Chapter 10
Situated Learning Theory and Geo-collaboration for Seamless Learning

Gustavo Zurita and Nelson Baloian

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. Therefore, this theory offers an excellent basis for developing applications supporting collaborative learning activities implementing seamless learning. In this chapter, we present and analyze two applications designed with the principles of situated learning, which implement learning activities taking place inside and outside the classroom without interruptions of either learning methodology or technical platforms. The first one supports the learning of models for wireless signal propagations. It starts with a classroom activity for learning the theoretical models, and then a field trip is used to measure actual signal strengths and compare them with the data generated by the models. The second one is a learning system and a methodology based on the use of patterns. Students learn about patterns by finding instances of them in the field or by recognizing new patterns unknown to them so far. The teacher proposes tasks to the students consisting of finding instances of patterns or discovering new ones along a path or inside a predefined area on a map. Both systems support the features of seamless learning across various scenarios in and outside the classroom, due to the encompassing formal and informal learning, personalized and social learning, physical and virtual worlds, across time and location, and ubiquitous knowledge access by context-aware in real learning scenarios.

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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 (Lave and Wenger 1991). 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 over 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) and the use of GPS data to pinpoint geographical locations (Clough 2010). In this work, we also consider the geographical location as an important context component which enriches the information the students are dealing with. In fact, in many scenarios the knowledge is inherently attached to the location where it is applied. One example may be a particular geological formation being studied or an architectural pattern which may shed some light about the development of a city revealing the data and architectural trends which prevailed when certain buildings where constructed.

The notion of "cognitive apprenticeship" (Brown et al. 1989) is also closely 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 in and outside school advances through collaborative social interaction and the social construction of knowledge."

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" (Wong and Looi 2011) has been proposed to define these new learning situations that are marked by a continuity of learning experiences across different learning contexts. Students, individually or in groups, carry out learning activities whenever they want in a variety of situations and that they switch from one scenario to another easily and quickly. 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 chapter, we describe our current research efforts that include the design of a learning environment that integrates mobile applications and geo-collaboration tools in order to support seamless learning based on the Situated Learning theory. Learning activities in these settings take place in and outside the classroom and encourage students to collect data in 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.

Situated and Seamless Learning Activities Supported by Geo-localization

Situated Learning and Geo-localization

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 Table 10.1 for examples). Few of them rely upon geo-localization features that characterized Geographic Information Systems (GIS). A GIS offers several functionalities, such as associating by geo-reference information of different nature to a specific geographic location using visually represented maps; recording the history of routes; making notes on real geographic points of reference, places, or zones; determining routes; comparing different notes made in different locations; following certain 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.

Therefore, collaborative activities can be introduced in situated learning scenarios and also to providing the seamless learning features by letting participants collaborate 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. These types 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. 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 (Wong and Looi 2011).

Lave and Wenger (1990) suggest that learning is better off 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. (1989) 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, it is necessary to identify its critical aspects in order to enable it to translate into teaching and learning activities that could be applied inside and outside the classroom (Brown et al. 1989). In response to this challenge, Herrington and Oliver (2000)

Table 10.1 Characterization of representative research projects using geo-collaborative situated learning applications. R1 to R9 rows correspond to the requirements of situated learning applications describe above

Reference	Mattila and Fordell (2005)	Ogata et al. (2006)	Kurti et al. (2007)	Wijers et al. (2008)	Bahadur (2009)	Miura et al. (2010)	Edge et al. (2011)
Place	Outside/inside the classroom.	Outside/inside the classroom.	Outside/inside the classroom	Outside the classroom	Outside the classroom	Outside the classroom	Outside the Classroom
Objective	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 participation and problem solving	Easily record and sharing of knowledge using maps, sketches	To learn Mandarin in real situations
Users	Primary and secondary school students	20–30-year-old users	4th and 5th grade students	12–14-year-old students	Secondary students	Sixth graders students	23–42 years old users
Technology	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
Collaborative mode	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, place among students, different place and 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
R1	√	√	√		√	√	√
R2	√	√	√	√	√	√	√
R3	√						
R4	√					√	
R5	√	√	√	√	√	√	
R6	√	√	√	√		√	√
R7	√	√	√	√	√	√	√
R8	√	√	√				
R9	√	√					

suggest a practical framework for designing situated learning activities including the following situated learning requirements:

R1. Provide authentic contexts reflecting the way knowledge is used in real life.
R2. Provide authentic activities.
R3. Provide access to expert performances and the modeling of processes.
R4. Provide multiple roles and perspectives.
R5. Support collaborative construction of knowledge.
R6. Promote reflection to enable abstractions to be formed.
R7. Promote articulation to enable tacit knowledge to be made explicit.
R8. Provide coaching and scaffolding by the teacher at critical times.
R9. 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 10.1 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.

