin@cc.kyushu-u.ac.jp*

**Abstract:** Until recently, there have been many studies which confirmed the effectiveness of the Classroom Response System (CRS). However, many of the existing CRSs use multiple-choice questions. In this paper, utilizing HTML5 technologies, we proposed a short answer collaborative learning CRS, called CLARES, to support group discussion. By the manner which the teacher determines right and wrong answers on-site, we propose that utilization of the CLARES may raise students to a sense of excitement and encourage a sense of expectancy and raise motivation.

**Keywords:** Collaborative learning, Group discussion, Classroom Response System, Smart phone

## Introduction

A Classroom Response System (CRS) is also known by other names such as a Personal Response System, Audience Response System, and Student Response System. The CRS is a system where learners can answer the teacher's questions immediately with mobile devices, and the system will then display the statistics result. According to this result, the teacher can grasp the level of understanding of each learner on the course content. The system turns every learner into an active learner. For instance, 'ClassTalk' [http://www.bedu.com] is a classroom response system that shows teachers the statistics of learners' answers in the classroom immediately [1]. By using the CRS, the students who usually tend to silence in the classroom can participate actively in class. The CRS has the following advantages:

- It allows students to submit their answers immediately.
- It collects the students' answer results, and produces statistical results showing how many students chose each of the answer choices.
- It is easy to participate in class even if he is a shy student.
- Teachers can check on students' understanding on site.
- Most of the traditional classes are conducted in a one-way teaching mode that is from teacher to students. CRS changes the one-way mode to a two way mode.

Moreover, with the development of the web technologies, such as HTML5, we can only use the Java Script and HTML to develop the application, which can be run on the web browser. Many web browsers, which were published after 2008, support the corresponding HTML5 function[1]. HTML5 is the latest technology in internet to look forward to. HTML5 supports animation, local storage and canvas technology which would make the web faster and

[1] http://ja.wikipedia.org/wiki/HTML5

elegant. Utilizing of HTML5, many developers have already started developing HTML5 applications.
In this paper, utilizing the HTML5 technologies, we proposed a short answer question based classroom response system, which called CLARES, to support group discussion and collaborative learning. Students can access CLARES not only from their PC (personal computer), but also from their notebook, PDA or smart phone. In CLARES, we used HTML5 technologies such as building tables dynamically, changing fonts or images dynamically and controlling mouse action. This system is not only support 1 to 1 (One computer to one person), but also support “one to many” (one computer and a group of students).

## 1. Related Works

Until now, we have developed some teaching assistant systems such as Quiz [2] and Web Drill [3]. Quiz is an iPhone based quiz system to help students to understand the linguistic culture in a mobile-learning environment; Web Drill is a web-based system to support building and managing teaching materials. As a teaching assistant system, CRS is a kind of major research topics, which has been conducting various studies. In this section, we did a survey of two systems (BeeDance and Clicker) and do a comparison among BeeDance, Clicker and CLARES.

### 1.1 BeeDance

BeeDance is a iPhone/iPod touchs based CRS system which was developed by CSK Corporation company[2], Japan. It is a two-way communication system to faculty the interaction between the teacher and students. BeeDance is a famous system in Japan, however, some problems are as follows:
a) BeeDance can be used only on iPhone/ iPod touch, however there are not many students have iPhone/ iPod touchs. Some schools provide students iPhone/iPod touchs during class., however, they have to lend iPhones to the students before the class, and maintain and recover iPhones after the class. It becomes a burner for teachers to lend and maintenance equipment such as charging the battery.
b) BeeDance not only supports the multiple-choice questions, but also supports short answer questions. However, it is not easy to input words by the keyboard of the Smartphone, so BeeDance is not suitable for short answer questions.
c) In order to avoid students to remember the number of the correct answer, it is better to randomly each time. BeeDance does not support to arrange answer alternatives, so the teacher has to take care about this problem when s/he creates questions.
d) Using BeeDance, the client software running on iPhone/iPod touchs can be downloaded freely, however, we have to pay for the software of server.
e) Sometime the teacher wants to pose questions on site. However, using BeeDance, the teacher has to prepare questions in advance.

### 1.2 Clicker

Clickers are broadly used on college campuses to record student responses to questions posed during a lecture in the world. The teacher uses a computer and a video projector to project a presentation for the students to see. The presentation slides built with the audience

[2] http://csklc.jp/product/bee.html

response software display questions with several possible options, more commonly referred to as multiple choice questions. The student participates by selecting the answer they believe to be correct and pushing the corresponding key on their individual wireless hand-held devices. The hand-held remote control that students use to convey their responses to questions is often called a "clicker."
After reviewing the literature, Caldwell (2007) reports "Most reviews agree that 'ample converging evidence' suggests that clickers generally cause improved student outcomes such as improved exam score or passing rates, student comprehension, and learning and that students like clickers [4]."
However, the Clicker has the following problems.
a) It needs specialized mobile equipment, "clicker".
b) We have to pay for the system as well as the remote control.
c) Using "Clicker", the teacher has to prepare questions in advance.

## 2. CLARES

As shown on table 1, the characters of CLARES are as follows:
a) There is no device limit. CLARES can run on PC or smart phones. As long as there is Internet, you can use CLARES anytime.
b) CLARES does not support individual learning, it supports a group of students to discuss the answer, and then submit their discussion results to the system.
c) CLARES is short answer questions system, we consider that it is effective to make students to think about the questions and give out a short answer.
d) We will public CLARES as free software.
e) Using CLARES, teacher can pose oral questions on site, so it needs not to prepare questions in advance.

