Some Studies and Lessons Learned from Ad Hoc Learning

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Abstract **This work proposes concepts, designs, experiences and lessons learned from some studies of ad hoc learning supported by wireless and mobile technologies. The ad hoc learning activity model supports learners communicating with or obtaining help from classmates or teacher, interacting with environment, and accessing teaching material from mobile device or Internet. Example scenarios with prototype systems for ad hoc learning are presented. Preliminary experimental and trial studies are conducted with these example scenarios in elementary and high school students. The potential impacts, limitations, and lessons learned in this study are also discussed from both the educational and technological points of view. Learning in a lively, vivid, and new learning environment, students are motivated with interests for learning the target domains. Ad hoc learning potentially extends the scope of learning activities and with more flexibility than in traditional school curriculum.**

I. Introduction

Mobile devices such as PDA, WebPad, Tablet PC, and cell phone are the key innovations to mobile learning since they are carrier as well as communication tools in outside classroom learning. The wireless technology, a new trend of recent communication technology, enables learning to occur outside the classroom by constructing wireless e-learning and communication environment for learners. Mobile learning, putting outdoor classroom as well as internet-enabled wireless devices into learning context, inherits all the advantages of e-learning and provides learners with flexibility in mobility and wireless material exchange, thus is helpful in enriching the content of traditional classroom learning as well as promotes the active and interactive learning. It facilitates students to learn in diverse physical locations outside classrooms with high feasibility.

Lehner & Nosekabel(Lehner & Nosekabel, 2002) refer mobile learning to "service or facility that supplies a learner with general electronic information and educational content that aids in acquisition of knowledge regardless of location and time." Sariola (2001) mentioned the advantages of mobile learning, " The mobile environment integrates studies that take place on campus, at home or outside university facilities into shared and flexible learning environment." Kynäslahti (2003) defined the word mobility from the educational point of view. He mentioned that the elements of mobility include convenience, expediency, and immediacy. Chang et al. (2003) proposed three essential elements of mobile learning: mobile equipments, communications technology, and user interfaces.

Ad hoc learning supports group work on projects and enhances communication and collaborative learning in outdoors. Ad hoc learning requires a wireless communication network to dynamically and immediately establish support for face-to-face communications among learners or between learner and instructor. With this support, learners may exchange their message or material, share their experience or get help from the other learners or instructor. Three ad hoc learning scenarios, Bird Watching Learning, Butterfly Watching Learning, and English Outside Classroom Learning are developed to provide students with opportunity of outside classroom learning.

In addition, we report experimental studies and lesson learned. Finally, we conclude with the potential educational benefits and future work of ad hoc learning. We observe that ad hoc learning potentially helps students to become capable, self-reliant, self-motivated, and independent learners.

II. Scenarios of Ad Hoc Learning

This section generally describes scenarios of ad hoc learning. Technology supported environment including supports in hardware, software, and networking is described. The educational purpose and the learning flow for each activity are also presented.

Ad hoc learning is one of the most important learning activity models of mobile learning. Ad hoc learning is characterized by many features. One feature is the support of wireless communication among a number of mobile learning devices. This feature supports a group of learners dynamically construct a network with support of interactions among intra-group or inter-group communication. Learners thus may transfer materials including the observation, experimental results, and notes to other members without the constraints of time and location. Learner may also get help from classmates or teacher at anytime and anywhere even they are mobile. Another important feature of ad hoc learning is that learners actively

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explore the information, thus the obtained knowledge usually has authentic property. In ad hoc learning, technology supports in dealing with the urgent events are often required. These supports include video and voice recording and immediate communication among learners even they are mobile in an outdoor environment.