Moop (Mattila and Fordell 2005) is a learning environment supported by mobile phones, through which learners analyze their thoughts and make observations. It 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. 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. With the teacher application it is possible to plan the route directly live on course in the nature and in the observation place.

LOCH (Ogata et al 2006) describes a computer-supported ubiquitous learning environment for seamsless 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 (Kurti et al. 2007), children use a mobile application with GPS to learn about "tree morphology" and "the history of the city square through centuries." The system challenges the students to identify different types of objects and conducting some tasks including recording still images and video describing how they solved the tasks they were assigned. In order to solve these problems, students are required to collaborate using a number of tools including instant text messaging between smartphones and computers.

MobileMath (Wijers et al. 2008) is designed to investigate how a modern, social type of game can contribute to students' engagement in seamless math learning. 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. They do this by constructing squares, rectangles or parallelograms by physically walking to and clicking on each vertex (point). 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 analyzing a specific domain and designing a generic and flexible platform to support situated collaborative learning. Students go around the city and learn how to participate in several social/group activities.

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 or a video which is shown as an icon. 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. Annotations on the maps allow children to add new information or experiences, related to what they have discovered after their outdoor activities. The children can collaboratively share information and knowledge about neighboring areas in the vicinity of their school.

In Micromandarin (Edge et al. 2011), a database of English-Chinese translations associated with their context of use was created. This application supports key functions: studying language based on where you are, using language you have learned based on where you are, and browsing all language you have seen through the application.

Based on the information shown in Table 10.1, we can conclude that from the requirements stated by (Herrington and Oliver 2000), the less frequently considered are the access to expert performances and the modeling of processes (R3), the coaching and scaffolding by the teacher at critical times (R8), and the authentic assessment of learning within the tasks (R9).

In the next sections, we present two applications based on the principles of situated learning supporting seamless learning across various scenarios in and outside the classroom.

Seamless Learning in Situated Learning

We consider that mobile geo-collaboration is an interesting option for designing computer-supported learning applications implementing seamless learning complying with the principles proposed by Wong and Looi (2011) in the following way:

SL1. *Bridging formal and informal learning*. The teacher may complement the theoretical educational content seen in the classroom (formal learning) with activities outside the classroom (informal learning). These activities may involve geo-location of data referring to the educational content by marking them on a map, carrying an historical record, and comparing the points, places, or geographical zones which students explore by themselves or visit by instruction of the teacher.

SL2. *Bridging personalized and social learning*. Students can perform learning activities individually, in small groups, by ad hoc networked group forming, and collaboratively; all these modalities may be configurable and combinable. For example, an activity might start by performing individual work and then evolve to a collaborative, face-to-face one. Moreover, the teacher may offer feedback synchronously or asynchronously, while students are engaged geo-localizing information in the field or afterwards.

SL3. *Bridging across time, across locations*. Students can move across various geographical places anytime in order to perform the tasks proposed by the teacher. They can also work collaboratively synchronously or asynchronously. The teacher may provide feedback synchronously or asynchronously as well. By making use of the current services available in the cloud (e.g., Google Maps, Google Street View), students may work in the field or virtually visiting a certain place.

SL4. *Encompassing physical and digital worlds*. Theatrical knowledge acquired in the classroom by means of "digital worlds" (simulation, models) can be checked and/or used in "physical and real worlds," for example, by searching concrete instances explained by the models.

SL5. *Ubiquitous knowledge access*. This means students can pull or push information from the Internet when learning is taking place in a specific geographic location. In this way, the contextualized information (to and from the students) can serve as evidence to support partially formed ideas and clarify misunderstandings, to trigger comparison with previously stored data, and to support an inquiry process or dialogue in situ. The contextual information pulling (buildings, parks, museums, etc.) can be provided by the place where the students are developing their activities (by the use of the GPS functionality of the mobile devices).

SL6. *Encompassing physical and digital worlds*. It is possible to combine digital and physical worlds with ambient environments that capture real-world information of users, devices, and locations (geographical information systems) and represent it in a format that is usable in the digital realm.