Table1. Comparison

| | **BeeDance** | **Clicker** | **CLARES** |
|---|---|---|---|
| **Devices** | iPhone/iPod touchs | Specialized device | No limit: PC/iPad/SmartPhone |
| **User** | Individual | Individual | Group(Collaborative learning) |
| **Question format** | 1.Multiple-choice 2.Short answer | Multiple-choice | Short answer |
| **Fees** | Have to pay for server license | Have to pay | Free |
| **Creating Questions** | Have to prepare questions in advance | Have to prepare questions in advance | Support posing question on site |

Moreover, the correctness is determined automatically in BeeDance and Clicker. As the results are shown immediately, it couldn't help feeling a sense of excitement, and the knowledge isn't left in the impression. In contrast, the correctness is not determined by system in CLARES, it will be determined by teacher himself/herself. After all the answer results of each group were projected on the screen, teacher can determine the correctness on site, in the same time, the teacher can comment on each group's answer, add to explanations to the answers if necessary. By the manner which the teacher determines right and wrong answers on-site, students can think and reflect during the teacher explained, the CLARES may make students to feel a sense of excitement and encourage a sense of expectancy and raise motivation. In addition, CLARES allows students to think again before the correct answer is displayed.

## 2.1 Check the Adequacy of the questions

If you use this system in the foreign language classes, the system can check the adequacy of questions. That is, the system can check whether the question suit the students' current level.

2.1.1 Determine the adequacy of the questions
In this system, we use a simple way to determine the suitability of the question.

*1) Checking the words which are not yet learned*
The system will check the question whether it contain the words are not yet learned. The words, student learned in every class, will be stored in to database. By matching the question content with the database, the system can check the suitability of the question. Some language such as German and French are inflected languages. By storing the basic type of the words, the system will determine the inflection automatically.

*2) Checking for duplication*
The system can check the duplication of question. In order to check the duplication, the system will search and match by the words of the question title and content from database. If there are questions which is matching over 80% , the question will be presented to teacher, and the teacher will determine whether it is a duplicate or not.

2.1.2 Inappropriate questions
If all the groups are incorrect, we can consider that the question is too difficult and not suitable for the students. If it is not a suitable question, the system will set an unsuitable flag for the question. After the lesson, the system will collect the questions with flag for teacher to urge reconsideration. The reconsideration question will be stored to database to reuse.

## 3. Implementation

3.1 Architecture of system.
This system can be accessed not only from PCs, but also from mobile devices such as a Smartphone, iPod touch. We used wireless LAN (IEEE 802.11b), Tomcat 5.0 as the server on the CentOS5.0. Database schema is designed and implemented using PostgreSQL. Utilizing the Struts framework, the system was developed as a web-based application with JAVA. The Struts framework is a web-based application framework which facilitates rapid application development, and it adopts MVC (Model-View-Controller) design pattern as it naturally fits into the web architecture. Figure 1 is the architecture of the system, there are 2 parts of CLARES:

1. Web Browser.
Teachers, students use a web browser to send request (HTTP) to the web server through PC or mobile devices such as Smartphone, PDA, iPad, iPhone and iPod touch. The answer results can be projected on screen through projector.

2. Web Server.
There are 3 parts of Web Server: teacher component, student component and manager component.
a) Teacher component.
After login with an ID and password, the teacher can:

1) prepare questions in advance,
2) give out question on site,
3) determine correctness of answers,
4) commend on the answers.
5) make answer results project on screen
6) make the aggregate results project on screen

b) Student component.
The student can:
1) discuss and answer questions,
2) upload the group's answer

c) Manager component .

The manager component does the following things:
1) set the access authority
2) store data
3) calculate aggregate results
4) manage groups
5) check the adequacy of the questions
6) accumulate answer result

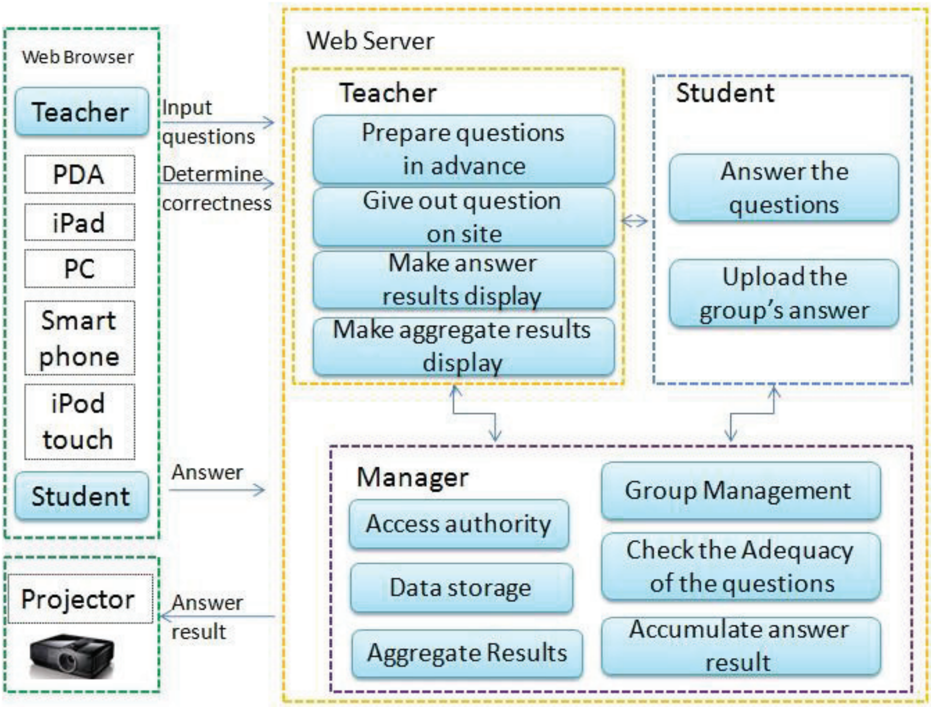


*Figure 1. System architecture*

3.2 Interface

3.2.1 Login interface.
The group user must register an account to use the system by "Register new account" interface. After login with the registered user account, the interfaces will be displayed according to the authority. There are three kinds of authority: "teacher", "manager", and

"group". The default authority is "group" and we can change the authority by "authorities' manager" interface.