In general, it is required to support an outdoor learning activity system on learners' mobile learning device. This system consists of modules that are most frequently required in the participation of outclass learning activity. As shown in Fig. 1, the system offers many useful functions which have been packaged into different modules. The *"Video-Management"* module and *"Voice-Management"* module allow students to record activity-related films, pictures, and conversations during the participation of the activity and share the record with other learners after activity. The *"Wireless Transmission"* module supports down load learning-sheet and activity-related materials from server and upload the activity record and reports to server in a wireless manner. In addition to retrieve the activity-related material from database, students can also exchange information through the "Wireless Transmission" module. To help student take notes, review, modify, or manage their notes, a *"Note-Management"* module is developed in the system. The *"Presentation-Management"* module helps student to prepare a presentation with integration of various formats including video, audio, picture and text after the activity. From the use of *"Help"* module, students may get help from teaching materials during the participation of activity. With the support of above mentioned modules, the system enables students to keep the track of their learning process, understand their learning efficiency, and overcome their learning disability.

Three scenarios of ad hoc learning and location-aware learning that have been conducted as example scenarios of MOCL are introduced.

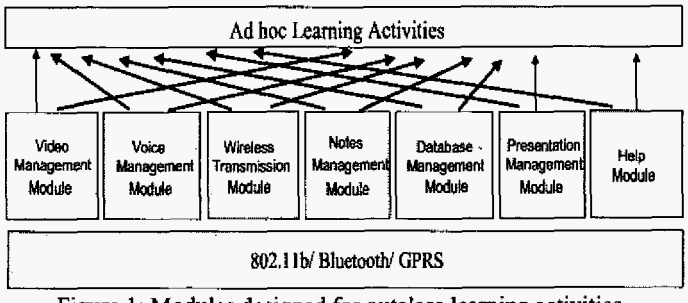


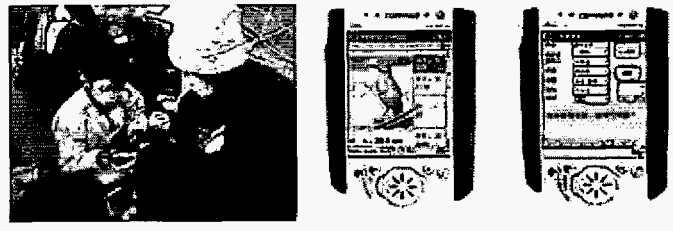
Figure 1: Modules designed for outclass learning activities.

(1) Bird Watching Learning Scenario

Birding watching learning (BiWL) are usually offered by a local bird watching society and led by experts (Chen *et al., 2003*). With the help of the BiWL (Bird-Watching Learning) system, it creates the fair opportunities and experiences necessary for students of elementary school to develop the knowledge and skills with their own learning. Each learner has a mobile learning device, which is a handheld device (PDAs) with a Wi-Fi-based (IEEE 802.11b protocol) wireless network card. The instructor has a small-sized mobile notebook with a Wi-Fi-based wireless network card and a digital video camera. The students at each school were randomly assigned into two groups, the BiWL-assisted group and the guidebook-assisted group.

The learning flow of bird watching is described in below. The BiWL system arranges six bird-watching activities throughout a season. The pre-test was administrated right before each activity. The experts in both groups first targeted the same kind of bird with the telescope (at least six birds per activity). Worksheet questions were further devised according to the key features of the bird. The team in the BiWL group acquired the picture and worksheet questions, identified the bird features, searched for the relevant information, and answered the questions with BiWL. The team in the guidebook group identified the bird features with the two-cone telescope, searched for the relevant formation with guidebook, received the questions orally, and provided answers on a paper worksheet. Finally, the teachers in both groups checked the students' answers. After the activity, the post-test was administered to the learners.

The BiWL system is implemented on a wireless mobile ad *hoc network* and offers a mobile learning system which scaffolds the learner. Scaffolding refers to the interactive support instructors, or more skilful peers, offer learners to bridge the gap between their current skill levels and a desired skill level. Ultimately, we deeply believe the learners can complete tasks on their own after repetitive authentic practice. Snapshots of BiWL are shown in Fig. 2.



(a) An outdoor bird-watching activity.

(b) A wireless querying interface.

(c) The wireless bird–answer interface.

Figure 2: Snapshots of outdoor bird-watching activity.