SL7. *Combined use of multiple device types*. An alternative to cope with the problem of the various existing mobile platforms that are incompatible (Android, IOS, BlackBerry OS, Symbian OS, Windows Mobile) is the use of open standards for developing applications capable of running on a browser. HTML5 has features like offline storage or the ability to handle data even when the app is no longer connected to the internet, geo-location, or the ability to detect and work with the location of the user as well as excellent rich media support, providing easy to implement audio and video elements. We propose the use of HTML5 to implement the functionalities, which we are mentioning here.

SL8. *Bridging multiple learning tasks*. This feature is about seamless and perhaps rapid switches between multiple learning tasks on the move (e.g., during field trips), mediated by the device. The tasks that we propose strike a balance between the restricting in situ activities (data collection and measurement, quick brainstorming or Internet search, brief note taking and geo-referencing data and information) to more sophisticated data analysis and knowledge co-construction tasks (i.e., deep meaning making) for the follow-up learning community after the field trips. The embodiment of such inquiry tasks in mobile seamless learning flows could serve as a means to nurture the twenty-first century skills and competencies.

SL9. *Bridging knowledge synthesis*. The ultimate aim of embracing seamless learning is arguably the synthesis of knowledge and the acquiring of the skills to perform the synthesis. We propose to implement functionalities to acquiring data in different contexts, locations, domains and forms and recording, organizing, processing and reflecting upon the knowledge. This will be mediated by him/her own mobile device that serves as a learning hub, thereby making connections and perhaps identifying discrepancies between pieces of knowledge and ultimately knowledge construction.

In the next two sections of this chapter, we introduce two applications designed with the principles of situated learning, which implement learning activities taking place inside and outside the classroom. The first one (section "Geo-collaborative application for learning wireless signal propagation") supports the learning of models for wireless signal propagations. The second one (section "Geo-collaborative application for "learning with patterns"") is a learning system and a methodology based on the use of patterns. Students learn about patterns by finding instances of them in the field or by recognizing new patterns unknown to them so far. Both systems support the features of seamless learning across various scenarios in and outside the classroom. They highly relay on the use of geo-located data to carry on the learning activity. They address the three requirements (R3, R8, and R9), which are more neglected by the similar applications considered in the literature review.

Geo-collaborative Application for Learning Wireless Signal Propagation

Many scholars agree that teaching and learning wireless communication is a challenging issue mainly because it is difficult for students to translate the theoretical models that are commonly used in this area to explain the propagation of the signal into explicit, practical knowledge (Etter 1994; Junqi et al. 2009). This knowledge is essential order to be able to plan wireless networks settings, which is a fundamental activity for this area. From a pedagogical perspective, situated learning offers an interesting framework to support the translation of abstract, theoretical knowledge into concrete skills by applying knowledge in realistic settings and carrying out authentic activities (Denk et al. 2007).

In wireless network planning, engineers must determine the location of a set of transmitters (antennas) and their characteristics, like transmission power, frequency, direction, etc., in order to cover an area using the minimum of resources (Yijia 1996). In order to do this, engineers normally use software, which simulates using mathematical models the propagation of the signal emitted by a transmitter. There exist various models that simulate the propagation under various landscape conditions (urban areas, suburban areas, mountainous areas, flat countryside areas, etc.) (Iskander and Yun 2002; Santos et al. 2005; Hata 1980). Choosing the right model for each situation is not an easy task because some scenarios may combine various landscape types at the same time. Therefore, planning the network requires performing real measurements at various locations in order to check if the applied model predicted the propagation correctly. Otherwise it will be necessary to correct the assumptions. It is important that engineering students understand the difficulty in choosing the right model and that the chosen model may not apply for the whole area which they are considering for simulating the signal propagation.

Situated learning recommends that students perform these modeling activities in a real environment with the help of an expert and having the opportunity to reflect about the learning experience. Collaboration is also considered by the situated learning to be an important aspect that should be present in this process.

The design and deployment of large-scale wireless networks consisting of various antennas providing a certain area with service, using minimum resources constitutes a real engineering activity actually performed by professionals of this area. This process has three stages: planning, implementation, and evaluation.

The *planning* stage is performed using cartographic information about the area, which should be covered with the signal emitted from the set of antennas, and using a signal coverage simulation tool. This activity consists of locating a set of antennas and simulating the area covered by them using available simulation software. Normally, software of this kind implements various electromagnetic signal propagation models and allows the user to choose which one to utilize in each case. The *implementation* stage consists on building the network of antennas based on the planning stage. Finally, the *evaluation* stage consists on measuring with real instruments that is the actual coverage of the signal by taking samples of the signal strength in various geographical strategic points. The information obtained from the measurements is gathered and contrasted with the data obtained by the simulation during the planning stage in order to make the necessary adjustments to the network for obtaining the desired results.