3.2.2 Teacher interface.

Teacher can set the group number by selecting the number of "Columns" and "Rows". As shown on the figure 2, it is a sample of 4 groups. By selecting the pull-down menu of "Columns" and "Rows" and clicking "Setting Matrix" button, the interface is split in to 4 groups A, B,C and D. The group name are displayed in the top left of each group area. The answer of each group will be shown on their group areas.

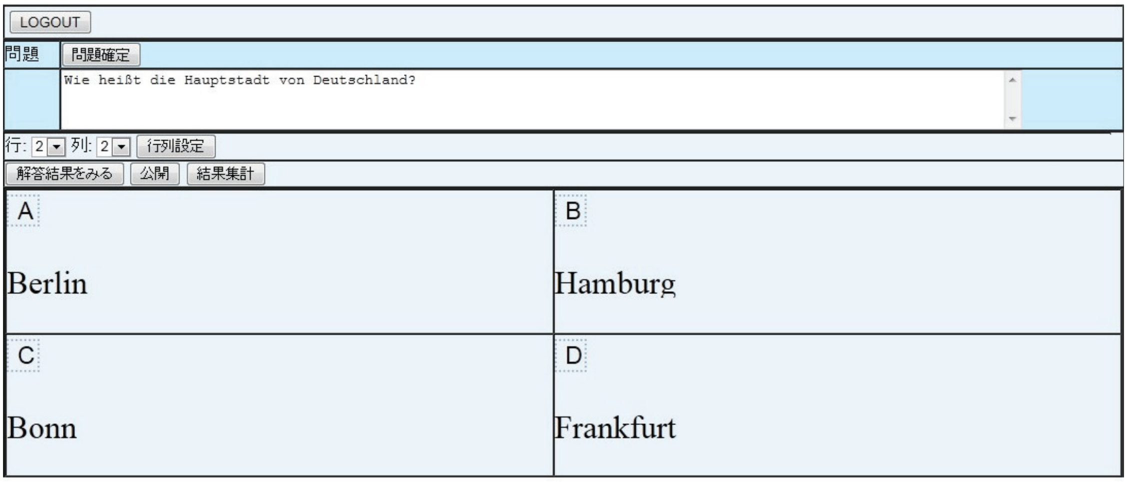


*Figure 2. Teacher interface*

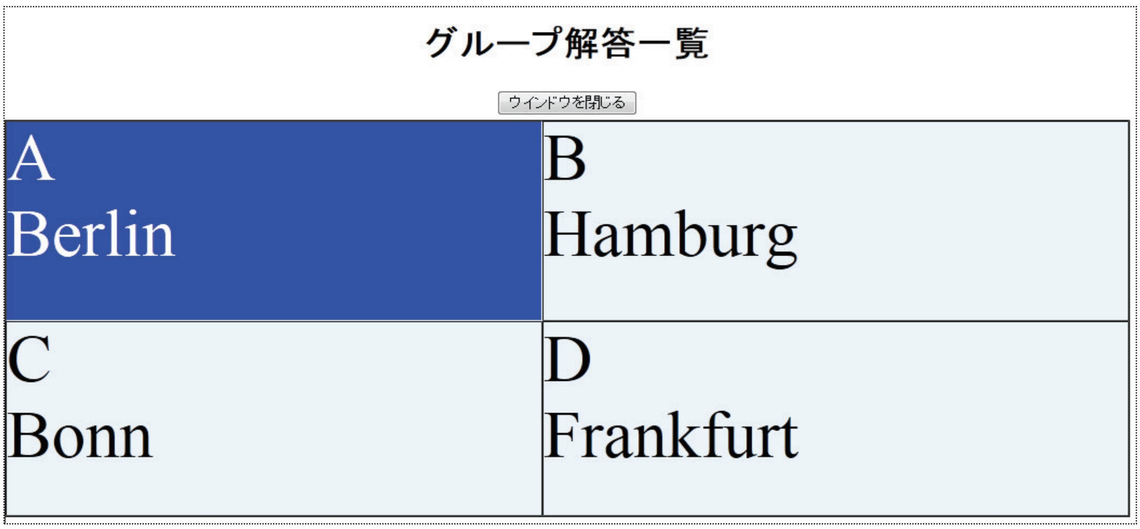


*Figure 3. The interface, which is projected on screen.*

After all groups submitted their answers, teacher click the "Open" button, and then Figure 3 will be shown on the screen of projector, which teacher can use it to determine the correctness of each group. As this is a short answer based system, the correctness is not determined by CLARES, it will be determined by teacher himself/herself. If the answer is right, teacher will click this group area, and this area will be highlighted in blue. As shown on Figure 3, "Berlin" is a right answer and the "A" group area was highlighted.

In order to go to the next question, teacher should click the "Public" button again, and the interface which was shown on projector is disappeared. In the same time, the performance of each group (correct or incorrect) will be recorded in the database.