(2) Butterfly Watching Learning Scenario

An outdoor butterfly watching activity and butterfly-watching learning (BuWL) system (Chen *et al., 2004*) is designed for providing mobile aids for students to become capable, self-reliant, self-motivated, and independent learners when they are engaged in outdoor activities of exploring nature on their own. Each individual learner has a wireless handheld device, which is a PDA with an IEEE 802.11 wireless network card and a small-sized CCD camera. One instructor has a notebook computer with a Wi-Fi wireless LAN card which serves as the local server. Learners are randomly assigned into two groups, includes BuWL group with the system and the guidebook group with the guidebook.

The BuWL system arranges six butterfly-watching activities throughout a season. Before each butterfly-watching activity, pre-test is conducted to each group on PDA. In the activity, the learners of BuWL group find one of the target butterflies on interest and take a close picture of it. By transferring the picture and giving searching conditions based on features to the BuWL

system, the learners are able to determine the butterfly being observed. Further, the BuWL system suggests the possible name list of the observed butterfly through image mapping technique. This gives the chance for the learners to modify their previous searching conditions and conclude to different determination. After observing each butterfly, the learner records their learning process to the journal. The information of the journal allows the learners to check for correctness after the activity. On the other hand, the learners of guidebook group practice for picture drawing and information searching with the guidebook. Finally, post-test that has the same questions as the pre-test is conducted to each group on PDA after each activity.

The most important spirit of education is to help learners have *self-confidence*, *technology*, and *knowledge* when they attempt to seek solutions. Characteristics of the independent learning model are learning knowledge more independently, and acquiring information more easily. A mobile BuWL system was implemented to empower the learner to engage in independent butterfly-watching activities. When a learner has sufficient knowledge and self-learning ability to overcome a problem, the instructor may relinquish control of decision making to the learner. Therefore, the BuWL system aids for students to become capable, self-reliant, self-motivated, and independent learners when they are engaged in outdoor activities of exploring nature on their own. Snapshots of BuWL are illustrated in Fig. 3.

(a) An outdoor butterfly-watching activity. (b) A wireless querying interface. (c) The nature journal system.

Figure 3: Snapshots of outdoor butterfly-watching activity.

(3) Outside English Learning Scenario

In classroom style English learning, reading and writing skills are usually more heavily emphasized. As a result, students are more confident about their reading and writing skills, but even after extensive study, they are fearful of conversing with a foreigner. An outside English learning activity is designed to satisfy both the desire of interaction with native English speaker and the demand of extending the scope of lesson study in textbook. Learning activity "Making an Interview with Foreigner (MIF)" is designed and conducted in senior high school. Each student is equipped with a tablet PC embedded with video & voice recording hardware and the developed outclass learning activity system. Students are partitioned into groups with each group containing three students.

In preparing, teacher will help each group to make an appointment with a foreigner. The teacher prepares a learning sheet that lists several questions for students to ask the foreigner about the similarly and difference in culture of Taiwan and his or her country. The teacher also designs the learning sheet including the learning flow, the rules, and the frequently used vocabularies, phrases, and sentences as the preliminary guidance in "help" module. Both the learning sheet and the help contents can be downloaded from the server of classroom in a wireless manner. During the interview, students may use the designed system to keep the track of interview process in their tablet PC. After that, students in a group will cooperatively prepare the presentation material to share their experience with the others. Finally, a web-based scoring system is provided for each group to score the presentation of the other groups, motivating them in English learning based on competitions.

The design of MIF scenario offers opportunities for students to interact with foreigner. Students are motivated to prepare and practice the topics and the vocabularies, phrases, sentences that might be used in the interview. The developed system also helps them record, review and share with the others the learning process. With the participation of outside English learning activity and the use of developed system, students increase their interest and motivate their active attitude in English learning. A real illustration of outside English leaning is given in Fig. 4.

(a) "Making an interview with Foreigner" activity. (b) Students record their activity process in mobile learning device.

Figure 4: Snapshots of outside English learning activities.