Starting from the described activity taken from the real life, a learning activity was designed based on the Situated Learning theory, which mainly consists in carrying on the evaluation stage. For this, we defined two roles: planner and measurer. For each role a specialized tool was developed in order to support their activities.

The learning activity envisages two sessions: the first one is the theoretical session where students learn in a classroom setting the various existing models for simulating the signal propagation. During the second session a practical workshop is performed which starts by defining working groups consisting of four students each. Two of them take the role planners and the other two the role of measurers. The tasks to be performed are also divided in two stages: the first one is the *input of data* stage and the second one the *evaluation* stage.

During the *input of data* stage *planners* will make a signal coverage analysis for a set of existing real antennas using a signal coverage simulation tool (see Fig. 10.1) and a collaboration tool (see Fig. 10.3). Both tools have two different interfaces implemented, one designed to be used on a desktop PC and the other to be used on mobile

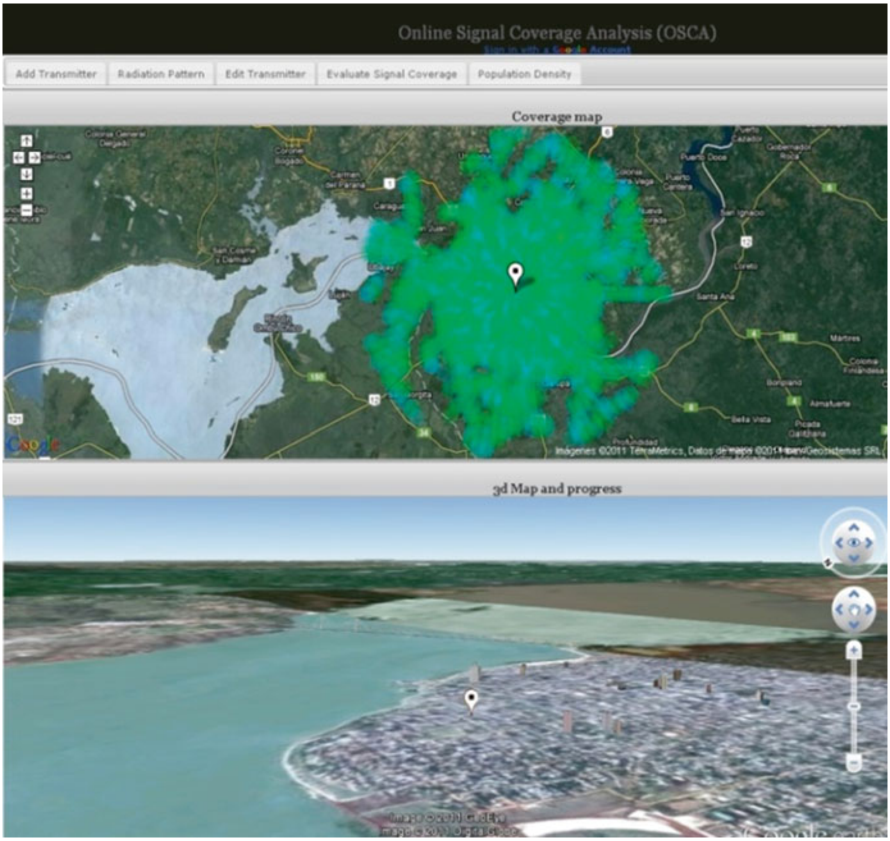
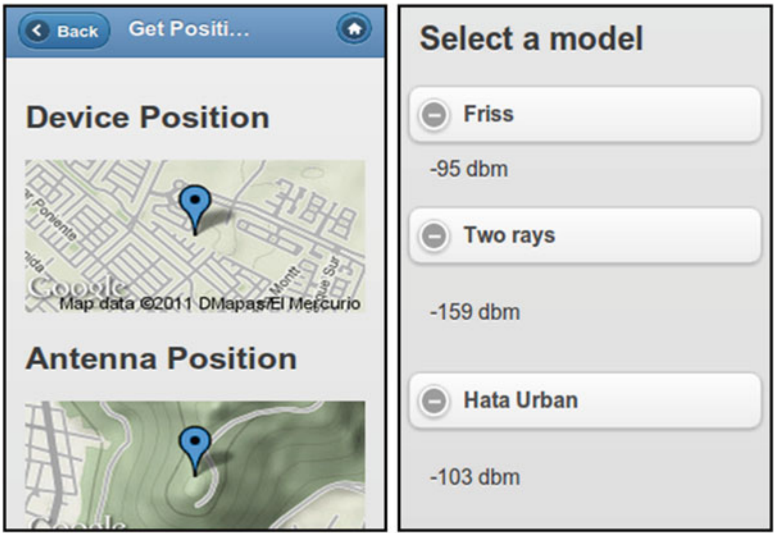