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### 3.2.3 Student interface

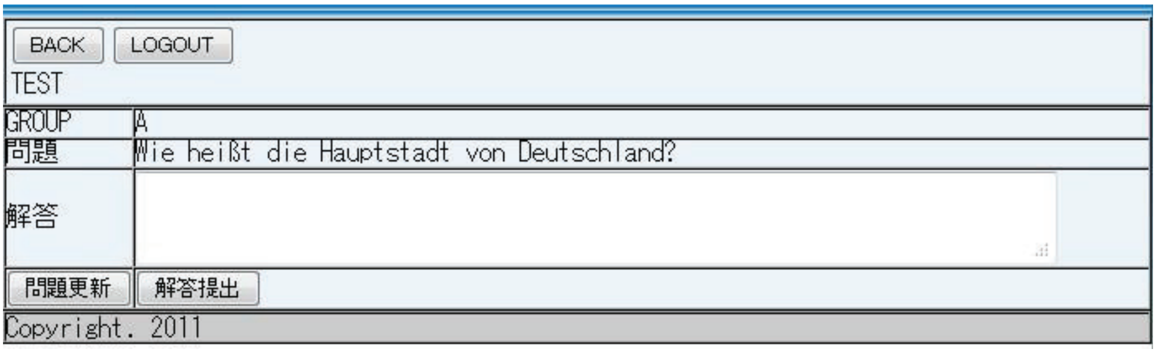


*Figure 4. Answer question interface.*

Figure 4 is the interface for students to answer questions. Students should login with group name, not the individual name. It allows four or five students to discuss in a group and then submit their group discussion results to the system. The system not only supports to submit answer by PC, but also supports to submit answer by mobile devices such as iPod touch, iPad , Smartphone.
The questions were prepared in advance will be show on this interface. There is a situation in the classroom where a teacher come up with a question on site and want to ask verbally to questions and know the understanding of students. In order to support this situation, CLARES allows only to input answer options while doesn't to input the contents of question.

### 3.2.4 Displaying answer results

| グループ | 正解数 | 不正解数 | 正解率 |
|---|---|---|---|
| A | 7 | 3 | 70% |
| B | 6 | 4 | 60% |
| C | 9 | 1 | 90% |
| D | 8 | 2 | 80% |

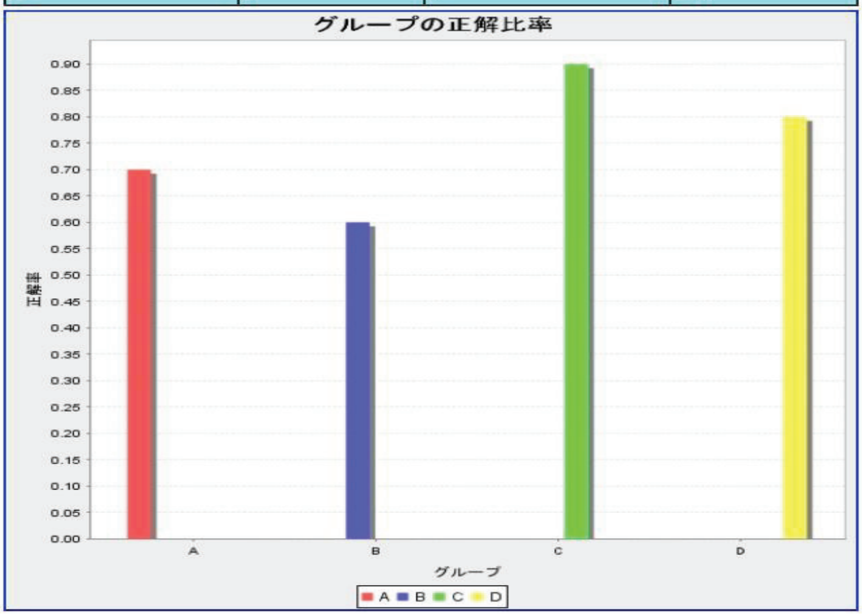


*Figure 5. Aggregate data of each group.*

After a few questions were answered, teacher can click "Aggregate result" button to collect the results and calculate the right answers of each group. The number of correct answers of each group will be graphically shown as Figure 5. By showing this graph, it can form competition and confrontation among the groups to raise learning motivation. The aggregate result can be saved as Excel file to evaluate the performance of students.

## 4. Conclusion and future works

In the paper, utilizing HTML5 technologies, we proposed a short answer system, called CLARES, which is a CRS. By using the CLARES, teacher can ask questions and determine right and wrong answers on-site. Students can think and reflect whenthe teacher explains. To comparison with the existed system, a sense of excitement and expectations has been long-lasting, so it increases the game element than the existed CRSs. Moreover, students discuss the question in a group and submit a short answer together, this facilitate collaborative learning among students.

As future works, we are planning to check the grammar automatically. By storing the grammar pattern into database, the system can check whether the same pattern is existed. Then we can know whether the pattern is learned or not. It is very difficult to check all of patterns automatically; so we only check the basic grammar.

In this paper, we only use simple function of HTML5. We are planning to use the functions such as Canvas. The Canvas can run on the low-spec devices, which cannot support the Audio, Video and Flash etc. By using the features of HTML5, we are planning to create question in audio and video format. It is also a future challenges to collect the data from Website and create questions automatically.

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Mohd Ayub A. F. et al. (Eds.) (2011). Workshop Proceedings of the 19th International Conference on Computers in Education. ChiangMai, Thailand: Asia-Pacific Society for Computers in Education.

# Combining Learning with Patterns and Geo-collaboration to Support Situated Learning

**Nelson BALOIAN[a*], Gustavo ZURITA[b], Marcelo MILRAD[c]**
[a]*Department of Computer Sciences, Universidad de Chile, Chile*
[b]*Department of Management and Information Systems, Universidad de Chile, Chile*
[c]*School of Computer Science, Mathematics and Physics, LinnaeusUniversity, Sweeden*
*nbaloian@dcc.uchile.cl

**Abstract:** Situated Learning stresses the importance of the context in which learning takes place. It has been therefore frequently associated with informal learning or learning outside the classroom. Mobile technologies can play an important role supporting this type of learning, since it mainly occurs on the field. In this paper we present a learning system and a methodology based on the use of patterns. Students learn about patterns by finding instances of them on the field, or by recognizing new patterns unknown to them so far. The teacher proposes tasks to the students consisting on finding instances of patterns or discovering new ones along a path or inside a pre defined area on a map. This work illustrates the role that geo-referenced data collected on the field can play in supporting situated learning activities.

