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.

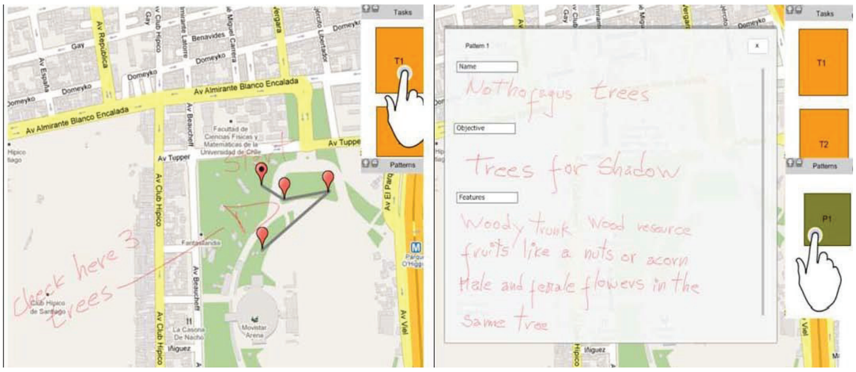

Fig 1. Task (left) and pattern (right) creation. The task consists of following a path

***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.

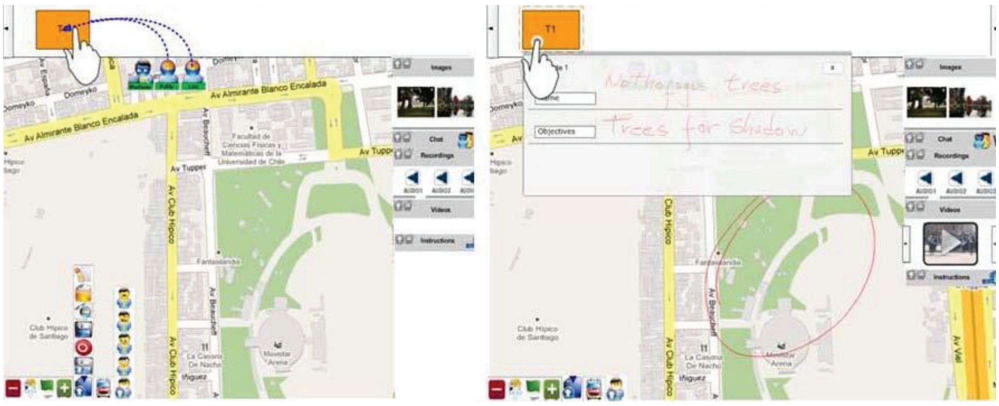

Figure 2: Assigning tasks to the students (left) and the Student's view of the task

***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.

References

[1]. Alexander, C., Ishikawa, S., & Silverstein, M. (1977). *A Pattern Language. Towns, Buildings, Construction*, Oxford, New York,.

[2]. Bahadur, S. & Braek, R. (2009). Platform support for situated collaborative learning, in *International Conference on Mobile, Hybrid, and On-line Learning*. p. 53-60.

[3]. Borchers, J., (2001). *A pattern approach to interaction design*, John Wiley & Sons, Chichester, USA.

[4]. Breuer, H., Zurita, G., Baloian, N., & Matsumoto, M. (2008). Mobile Learning with Patterns. *Procs. of the 8th IEEE Intl. Conf. on Advanced Learning Technologies Santander, Spain, July 1-5*.

[5]. Brown, J.S., Collins, A., Duguid, P. (1989). Situated Cognition and the Culture of Learning. p. 32-42.

[6]. Edge, D., Searle, E., Chiu, K., Zhao, J., & Landay, J.A. (2011). MicroMandarin: mobile language learning in context: ACM.

[7]. Ewell, P. (1997). Organizing for learning: A point of entry. *in Draft prepared for discussion at the AAHE Summer Academy at Snowbird. National Center for Higher Education Management Systems (NCHEMS). Downloaded from: http://www.intime.uni.edu/model/ learning/learn_summary.html*

[8]. Gamma, E., Helm, R., Johnson, R., & Vlissides, J. (1995). *Design Patterns. Elements of Reusable Object-Oriented Software*, Addison Wesley, Reading. MA, USA.

[9]. Herrington, J. & Oliver, R. (2000). An instructional design framework for authentic learning environments. p. 23-48.

[10]. Howard, J., Mutter, S., & Howard, D. (1992). Serial pattern learning by event observation. *Journal of Experimental Psychology: Learning, Memory, and Cognition*. 18(5): p. 1029-1039.

[11]. Kurti, A., Spikol, D., Milrad, M., Svensson, M., & Pettersson, O. (2007). Exploring How Pervasive Computing Can Support Situated Learning. *Proc. of Pervasive Learning Workshop at Pervasive*. p. 19-26.

[12]. Lave, J. (1988). *Cognition in Practice: Mind, mathematics, and culture in everyday life*, ed. C.U. Press, Cambridge, UK.

[13]. Lave, J. & E. Wenger. (1990). *Situated Learning: Legitimate Periperal Participation*, ed. C.U. Press., Cambridge, UK.

[14]. Mattila, P. and Fordell, T. (2005). MOOP - Using m-Learning Environment in Primary Schools. Proceedings of *mLearn2005*.

[15]. Miura, S., Ravasio, P., & Sugimoto, M. (2010). Situated Learning with SketchMap. Interaction Technology Laboratory, Department of Frontier Informatics, The University of Tokyo: Tokyo.

[16]. Ogata, H., C. Yin, R.G.P. J., N.A. Saito, Y. Yano, Y. Oishi, & Ueda, T. (2006). Supporting Mobile Language Learning outside Classrooms, in *The Proceedings of IEEE International Conference on Advanced Learning Technologies*. ICALT 2006: Kerkrade, Netherlands. p. 928-932.

[17]. Posner, M. & Keele, S. (1968). On the genesis of abstract ideas. *Journal of Experimental Psychology*. 77 (3): p. 353-363.

[18]. Restle, F. (1970). Theory of serial pattern learning: Structural trees. *Psychological Reiew*. 77(6): p. 481-495.

[19]. The Pedagogical Pattern Project, Online (last visited on Nov. 5th, 2009): http://www.pedagogicalpatterns.org,.

[20]. Vanderbilt, C.T.G.a. (1993). Anchored instruction and situated cognition revisited. *Educational Technology*. 33: p. 52-70.

[21]. Wijers, M., Jonker, V., & Kerstens, K. (2008). MobileMath: the Phone, the Game and the Math. *in Paper presented at the 2nd European Conference on Games Based Learning. Barcelona, Spain. from http://www.fi.uu.nl/isdde/documents/curriculum_jonker.pdf*.

[22]. Wong, L.H. & Looi, C.K. (2011). What Seams Do We Remove in Mobile Assisted Seamless Learning? A Critical Review of the Literature. *Computers & Education*., 57(4): 2364-2381.