Fig. 10.1 Coverage analysis tool on desktop browser with the 2D (*up*) and 3D (*bottom*) views. The *white* marker on both views represent the location of the antenna. The *light green* area of the 2D view corresponds to the area covered with signal according to the simulation model

devices (see Fig. 10.2). Students get the necessary information about the antennas in order to perform the simulation like the geographical location, height, strength, radiation pattern, etc. This information is used to feed the signal coverage analysis software, which actually performs the simulation after students choose the propagation model they consider is the most adequate given the cartographic information provided by Google Earth. Once the simulation is performed and simulated data about the signal strength for the whole area is obtained, students receive a set of coordinates of various geographical points, which they have to input into the collaboration tool along with the data about the simulated signal strength for each of these points.

During this stage the *measurers* have to go to the places designated by the coordinates, which were given to the *planners*. At those places, *measurers* use professional signal strength tools to obtain the corresponding information of the real signal strength at that location. Then, they input this data using the collaboration tool in order to share it with the rest of the team.



Device Position

Antenna Position

Select a model

Friss

-95 dbm

Two rays

-159 dbm

Hata Urban

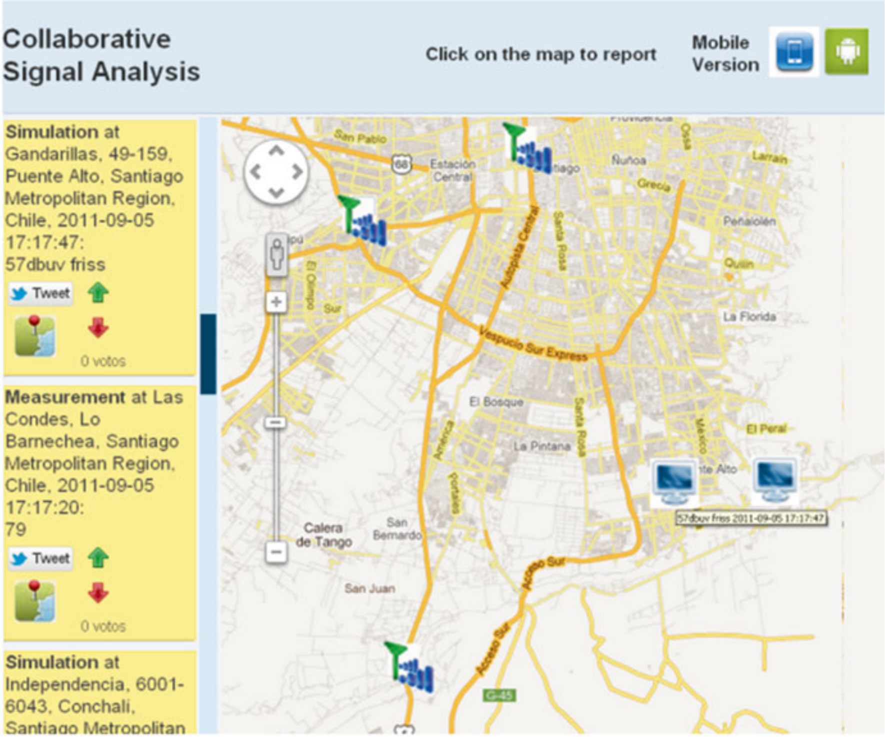
-103 dbm

Fig. 10.2 The picture on the *left* shows the upper half of the mobile device's interface. The map on the *top* shows the student's current position according to the device's GPS. The map on the *bottom* shows the antenna's location. On the *right*, the bottom half of the interface shows the signal strength values according to each available model is displayed

During the *evaluation* stage, *planners* and *measurers* work using a collaboration platform we have developed (a detailed description is provided in the next section) in order to find which is the model that better predicts the real measured value of the signal strength by comparing both data: the simulated and the measured. However, students will realize that there is no single model, which predicts the real value for the whole area. The actual learning occurs when students have to justify the reason for this, by checking the different geographic and building scenarios in site. The system allows them to input and browse the simulated and real data in order to compare them and start discussion.

The Software and Hardware

As mentioned in the previous section the software consists of two applications, one for each role. These are the coverage analysis tools for planners and the collaboration tool, which is used in both steps by both roles. The first one was already developed for a previous work reported in (Baloian et al. 2012) for supporting a learning activity for a single learner scenario. The collaboration tool interacts with the coverage analysis tool and was developed in order to enhance the learning experience by including the collaborative learning activities in the way the Situated Learning theory recommends.



