Mobile Computing as a Supporting Tool for Situated Learning: 
A LACCIR Initiative

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ABSTRACT

This paper reviews some research initiatives to allow situated learning through the use of computer-supported mobile activities. The article also describes the development of a learning activity based on the situated learning theory, which makes use of a mobile application to help students to relate learning activities inside the classroom with activities performed in the field and at home. The application supports learning by discovering patterns, which might be used in various knowledge areas. This research work has been performed within the context of the LACCIR (Latin American & Caribbean Collaborative ICT Research) initiative, which is also briefly described in this article.
Introduction

Raising the quality of education has often been cited as one of the most important strategies, if not the most important, to help Latin-American countries to reduce the gap with developed countries. Important governmental initiatives have been carried out to introduce computer technology at schools in order to support more effective teaching/learning practices, as well as to introduce the students to the technological world, including the Internet.

Computers were initially used, almost exclusively, to support the individual learning situation in computer labs or classrooms. Nowadays, computer devices of various types are being used to support several learning scenarios, such as individual, collaborative, mobile, synchronous and asynchronous. Due to the popularity of mobile computing, the learning process can be done almost anywhere and anytime. Learners can download and read learning material while using public transport, waiting for an appointment, or even when convalescent in a hospital. The flexibility the students have to access the learning material and interact with other learners, allows for a shift of the instructional paradigm. This new paradigm, which has been often cited as ubiquitous learning, brings new opportunities and poses new challenges to educators as well as educational institutions. However, the expected goal that new technologies will transform learning practices has not yet been fully realized, especially if we take into account what has been going on in computer supported collaborative learning (Kurti et al., 2007).

Many researchers’ opinion is that one of the main problems is that the various systems developed for several learning scenarios mainly address a specific learning situation. Thus, there are too many different systems supporting the different learning situations (Breuer et al., 2008). Reaching a continuous computing support across different learning activities is difficult, because data and services involved in the various applications might not be compatible, and therefore the students and teachers have to learn the usage of various systems (with different human-computer interaction paradigms) to perform the instructional activities ubiquitously.

Although in the past few years there have been some technical developments aimed at integrating different computer worlds and enabling a “continuous computing” across mobile and non-mobile devices, some important research questions remain: how can pervasive technologies be used to support new ways of learning about different educational subject matters? and how can these technologies support learners working individually or collectively, inside or outside the classroom without technological disruptions and sharing their understanding of the learning material? In our opinion, the Situated Learning Theory can give us an important guide to answer these questions.

Situated learning states that learning requires theoretical concepts learned inside the classroom to be linked to practical situations in authentic contexts where they can be applied (Drummond, 2010). According to Brown (1989) and Vygotzky (1994), the way in which humans learn implies practicing the concepts acquired in theory. Vygotsky explains that teaching and learning activities involving conceptual knowledge (learned inside a classroom) and practical implementation (in real situations) are not only complementary, but also feedback into each other in a process of ongoing and increasing interaction. According to Rogers et al. (2005) and Uden (2007), situated learning needs to be intentionally intensive and explicit in the proposed curriculum.
The recent developments in mobile, wireless and positioning technologies, combined with contextual computing, provide an opportunity for curricular development that may take advantage of these devices for supporting learning activities based on the Situated Learning Theory. Mobile and wireless technologies allow interaction with the real world in new ways because computational power and interaction are available outside the classrooms limits. According to Rogers et al. (2005), mobile technologies, combined with content access virtually anywhere and anytime, allow learners to gain new learning experiences in a variety of situations beside the classroom itself (Uden, 2007).

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 (Kurti et al., 2007; Miura et al. 2010; Vanderbilt, 1993).

The notion of cognitive apprenticeship (Brown et al., 1989) 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., (Brown et al., 1989) have criticized the de-contextualized 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, enhanced by mobile computing and position technologies, provides new ways to integrate indoor and outdoor learning experiences. The notion of "seamless learning" (Wong and Loi, 2011) 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. Seamless learning also allows a switch from one scenario to another, easily and quickly, using their personal mobile device as a mediator. In these learning situations, students 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 work we present the development of a learning activity based on the situated learning theory, which makes use of mobile technology to relate activities inside the classroom with activities performed in the field and at home.