**Keywords:** Mobile Learning, Mobile Computing, Geo-collaboration, Situated Learning

## 1. Introduction

Situated learning is a general theory of knowledge acquisition that emphasizes the importance of the activity, the context and the culture in which learning occurs [12, 13]. Social interaction is another critical component of situated learning; learners become involved in a "community of practice" which embodies certain beliefs and behaviors to be acquired. Educational technologists have been applying the notion of situated learning in the last two decades, in particular promoting learning activities that focus on problem-solving skills [11, 15, 20]. The notion of cognitive apprenticeship [5] is also close related to situated learning as: "Cognitive apprenticeship supports learning in a domain by enabling students to acquire, develop and use cognitive tools in authentic domain activity. Learning, both outside and inside school, advances through collaborative social interaction and the social construction of knowledge". Brown et al., [5] have criticized the decontextualized kind of learning that usually emerges as a result from the separation between learning and doing.

Now the integration of one-to-one computer-to-learner models of technology enhanced by wireless mobile computing and position technologies provides new ways to integrate indoor and outdoor learning experiences. The notion of "seamless learning" [22] has been proposed to define these new learning situations that are marked by a continuity of learning experiences across different learning contexts. Seamless learning implies that students, individually or in groups, can carry out learning activities whenever they are curious in a variety of situations and that they can switch from one scenario to another easily and quickly using their personal mobile device as a mediator. In these learning situations, learners are able to examine the physical world by capturing sensor and geo-positional data and conducting scientific inquiries and analyses in new ways that incorporate many of the important characteristics suggested by situated learning.

In this paper we describe our current research efforts that include the design of a learning environment that integrates learning with patterns, mobile applications and geo-collaboration tools in order to support situated learning. Learning activities in these settings take place inside and outside the classroom and encourage students to collect data on the field in order to find, relate and document patterns of any nature. An important element of the collected data is the geographical location where instances of the pattern being learned are located. The rest of the paper is organized as follows; sections 2 and 3 describe the theoretical aspects related to geo-collaboration and *learning with patterns* in order to provide the foundations that guide our efforts. Section 4 lists a set of requirements for supporting situated learning activities which it is used to classify related research efforts in the field. The articles proceeds by describing in section 5 the rationale and features of a system we have developed aiming at supporting situated learning by integrating learning with patterns and geo-collaboration. Section 6 concludes this paper by providing some conclusions and describing possible lines of future research.

## 2. Using Geo-collaboration to support Situated Learning

Some interesting applications supporting learning activities guided by situated learning making use of geo-referenced data over maps and mobile devices have been developed in the past years (see next section). Few of them rely upon geo-localization features that characterized Geographic Information Systems (GIS) while most of the applications are based on the notion of location-based services (LBS). A relevant difference between LBS and GIS is that a GIS application also geo-references information using visually represented maps, in addition to offering localization services as LBS does. A GIS also offers several additional functionalities, such as associating information of different nature to a geographic location, recording the history of routes, making notes on real geographic zones, determining routes, comparing different notes made in different locations, etc. These different functionalities and information layers certainly may introduce an added value to situated learning applications supported by geo-localization, as they allow to make connections between places, content, learning activities and learners.

Collaborative activities can be introduced in situated learning scenarios by letting participants collaboratively geo-reference information, as well as solving tasks in particular locations taking advantages of the affordances of mobile technologies. Students may collaboratively work at the same time and in the same place, at the same time and in different places, at different times in the same place or at different times in different places. Teacher also may be able to work collaboratively with students at the same time and in different places; for example, tracking students working outside the classroom using mobile devices, tracking students' movements on a geo-referenced map in the classroom and interacting with them remotely. These interactions may also take place at different times in the same place while both the teacher and students are inside the classroom providing feedback and analyzing activities already performed by the students.  These type of collaborative activities have not been widely explored yet in situated learning settings since most of the research efforts have only focused on one or another modality (see related work in situated learning presented in section 4). Moreover, few efforts consider the benefits of other learning modalities like personalized and social learning, encompassing physical and digital worlds, ubiquitous knowledge access, combining use of multiple device types, knowledge synthesis or learning with patterns [22].

## 3. Learning with Patterns

Patterns play a significant role in learning. Research findings in the field of learning psychology provide some indications that human learning can be explained by the fact that learner discover, register and later apply patterns [7, 10, 17, 18]. These cognitive processes "involves actively creating linkages among concepts, skill elements, people, and experiences" [7]. For the individual learner, the learning process involves "'making meaning' by establishing and re-working patterns, relationships, and connections" [7]. Patterns are recurring models, often are they presented as solutions for recurring problems. Natural sciences, mathematics and arts also work with patterns. The exact use of the term however, varies from discipline to discipline. The first formalization of pattern description and their compilation into networks of “pattern languages” was proposed by Alexander et al., [1]. A pattern consists of a set of components including the name of the pattern, description of the problem it solves, the solution to this problem, an example and the relations it has to other patterns. This approach has been adopted by many disciplines like architecture, software development [8], interaction design [3] and pedagogy [19].