Collaborative Signal Analysis

Click on the map to report

Mobile Version

Simulation at Gandarillas, 49-159, Puente Alto, Santiago Metropolitan Region, Chile, 2011-09-05 17:17:47: 57dbuv friss

Tweet

0 votos

Measurement at Las Condes, Lo Barnechea, Santiago Metropolitan Region, Chile, 2011-09-05 17:17:20: 79

Tweet

0 votos

Simulation at Independencia, 6001-6043, Conchali, Santiago Metropolitan

Fig. 10.3 The desktop web browser interface is used to input simulated or measured signal strength values for various locations. For this the user clicks on the map and enters the information. Screen icons indicate a simulated value for that location was inputted; antenna icons indicate a measured value. On the *left* column, detailed information for each data on the map is shown

Coverage Analysis Tool

This tool has two interfaces, one for desktop computers and another for mobile devices. The desktop interface supports the planning activity in the classroom that includes performing simulations and storing the generated data. The mobile interface is designed to provide the simulation data while working on the field.

The desktop interface has four main features:

Add transmitter: The goal of this feature is to provide an easy way to perform the planning step, using a 2- and a 3- dimensional map. The 2D map is used to specify an approximate location of the antenna. This map is synchronized with the 3D view (see Fig. 10.1). After this, the antenna can be set with a double click on the 3D view. Then, the technical specifications of the transmitter can be filled in a pop-up form (not shown in Fig. 10.1), which includes the propagation model to be used in the simulation.

Edit a transmitter: In order to allow students to test different models, the specifications of a transmitter can be edited.

Radiation pattern: Each type of transmitter has a specific radiation pattern, which defines the transmission power on a specific direction. This is an important parameter for simulating the signal strength.

Evaluate the spatial coverage: This function performs the actual simulation by computing the signal strength in the whole area by applying the selected propagation model for that antenna.

The mobile interface allows students to retrieve the simulated signal strength values at the current location according to all available models while students are working on the field. First, the Select antenna function should be performed in order to choose the antenna from the available set according to which the signal strength should be computed. Then the GetPosition button should be pressed in order to let the system retrieve the current position of the student with the mobile device using the GPS of the mobile device. Then the system shows the simulated signal strength emitted from the selected antenna at the device's position according to all available models. Figure 10.2 illustrates the system's interface for the mobile devices. At the right-hand side, the simulated signal strength according to the available models is displayed. At the left-hand side, the mobile device's position (where the student is current standing) and the selected antenna position are shown. By clicking on the button labeled with the model's name, more information about the simulation results is displayed.

The Collaboration Tool

This tool has also two interfaces, one for desktop and another for mobile devices. The desktop interface is used during the planning activity in the classroom, and the mobile is the collaboration tool that is used on the field while students are measuring the signal strengths. The desktop version has two features: report a simulation value and vote for a measurement or simulation. The mobile has three features: report a measurement, and vote for a measurement or simulation.

Report a simulation (available on desktop version only): Students publish the simulated signal strength for a certain location. The goal of this procedure is to have the values available for the evaluation step, in order to allow students to compare this value with the measured one (see Fig. 10.3).

Vote (available on desktop and mobile versions): During the evaluation step students have to choose the most adequate model to predict each measured value of the signal's strength. While planners have better information about the simulation results and the geographical characteristics of the area between the antenna and the device position, measurers have on-site information about the local conditions for a certain point. Both actors can use the voting system to express their preference for one model or the other according to their information.

Report a measurement (on mobile version only): This functionality allows students on the field (measurers) to publish measured values to the rest of the group (other measurers and planners). The measurer first obtains the signal strength with a measuring device. In order to publish this value, the button labeled with Signal should be pressed, then the value should be typed in and the Report button pressed. The system automatically adds the location information using the GPS feature of the mobile device and shows it on a map.