III. Preliminary Trial Studies

This section presents the trial test and discusses the impact of conducted learning activities on learners' learning. A series of investigation with questionnaire are done before and after the activity. The questionnaire respondents are students who participate in outclass learning activities with the use of mobile learning device.

According from the trial studies, the mobile learning device is most frequently used as a tool to collect information(92%), communicate with other learners(88%), or join the network community(78%). These results also verify the features of active pulling information and interaction among learners in Ad hoc learning. The experimental study also reveal that majority (more than 92%) of students gain more in field learning and computer learning from the activities. Besides that, some students gain more peer interaction or applied experience in the activity.

Having opportunities of participating in ad hoc learning activities, students approve the following contributions in their learning. The support of mobile learning device and the developed platform help ad hoc learning in immediately obtaining response and reward, sharing and discussing the process with peer colleague, and training the response,

communication, and presentation abilities. Course designed with integrating the use of high technology also help students learn in more active, diversified, funny and convenient manner and have more motives in learning. Personal gains are found in the extension of learning scope, the rich resources in urgent use, and more understanding in computer and field learning.

The effect that ad hoc learning has influence on students might be diversified according each student's learning attitude, learning ability, the habit of using mobile learning device. This is also related to the student's individual interests and attention in the field learning. In brief, most students consider that ad hoc learning is positive to their learning interests and performance. Many students give more positive response to the activity and they did gain more knowledge and some professional skills during the participations of ad hoc learning activities.

IV. LESSONS LEARNED

The following discusses what we have learned from the study of ad hoc learning.

1. Wireless applications could be the ideal mobile aids that scaffold the students to become capable, self-reliant, self-motivated, and independent learners while the following two points has been considered.

(1) Modeling and scaffolding (from the expert) are necessary for autonomy

Although mobile technology provides more autonomy to the learners, most learners have difficulties in managing the learning environment at beginning, especially for young children. Not to mention the functions of the mobile system itself might be complicated, the learners might not have the ability to recognize the subjects and timing to use the system. Besides, no matter how intelligent and sophisticated the system is, the enthusiasm and erudition of the experts could never be substituted. Therefore, the learners need to be prepared for the autonomy. The modeling and scaffolding from the expert may arouse the learners' interest to the learning subject and provide authentic complete experience to the whole learning task.

(2) Mental effort is crucial for learning

Although mobile learning technology provides all kinds of supports by allowing the learner to access information, interact with environment, and communicate with others, there is a risk that the learner might simply duplicate the information without any thinking, especially while the information is automatically pushed to the learner's device. To avoid reproductive resulting low-order learning, we suggest the mobile learning activity must engage learners in high-order thinking and that takes them a great mental effort. That is, the wireless applications should work more than "fingertip" tools that learners use naturally, effortlessly, and effectively. They need to work as cognitive tools that provide an environment and a vehicle that often require learners to think harder.

2. Wireless applications could also be the ideal mobile aids that scaffold collaborating peers as they work on problems and critique other students' solution. Two interesting results are found in our experience:

(1) Collaborating peers could share the risk of making errors

Due to the cost of mobile devices, the empirical studies of the systems we developed were limited to involve only small scale of learners. In many cases, collaborative learning was caused by sharing devices. While the learners worked together for information searching or data recording by sharing one single device, they also share the risk of making errors. We found the collaborating peers have more courage to try and explore. And it is an important condition for successful outclass mobile learning.

(2) Collaborating patterns usually were formed from the beginning

While sharing device to learn, it is interesting to know how the learners managed for job sharing. Although the learners were suggested to take turns for device operating, we found the job is always dominated by one specific learner. The learner usually is the one who was assigned to hold the device in the first time activity and therefore got more familiar with the functions of the device. It is possible that other learners took an easy way and let this learner to in charge of the device for each activity. Therefore, the collaborating patterns usually were formed form the beginning.

3. The effect of wireless applications should be evaluated after the following effects are gone. Therefore, the duration of mobile learning should not be too short.