The next section presents the relationship between mobile computing and situated learning. The principal requirements for designing a learning activity based on this theory are also presented. Following this, a comparative description of various mobile learning tools is presented from the situated learning perspective. Then, we describe an application designed based on the requirements previously presented. This application supports learning by discovering patterns which might be of learning subjects of various fields during a student trip outside the classroom. The next section we briefly describe the LACCIR initiative (LACCIR, 2012), which is a
distributed research federation that promotes research and innovation in this area. Finally, conclusions and an outlook about how the tool can be used for supporting learning in various subjects are presented.

**Mobile Computing and Situated Learning**

Mobile computing has been recognized as a fundamental support to implement activities based on the situated learning theory (Naismith et al., 2005). In order to make this theory operational, Brown et al. (Brown et al., 1989) identify the critical aspects of situated learning to enable it to translate into teaching methods that could be applied in the classroom. These researchers propose a set of procedures that allow cognitive apprenticeship in a situated learning context. These start with a task embedded in a familiar activity, which gives students the opportunity to put their implicit knowledge in practice in order to support more complex, apparently unfamiliar tasks. This allows students to generate their own solution paths, which helps make them conscious and creative members of the problem-solving context. In response to this challenge, Herrington & Oliver (2000) suggest a practical framework for designing situated learning activities and tools. The framework considers the inclusion of the following requirements:

- C1. Provide authentic contexts reflecting the way the 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.

**Applications to Support Situated Learning**

Many learning applications have been developed considering these requirements. Several of them are mobile applications for geo-collaboration, which can be successfully used to implement learning activities grounded on situated learning. Next we briefly present 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.

**Moop** (Mattila and Fordell, 2005) is a learning environment supported by mobile phones, through which learners analyze their thoughts and make observations. The solution has been designed for primary school children and it 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. 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.
LOCH (Ogata et al., 2006) describes a computer supported ubiquitous learning environment for language learning. It was conceived to assist overseas students to learn Japanese involving real life situations. Students can make use of their PDAs (or smartphones) for writing down notes, recording questions, taking pictures and reporting back to the teacher. At anytime, the teacher is monitoring the position of the students and she can establish communication with them, either through instant messaging or IP phone, both preinstalled on the mobile device.

In AMULETS (Kurti et al., 2007) 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 smartphones and computers at a specific location.

MobileMath (Wijers et al., 2008) was designed to investigate how a modern, social 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 (Bahadur and Braek, 2009) has been developed as a case study to help analyze a specific domain and design 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 (Miura et al., 2010), children carry a PDA and create a map using a stylus pen by drawing streets and placing icons such as hospitals or 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.

Micromandarin (Edge et al., 2011) is a mobile application that implements a database of English-Chinese translations associated with the context of use. The application supports the learning of a second language while people interact with native speakers. Such a learning process leverages the location-based service Foursquare to provide contextual relevant information according to the user location. Although the application was designed to support the learning of Mandarin Chinese language, it can also be used to support contextual microlearning of various other languages.

Table 1 presents a summary of these proposals. The C1 to C9 rows correspond to the requirements of situated learning applications described above. Name=application name, Plc=place where it can be used, Obj=objective
of the application, Trg=target students population, Dev=required devices, Clm=collaborative space/time mode, Evt=evaluation strategy.

<table>
<thead>
<tr>
<th>Name</th>
<th>Moop</th>
<th>Loch</th>
<th>Amulets</th>
<th>MobileMath</th>
<th>Treasure Hunt</th>
<th>SketchMap</th>
<th>Micromandarin</th>
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</thead>
<tbody>
<tr>
<td>Plc</td>
<td>Outside/Inside the classroom.</td>
<td>Outside/Inside the classroom.</td>
<td>Outside/Inside the classroom.</td>
<td>Outside the classroom</td>
<td>Outside the classroom</td>
<td>Outside the Classroom</td>
<td></td>
</tr>
<tr>
<td>Obj</td>
<td>Learning in a mobile scenario by sharing observations</td>
<td>To learn Japanese in real life situations.</td>
<td>Enhance content of the curricula, enriching the field experience</td>
<td>Game learning to analyze and learn math problems</td>
<td>Game learning through participation and problem solving</td>
<td>Easily record and sharing of knowledge over maps using sketches</td>
<td>To learn Mandarin Chinese in real situations</td>
</tr>
<tr>
<td>Trg</td>
<td>Primary and secondary school students</td>
<td>20 to 30 year old users</td>
<td>4th grade students and 5th grade students</td>
<td>12 to 14 year old students</td>
<td>Secondary students</td>
<td>Sixth graders students</td>
<td>23 to 42 years old users</td>
</tr>
<tr>
<td>Dev</td>
<td>Mobile phones with cameras</td>
<td>PDA/smartphones with GPS, Bluetooth, Wi-Fi, and smart board</td>
<td>Mobile phones with GPRS connection and a with GPS receiver</td>
<td>Mobile phone with a GPS receiver</td>
<td>Laptops with GPS receiver and Google maps</td>
<td>Tablet PC, a USB camera and a GPS receiver</td>
<td>Phone with GPS</td>
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<tr>
<td>Clm</td>
<td>Same time, different places between students and teacher using a voice channel</td>
<td>Same time, same place and different places among users and teacher</td>
<td>Same time and place among students, different time and place between students and teacher</td>
<td>Same time, same place</td>
<td>Same time, same place and different places among students</td>
<td>Students interact and share with different roles. Same time, same place</td>
<td>Not specified</td>
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<td>Observation</td>
<td>Questionnaires</td>
<td>Questionnaires</td>
<td>Observation</td>
<td>Simple testing, Usability and utility</td>
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<td></td>
</tr>
</tbody>
</table>