There is important evidence that patterns play an important role in learning: “learning with patterns” modality. However, they have seldom been used to support the development of cognitive and social skills apart from the field mathematics [10,17, 18]. Breuer et al., [4] present a mobile learning system supporting collaborative searching and documenting of instances of a certain pattern on the field. Learning with patterns can involve more activities than just collecting evidence on the field. It may start in the classroom with the teacher introducing the pattern approach, the pattern structure and pattern languages. The teacher then proposes a research topic, e.g. which are the most common trees in the city parks? and then he/she asks the students to collect examples following a certain path or searching randomly within a certain area. Students then explore the area, take pictures of the parks and trees, make notes and sketches, etc. In the field or at home, they reflect upon why finding a certain tree is more suitable for this city than others, which are the elements it has that makes it a good pattern, and document what they found within the given categories. Moreover, they may exchange and debate with peers for or against the patterns they want to propose and the examples they had found. Each pattern proposition is reviewed by two peers. Back in the classroom, they present their patterns on the whiteboard, and, moderated by the teacher; they evaluate their propositions and discuss the hierarchy and the relations between the patterns they intend to work with in order to create their own pattern language. Students would then go on to apply their own patterns by building models that represent ideal representations of these patterns and pattern languages for a specific context.

## 4. Connecting Mobile Learning and Geo-collaboration with Situated Learning

Lave & Wenger [13] suggest that learning is better when knowledge is presented in an authentic context, i.e., settings and applications that would normally involve that knowledge. They also claim that learning requires social interaction and collaboration. Brown et al., [5] list a set of procedures that are characteristic to cognitive apprenticeship in a situated learning context; starting with a task embedded in a familiar activity which shows the students the legitimacy of their implicit knowledge and its availability as scaffolding in apparently unfamiliar tasks; allowing students to generate their own solution paths which helps make them conscious creative members of the problem-solving context; and helping students to acquire some of the culture's values. In order to make the ideas guiding situated learning operational, is necessary to identify its the critical aspects in order to enable it to translate into teaching and learning activities that could be applied inside and outside the classroom [5]. In response to this challenge, Herrington & Oliver [9] suggest a practical framework for designing situated learning activities including the following requirements:

C1. Provide authentic contexts reflecting the way knowledge is used in real life.
C2. Provide authentic activities.
C3. Provide access to expert performances and the modeling of processes.
C4. Provide multiple roles and perspectives.
C5. Support collaborative construction of knowledge.
C6. Promote reflection to enable abstractions to be formed.
C7. Promote articulation to enable tacit knowledge to be made explicit.
C8. Provide coaching and scaffolding by the teacher at critical times.
C9. Provide for authentic assessment of learning within the tasks.

Recently, a few situated learning applications that rely on geo-collaboration have been tested and they are described below. Table 1 presents a selection of related research efforts in this field ranging from 2005 until today which include the usage of mobile devices and geo-localization over maps.

**Table 1.** Characterization of representative research projects using geo-collaborative situated learning applications. C1 to C9 rows correspond to the requirements of situated learning applications describe above. Ref=reference - year, Plc=place, Obj=objective, Trg= Target group, Tec=technology, Clm=collaborative space/time mode, Evt=evaluation

| Ref | [15] -2005 | [17] - 2006 | [12] - 2007 | [22] - 2008 | [2] - 2009 | [16] - 2010 | [7] - 2011 |
|---|---|---|---|---|---|---|---|
| Plc | Outside/Inside the classroom. | Outside/Inside the classroom. | Outside/Inside the classroom. | Outside the classroom | Outside the classroom | Outside the classroom | Outside the Classroom |
| Obj | Learning in a mobile scenario by sharing observations | To learn Japanese in real life situations. | Enhance content of the curricula. enriching the field experience | Game learning to analyze and learn math problems | Game learning through participa- tion and problem solving | Easily record and sharing of knowledge over maps using sketches | To learn Mandarin in real situations |
| Trg | Primary and secondary school students | 20 to 30 year old users | 4th grade students and 5th grade students | 12 to 14 year old students | Secondary students | sixth graders students | 23 to 42 years old users |
| Tec | Mobile phones with cameras | PDA with GPS, Bluetooth. Wi-Fi , and smart board | Nokia 6630 with GPRS connection. And HP iPAQ 6515 with GPS | Mobile phone with a GPS receiver | Laptops with GPS receiver and Google maps | Tablet PC, a USB camera and GPS receiver | Iphone with GPS |
| Clm | Same time, different places between students and teacher using a voice channel | Same time, same place and different places among users and teacher | Same time, same place among students, different place and different time between students and teacher | Same time, same place | Same time, same place and different places among students | Students interact and share with different roles. Same time, same place | Not specified |
| Evt | Observation | Questionnaires | Questionnaires | Observation | Simple testing. | Usability and utility | Questionnaires |
| C1 | √ | √ | √ | | √ | √ | √ |
| C2 | √ | √ | √ | √ | √ | √ | √ |
| C3 | √ | | | | | | |
| C4 | √ | | | | | √ | |
| C5 | √ | √ | √ | √ | √ | √ | |
| C6 | √ | √ | √ | √ | | √ | √ |
| C7 | √ | √ | √ | √ | √ | √ | √ |
| C8 | √ | √ | √ | | | | |
| C9 | √ | √ | | | | | |

**Moop** [14] is a learning environment supported by mobile phones, through which learners analyzes their thoughts and make observations. Moop has been designed for primary school children and has the following tools: a control for a camera, a video camera and a voice recorder. When a GPS-locator is connected, the location information will follow observations automatically. Maps can be downloaded from a server via a data connection and a GPS-positioning system. A location-bound task course is created with the help of a GPS-locator and a user can easily proceed on course to reach the set goals. Planning the route with the Moop's map view allows for a variety of learning situations and study plans. **LOCH** [16], describes a computer supported ubiquitous learning environment for language learning. It was conceived to assist overseas students to learn Japanese while involved in real life situations. Students can make use of their PDAs for writing down annotations, recording questions, taking pictures and reporting back to the teacher. At anytime, the teacher is monitoring the position of the students and can establish communication with them, either through instant messaging or IP phone, both preinstalled on the PDA. In

AMULETS [11], children use a mobile application (including GPS) to learn about "tree morphology" and "the history of the city square through centuries". Collaborative missions were introduced in order to provide students with challenging problems. The challenges in both scenarios were based on identifying different types of objects (trees or places) and conducting some tasks (measuring the height and age of trees, or discovering data associated to specific locations). In order to solve these problems, students were required to collaborate using a number of tools including instant text messaging between the smartphones and computers at a specific location.