Geo-collaborative Application for "Learning with Patterns"

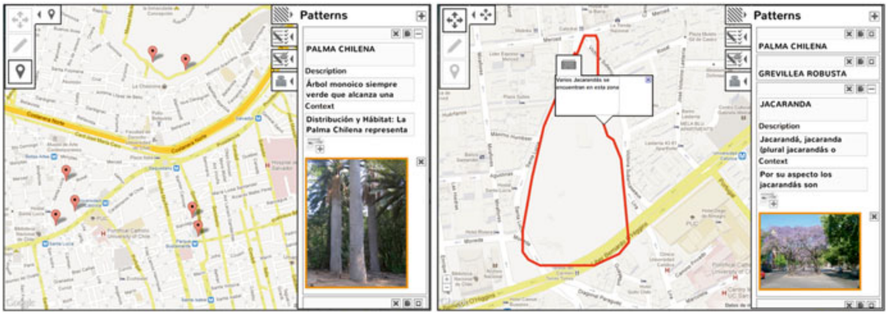
Patterns play a significant role in learning. Research findings in the field of learning psychology provide some indications that human learning can be explained by the fact that learner discover, register, and later apply patterns (Ewell 1997; Howard et al. 1992; Restle 1970). These cognitive processes "involves actively creating linkages among concepts, skill elements, people, and experiences" (Ewell 1997). For the individual learner, the learning process involves "making meaning' by establishing and re-working patterns, relationships, and connections" (Ewell 1997).

Learning with Patterns

Patterns are recurring models and often are 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. (1977). A pattern consists of a set of components including the name of the pattern, the 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 (Erich et al. 1995), interaction design (Borchers 2000), and pedagogy (The Pedagogical Pattern Project 2013). Although the evidence that patterns play an important role in learning, they have seldom been used to support the development of cognitive and social skills apart from the field mathematics. Here we show how this concept can be further be used to support learning.

Application Description

Based on the information described in the previous paragraph, we have developed a prototype of a system 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 neoclassical architecture found in the city or discovering patterns starting from the evidence found in the field (e.g., studying the



PALMA CHILENA

Description: Árbol monoico siempre verde que alcanza una

Context: Distribución y Hábitat: La Palma Chilena representa

Varios Jacarandás se encuentran en esta zona

PALMA CHILENA

GREVILLEA ROBUSTA

JACARANDA

Description: Jacarandá, jacaranda (plural jacarandás o

Context: Por su aspecto los jacarandás son

Fig. 10.4 Teacher's view of the system. *Left*: pattern creation of a "Palma Chilena" with a picture of it that is geo-localized in the exact locations where they are found. *Right*: pattern creation of a "Jacaranda," whose picture illustrates an example and also the region where they are found, which is indicated on the map

Identificar 2 palmas chilenas y 2 jacarandas

Description: Recorrer solo los espacios delimitados

Identificar Salcillas

Description: Registre salcillas cerca de puntos marcados

Identificar grevillea robusta y palma chilena

Description: Según secuencia y recorrido descritos

PALMA CHILENA

GREVILLEA ROBUSTA

SALCILLA, ZARCILLA, COPIHUITO

JACARANDA

Fig. 10.5 Teacher's view of the system for the task definitions, which are made by following a path (*left*) and marking specific locations (*right*) in which the students need to work with

reasons of why certain patterns of trees appear more often in city parks). According to the specific scenario described in the next paragraphs, the following functionalities for a system supporting them have been identified:

Creating patterns: To create a pattern means to define its components, describing its elements: name, description, context, etc. For each pattern, these components are annotated over the map by freehand writing (see Fig. 10.4). Additional multimedia objects (pictures, videos, etc.) can be associated to the description of the pattern.

Creating tasks: Teachers can create tasks consisting of instructions to be given to the students, containing the description of activities and their corresponding instructions annotated over the map with a specific path (left of Fig. 10.5) or to randomly explore a pre-defined area within the city in order to find evidence of patterns (right Fig. 10.4) or visit specifically marked places (right of Fig. 10.5). Therefore, the teacher can define a path, an area, or mark points by freehand

Un jacaranda encontrado

Identificar grevillea robusta palma chilena
Identificar Salcillas
Identificar 2 palmas chilenas 2 jacarandas

PALMA CHILENA
JACARANDA

Identificar grevillea robusta palma chilena
Identificar Salcillas
Identificar 2 palmas chilenas 2 jacarandas

GREVILLEA ROBUSTA
PALMA CHILENA

Fig. 10.6 Two students' views, with instances of the patterns and tasks provided by their teacher. Each of the three tasks shown in both interfaces belongs to the same team. The third assigned task is highlighted on the *left* and the *right* shows the first. Both interfaces show the task development already done collaboratively

sketching the limits of it onto the map. Consequently, the task for the students will consist of exploring a geographic area by following a path, randomly visiting a concrete area, or specifically visiting marked locations, in order to collect data about the instances of a pattern. Furthermore, the teacher can associate previously defined patterns to the task or create new ones inside the task creation process. Figure 10.2 shows the creation of various tasks and their associations of these to the corresponding pattern(s).