Table 1. Characterization of representative research projects using geo-collaborative situated learning applications.
Based on the information shown in table 1, we can conclude that from the requirements stated by Herrington and Oliver (2000), the less frequently considered are: (C3) the access to expert performances and the modeling of processes, (C8) the coaching and scaffolding by the teacher at critical times and (C9) the authentic assessment of learning within the tasks.

**Designing a geo-collaborative application for situated learning**

This section presents a prototype of a system (including a Web visualization tool and a mobile application) to support geo-collaborative learning activities. The application allows students collecting data on the field to find evidence of previously known patterns. For example, knowing the patterns of neo-classical architecture the application can find examples in the city, or discover patterns 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. After an analysis of the students’ work scenario and the learning activity to be supported, we have identified the following functionalities for the software application:

**Creating Patterns:** Creating a pattern means to define its components. This consists on defining its elements: name, goal, description, forces, etc. These components are input by free-hand writing. Additional multimedia objects (e.g. pictures, videos or audio) 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.

![Figure 1](image-url)  
*Figure 1. Task (left) and pattern (right) creation. The task consists of following a path.*
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.

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.

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 evaluating 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.

The LACCIR Virtual Institute

The capabilities provided by Information and Communication Technologies (ICT) are critical to economic, educational and social advancement, since ICT is considered a transversal area for several key disciplines, such as education, health, commerce, services, agri-business and manufacturing. Improving the capabilities in ICT research can help LAC countries to improve the opportunities to find solutions to their common problems. This objective has been acknowledged in the working agenda of the Organization of American States (OAS, 2008), which argues the scientific and technological research on ICT is a critical element for the economic and social development of the LAC region. Higher education institutions must participate as partners with government and industry in nationally-balanced, socio-economic strategies to increase this research capability. This is particularly applicable to education at any level. However, there is an evident lack of critical mass in ICT research in most LAC research institutions, which is illustrated by the scarce results the region has at a world-wide level (Casas et al., 2012). Moreover, very few private enterprises are involved in research and development, as compared to leading countries in Europe, Asia and the USA.

These issues place an urgent call for collaboration and partnership in the region. The Latin American and Caribbean Collaborative ICT Research (LACCIR) Federation was created in 2007 as a contribution to address this challenge. This initiative provides LAC research institutions with a virtual collaborative environment to promote cross-country research, educational solutions and technology transfer to the local organizations.

The research related to educational technologies in general and situated learning based on mobile applications described herein, has been done in collaboration among several Latin American countries and supported by LACCIR.

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 incorporate 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 successfully 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 the second section of this article we presented the requirements for designing learning environments that support situated learning, and in this section we will analyze how the proposed system fulfills 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 also been 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 of 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 feature 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 fields 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 & audio) linked to the user localization will enrich their observations.

There are still many amazing challenges to face in computer supported learning. As technology evolved, researchers have experimented how to use the new computer devices and services to support learning achieving various levels of success. Nowadays computer technology is getting more and more ubiquitous, mobile and integrated. This is quite an interesting opportunity to experiment with learning integrated approaches to computer supported learning, since the technology is now available. Moreover, we see in this approach an answer to some of the problems that Computer Supported Learning (CSL)-researchers have identified as unresolved, especially those related to systems supporting a particular learning setting successfully, but failing to be used on a day-by-day basis. We have seen in the situated learning theory an opportunity to address an integral learning environment because it comprises learning activities in various settings and modes.
References