MobileMath [21] is designed to investigate how a modern, social type of game can contribute to students engagement in learning mathematics. It is played on a mobile phone with a GPS receiver. Teams compete on the playing field by gaining points by covering as much area as possible constructing squares, rectangles or parallelograms by physically walking to and clicking on each vertex (point). It is possible to 'hinder' other teams and to deconstruct the shapes they made; points are gained by this also. During the game, in real-time the locations of all teams and all finished quadrilaterals are visible on each mobile phone. The treasure hunt game [2] has been developed as a case study to help analyzing a specific domain and designing a generic and flexible platform to support situated collaborative learning. Students go around the city and collaborate participating in several social/group activities. When the game starts each player receives a clue to identify a"treasure": a historical place, museum, or location within the city.

In SketchMap [15], children carries a PDA and create a map using a stylus pen by drawing streets and placing icons such as hospitals or a municipal offices. Using a USB camera attached to the tablet PC children can capture an image, a sound or a video which is shown as an icon representing the captured image, sound, or video, and added to the palette. The icon can be dragged from the palette to anywhere on the map. The system supports reflection by allowing the children to replay their map creation processes. In Micromandarin [6], a database of English-Chinese translations associated with their context of use was created. Based on the information shown in table 1, we can conclude that from the requirements stated by [9], the less frequently considered are: the access to expert performances and the modeling of processes (C3), the coaching and scaffolding by the teacher at critical times (C8), and the authentic assessment of learning within the tasks (C9). Moreover, none of the applications described above has introduced the "learning with patterns" modality so far.

## 5. Designing geo-collaborative application for "learning with patterns"

Based on the results described in the previous section, we can conclude that mobile geo-collaboration can be successfully used to implement learning activities grounded on situated learning. We have developed a prototype of a system (including a web visualization tool and a mobile application) to support geo-collaborative learning activities that include collecting data on the field in order to find evidence of previously known patterns, for example, knowing the patterns of neo-classical architecture find examples in the city, or discovering patterns starting from the evidence found on the field, e.g. studying the reasons of why certain patterns of trees appear more often in the parks of a city. According to the specific scenario described at the end of section 3, the following functionalities for a system supporting them have been identified:

***Creating Patterns***: To create a pattern means to define its components. Creating a pattern consists on defining its elements: name, goal, description, forces, etc. These components are input by free-hand writing. Additional multimedia objects (pictures, videos or sound) can be associated to the pattern. Depending on the assignment, students may also create patterns in order to document findings which following a certain pattern. Patterns and tasks can be created by the teacher during the class, as they are presented to the students before using an electronic board or projecting the screen of a touch sensitive computer to the whole class. It is important to mention that they are explained to the students before the students start their task. Figure 1 shows the creation of a task and the creation of a pattern inside a task.

***Creating Tasks**:* Teachers can create tasks consisting of instructions to be given to the students. They may include activities such as following a certain path or to randomly explore a designated area within the city in order to find evidence of patterns. Task creation begins with defining a referencing geographic point. This will cause the system to download a map where this point is located. Currently, maps are downloaded from Google Maps using a free available API. Thereafter, the teacher can mark an area by freehand sketching the limits of it over the map. In this case, the task for the students will consist of exploring the area randomly in order to collect data about the instances of a pattern inside this area. The teacher may also define a path by marking certain points on it. In this case the students will have to follow the path and find evidence (or lack) of certain patterns in the designated points. Thereafter, the teacher can associate already defined patterns to the task or create new ones inside the task creation.

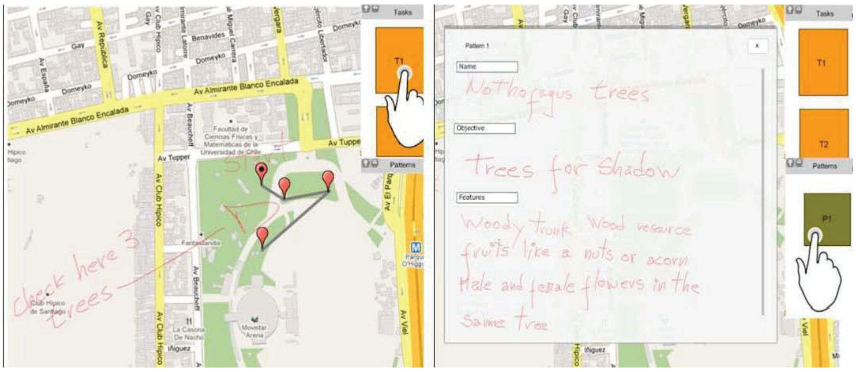


Fig 1. Task (left) and pattern (right) creation. The task consists of following a path

***Assigning tasks to students**:* In the classroom and before leaving for the field activity, students turn on their mobile devices running the application. The teacher's application automatically discovers the instances of the student's application and displays them on the screen as an icon, as seen in the figure 2 (left). By just dragging and dropping the student's icon over the task icon, the task proposition is transmitted to the student's device and shown.