(1) Fear to break the expensive devices

In our studies, we found that not only the learners but also the instructors have a great fear to break the expensive devices at beginning. The learners were informed that the device is fragile and expensive. This concern usually made the learners in tense and could not enjoy the process of learning. This kind of fear and worry would be disappeared until they get familiar with the system.

(2) Fear to the new technology

There is also some subject-matter experts (e.g. bird guider) showed fears and denial to the benefits of the new technology. They got barrier to change from the teaching method that they had been familiar with. They also had feared that the new technology might replace their contribution to students' learning. They need time to adapt themselves not only to the new technology itself, but also the model of learning created by the new technology. Many of them finally realized their own value would never be replaced and how their job could be enhanced by the new technology.

(3) Novel effect

Like many other new technology was first introduced to the educational setting, the learners showed great interest to the wireless devices at the beginning (i.e. the novel effect). The interest and motivation caused by novelty might be gone in a while unless they could be motivated by the system design and instructional design.

From the empirical studies, we found that six unique medium's capabilities of wireless application in learning are identified as urgency of learning need, initiative of knowledge acquisition, mobility of learning setting, interactivity of the learning process, situating of instructional activity, and integration of instructional content (Chen, Kao, & Sheu, 2003).

- *Urgency of learning need*: The wireless applications are usually used for an urgent matter of learning.
- *Initiative of knowledge acquisition*: The information provided by the wireless applications is based on the learners' requests.
- *Mobility of learning setting*: The educational practice can be performed at any time and any place.
- *Interactivity of the learning process*: The learner can communicate with experts, peers, or other materials effectively
- *Situating of instructional activity*: The problems encountered, as well as the knowledge required are all presented in authentic context.
- *Integration of instructional content*: The mobile applications integrate many information resources.

From our studies, we found two common methods of design that can take advantages of wireless applications to make a difference in learning.

(1) Method of Scaffolding

The method of scaffolding is especially suited for the situation while the learners' abilities have not reached the mastery level. This method can be applied to the system design as well as the instructional design. A designed mobile system provides many functions of supports, including maps, guides, databases, transmission, and communication for learning. A designed mobile learning activity scaffolds the learners to construct their knowledge by naturally interacting with the database, the environment, the instructors, and their peers through the system.

(2) Method for Independency

While the learners have possessed certain level of ability, the method for independency can be applied. The system design for independency is emphasized on how to enhance the learners' ability to complete independent learning task, such as picture taking, voice or video recording, and learning journals. MOCL should be designed to nurture student's ability of independent problem solving, knowledge retrieving, decision making, and result evaluation.

V. Conclusions and Future Work

From the experimental trials, we noticed that collaborating peers as they work on problems and critique other students' solution are scaffolded in ad hoc learning. We observed that modeling and scaffolding from the designed system are necessary or even crucial for autonomy and the mental effort in learning. We noticed several features common to ad hoc learning. First, outside classroom learning activities are essentially highly authentic. In particular, the nature can be regarded as a large classroom. This implies ad hoc learning will potential nurture lifelong learning about the nature. Second, our design of ad hoc learning scenarios facilitates reflective learning through group discussion and peer evaluation. Third, students were highly active and engaged in their learning, possibly due to multiple motivational factors. The use of novel technologies (possibly treating them as toys), more vivid outside classroom environment than inside classroom, dealing with authentic physical objects, small group interactions are among these factors.

In general, advanced computing technologies such as artificial agents, massive database of human experiences, recommendation systems can further empower student ability in achieving various learning tasks in ad hoc learning. However, we view ad hoc learning should be designed as a supporting environment for engaging learners in high-order thinking, extensive discussions, problem solving, and independently learning. In particular, ad hoc learning should also be viewed as a scaffolding environment. That means technology support in ad hoc learning should be faded away when students have mastered how to learn outside classroom. Another work in the future is to sustain observation of the impact of ad hoc learning described above. Finally, ad hoc learning and location-aware learning are not exclusive. A future attempt is to design and investigation of scenarios combining these two genera of scenarios.

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