The teacher can create these patterns and tasks 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.

Assigning tasks to students: In the classroom, and before going to the field activity, students turn on their mobile devices (Tablets or Tablet PCs) running the application. The teacher's application automatically discovers the students' application and displays them on the screen as an icon. 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, explore an area of the city, or go to specific places gathering data to collaboratively create instantiations of the pattern when they find certain elements that they think correspond to the pattern given by the teacher. Instantiations consist of text descriptions, pictures, or sketches of a certain object found which complies with the pattern definition; see Fig. 10.6.

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."

Conclusions

Current developments in mobile computing and wireless networks facilitate and promote the implementation of computer-supported learning systems that can be deployed ubiquitously. The Situated Learning theory can be used as a good frame for designing computer-supported learning activities, which take place in the field. An interesting subset of this kind of learning systems is the set of applications that make intensive use of geo-referenced information, when the knowledge being acquired is strong related to a geographical location. In this work, 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. 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. This is mainly due to current developments in mobile computing and wireless networks, which allow the development of computer-supported learning systems that can be deployed ubiquitously. The Situated Learning theory is a good frame for the development of computer-supported learning activities that take place in the field. An interesting subset of this kind of learning systems is the set of applications that make intensive use of geo-referenced information, when the knowledge being acquired is strong related to a geographical location. A key element for these systems is the availability of maps and geographical information in general. This is fortunately nowadays provided as Cloud Services by a number of providers for free.

In section "Situated and seamless learning activities supported by geo-localization", we presented the characteristics of seamless learning. Here, we will analyze how the two developed systems fulfill them. Table 10.2 illustrates how the developed applications comply with the mentioned characteristics, 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 these systems are able to support different learning modes and stages, without disruptions of methodology, interaction paradigm, or data compatibility. In fact, the systems are able to run on different platforms. They have been used on PCs inside the classrooms, where the teacher used an electronic board. Handheld and Tablet PCs have been also used to run these systems. The common aspect on all these platforms is the touch screen and the big difference is the size.

The design of both developed systems considers functionalities which include the requirements of situated learning mentioned in (Herrington and Oliver 2000). Particularly, they consider the three requirements (R3, R8, and

(continued)

Table 10.2 The requirements and the system features fulfilling for both seamless learning applications (SL1 to SL9)

	Application for "Learning with Patterns"	Application for "Wireless Signal Strength Propagation"
SL1	Formal learning takes place in the classroom with the teacher explaining and presenting patterns; informal learning takes place in the field with students finding instances	Formal learning takes place in the classroom with the teacher explaining and presenting various models of signal propagation; informal learning takes place in the field with students measuring actual values and discussing about the validity of each model
SL2	Personal learning occurs when students learn a pattern and social learning when they collaboratively work in the field collecting instances and discuss about them	Personal learning occurs when students learn the models theoretically; social learning occurs when they take the measurements in the field and share and compare their analysis results in order to find the best prediction model
SL3–4	Students learn the theory about patterns in the classroom and then they work in the field gathering data and come back to the classroom to present their findings. All this is done in different times and places	Students learn the theory about models in the classroom and then they work in the field taking measures. Then they discuss about the obtained data synchronously or asynchronously
SL5	Mobile devices allow students to access the information about the patterns anywhere and anytime, which will help them to accomplish their task; they also may receive advice from the teacher during the field trip	With the mobile devices students have access to the simulation data as well as other information they may download from the internet
SL6	Students work with digital maps annotating them in order to represent facts of the real world	Students must compare the results given by the simulated world with the real facts of the measured data
SL7	The technology used to develop the application (HTML5) allows it to be run in a variety of devices	Same as for the other application
SL8	Since the application interface used in the classroom and the one for the working in the field are very similar, the switching between the various tasks is easy	Although applications used in the classroom or laboratory and the one used in the field are not similar, the interaction logic in all of them has been kept coherent in order to facilitate the switching from one task to another
SL9	Students present their findings in the field back in a classroom session where they reflect about the importance and distribution of the pattern instances	Students reflect on results of measurements obtained in the field in order to generalize the acquired knowledge

(continued)

R9) which are more neglected by the similar applications considered in the literature review: (R3) in both cases, the teacher can interact in real time with the students while they work in the field; (R8) because of this, the teacher can offer coaching and scaffolding at critical times; and (R9) the teacher can asses students' work in authentic conditions.

We think that the approach presented in this chapter can be applied to different learning fields, for example, (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, and sound), associated with its localization, will enrich their observations.

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