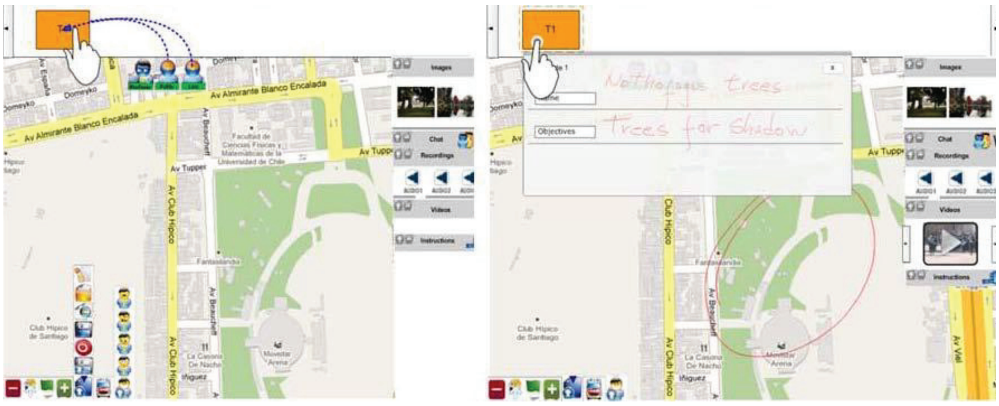


Figure 2: Assigning tasks to the students (left) and the Student's view of the task

***Instantiating patterns**:* According to the proposed task, students may follow a certain path or explore an area of the city gathering data to collaboratively create instantiations of the pattern when they find a certain element that they think it corresponds to the pattern giving by the teacher. They can also exchange pattern instances created individually. Instantiations consist of photographs or handmade sketches of a certain object found which complies with the pattern definition.

***Monitoring students' work***: teachers can monitor the students' work in areas where internet is available and a client-server communication is possible. The student's application sends the current position at regular time intervals to a server. This information is taken by the teacher's application which displays the student's position on the map. It is also possible for the teacher to communicate with the students via chat to give more instructions about the task in "real time".

The system has been implemented and pre-tested by early users in an experiment with four subjects aged 22 to 24 aimed at evaluate the user interface. The task they were given was to find out which were the most common tree types in a certain park. For this experiment tablet PCs were used. The activity lasted for 1.5 hours.

## 6. Conclusions and Future Work

In our current efforts, we are proposing the design of learning activities that incorporate elements of situated learning that are supported by the use of geo-collaboration tools and mobile applications which incorporates learning with patterns. From our literature review, we can see on the one hand that learning activities using mobile technologies and geo-collaboration have been successful implemented and on the other hand, it has been recognized that patterns can play an important role in the learning process. Since the proposed system presented in the previous section can be used to handle patterns in any field/discipline, it can be used in a variety of learning scenarios. In section 4, we presented the requirements for designing learning environments that support situated learning. In this section, we will analyze how the proposed system fulfils them. Table 2 illustrates how our suggested solution supports all requirements for situated learning, some in a better way than others. An important characteristic of the learning approach proposed in our current efforts is that it starts in the classroom, continues on the field; proceeds then at home or in a computer lab and ends with a learning session inside the classroom again. This again can create another cycle which is interesting from the point of view that the sake system is able to support different learning modes and stages, without disruptions of methodology, interaction paradigm or data compatibility. In fact, the system is able to run on different platforms. It has been used on PCs inside the classrooms, where the teacher used an electronic board to create patterns and tasks during the class. It has been also used on tablet PCs as well as on handheld computers. The common aspect on all these platforms is the touch screen and the big difference is the size. However, the way of using sketching and gestures to control the applications was positively evaluated by the early users. They also positively evaluated the fact that they use the same interaction paradigm regardless the platform they were using, so they do not need to learn how to interact with another application interface.

**Table 2:** On the left the requirements. On the right, the system features fulfilling that requirement is explained

| | |
|---|---|
| **C1** | Patterns instances are searched for in the very place they appear naturally |
| **C2** | Finding pattern instances in natural environments is a typical work experts often do. |
| **C3** | There are two roles: the teacher and the student. In certain cases students might also propose tasks taking the role of the teacher |
| **C4** | After completing the field work, back in the classroom the teacher provides examples from the expert's regarding the task. |
| **C5** | Students work collaboratively on the field in order to collect the relevant data and share it |
| **C6** | Students present their findings in front of the class reflecting about the patterns they found |
| **C7** | The system allows students to collect data, relate and communicate them formalizing their unsorted ideas about what they find |
| **C8** | The teacher can help students during the work on the field, as well as back in the classroom |
| **C9** | Possible patterns and patterns instances are checked by the students and the teacher during the work |

Although the first trial of the system has been done implementing a rather simple learning activity, it is easy to see that this approach can be used to learn and discover more complicated patterns across different fields. Below we provide some examples of different field in which we plan to conduct some future trials in order to validate our approach: a)

**Geology** students must perform collaborative activities like field measurements and observations that can be monitored and controlled remotely by a teacher. Students must geo-reference their notes, take pictures and make recordings at concrete points that will be constructed jointly and/ or with their peers; b) **Architecture** students may recognize construction styles and design patterns in specific areas of an urban space. Students may also collaboratively survey construction styles or design patterns in a certain zone using geo-referenced notes to understand the changes in the construction development; c) **Social sciences**. Students of anthropology, psychology or sociology may conduct field observations for which collaboratively created data and information notes of diverse nature (text, images, video & sound), associated with its localization will enrich their observations.

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The 19th International Conference on Computers in Education 2011

28 November - 2 December • Chiang Mai, Thailand

Proceedings of the 19th International Conference on Computers in Education ICCE 2011

ISBN 978-616-12-0186-9