Social Knowledge Building in a Mobile Learning Environment

Conference Paper · November 2007

DOI: 10.1007/978-3-540-76888-3_56 · Source: DBLP

7 authors, including:

Manuel Gentile
Italian National Research Council
81 PUBLICATIONS **131** CITATIONS
SEE PROFILE

Davide Taibi
Italian National Research Council
87 PUBLICATIONS **264** CITATIONS
SEE PROFILE

Luciano Seta
Italian National Research Council
67 PUBLICATIONS **83** CITATIONS
SEE PROFILE

Onofrio Di Giuseppe
Italian National Research Council
26 PUBLICATIONS **31** CITATIONS
SEE PROFILE

Social Knowledge Building in a Mobile Learning Environment

Manuel Gentile, Davide Taibi, Luciano Seta, Marco Arrigo, Giovanni Fulantelli, Onofrio Di Giuseppe, and Gaspare Novara

Italian National Research Council, Institute for Educational Technologies, via Ugo La Malfa, 153, 90146 Palermo, Italy
{gentile,taibi,seta,arrigo,fulantelli,digiuseppe,novara}@itd.cnr.it
http://www.itd.cnr.it/

Abstract. According to the social constructivism paradigm, knowledge is not transferred from teachers to students, but is the result of collaborative activities; when these activities take place in a mobile environment, it is extremely important to consider how the temporal and spatial factors can influence the collaborative process. In this work we define a model for mobile Knowledge Building Process (mKBP); starting from this model, we propose to analyse the evolution of a mobile collaborative learning experience through its interactions with the social, the information and the geographic spaces. Finally, we present the methodologies and the tools used to investigate the data gathered during a specific mobile learning experience carried out at the Institute for Educational Technologies of the Italian National Research Council, in the framework of the Mobile and Ubiquitous Learning (MoULe) project.

Keywords: mobile learning, social knowledge building, social network analysis.

1 Introduction

In the last few years we have witnessed an increased use of mobile technologies within educational contexts. An analysis of the literature reveals an evolution over time. In fact, early studies focused on technological aspects and especially on the use of mobile devices in the classroom, while later research has concentrated on pedagogical aspects.

The most recent studies consider the use of mobile technologies from the wider point of view of learning experiences, which are often based on innovative methodologies where learning is seen as a continuous and social process, which takes place both inside and outside the classroom.

An important aspect explored in recent literature is the development of mobile computer-supported collaborative learning projects (MCSCL) [1].

The idea that collaboration is a basic form of human activity, essential for cultural development, has been stressed intensively by many writers throughout the history of psychology [2], [3], [4], [5].

R. Meersman, Z. Tari, P. Herrero et al. (Eds.): OTM 2007 Ws, Part I, LNCS 4805, pp. 337–346, 2007.

In a community of learners, as proposed by Brown and Campione in [6], the core activity is participation in a collaborative process of sharing and distributing expertise. As stated by Brown in [7], "Learning and teaching depend on creating, sustaining, and expanding a community of research practice. Members of the community are critically dependent on each other. No one is an island; no one knows it all; collaborative learning is not just nice, it is necessary for survival".

Some research presents mobile CSCL experiences which provide students with handheld computers to engage in collaborative student activities anytime, anywhere. Examples in this field are:

- *CatchBob!* (coordinatet by the CRAFT - Center for Research and Support of Training and its Technologies, Swiss Federal Institute of Technology Lausanne, web site http://www.i-cherubini,it/mauro/projects/MapTribe) which aims to study how the perception of space and places can influence the collaborative learning processes [8].
- *Charles River City* (coordinated by the MIT Teacher Education Program's Handheld Augmented Reality Simulations, USA, site http://education.mit.edu/ar/index.html) is another Augumented Reality game similar to Enviromental Detectives except that the environment simulated on the pocket PC is more dynamic and flexible and the students can communicate in real time and modify the setting and their roles.
- *Create-A-Scape* (coordinated by the Futurelab, UK, site http://www.futurelab.org.uk/) is a web site which provides tools and assistance to students and teachers who want to create mediascapes, or rather a collection of location-sensitive images and sounds placed on a PC map, so when a user visits the physical location carrying a Personal Digital Assistant (PDA) he will be able to see and listen to them.

When we talk about collaboration, what do we really mean? In everyday language the term 'collaboration' appears to refer to any activity that a pair of individuals, or a group of people perform together. Among researchers, however, including those in academic fields, the term 'collaboration' is understood rather differently.

Within learning sciences, different definitions exist, but they all share the same idea of collaboration as a special form of interaction that supports knowledge building processes [9]. In such a vision, according to social constructivism, knowledge is not transferred from teacher to student, but is the result of collaborative activities oriented towards the development of conceptual artefacts, and towards the development of collective understanding through social negotiation. Some projects introduce building knowledge into mobile activities such as [1] and [10].

In this work we present a model of collaborative knowledge building process in a mobile learning environment developed in the framework of the Mobile and Ubiquitous Learning (MoULe) project, carried out at the Institute for Educational Technologies of the Italian National Research Council.

The MoULe project is based on the creation of learning communities who collaborate in the construction of an augmented reality where digital objects are related to physical places.

In the latter part of the paper, we present the learning experience carried out by students, providing some preliminarily results based on the analysis of data social interaction and knowledge building processes.

2 Model of a Collaborative Knowledge Building Process in a Mobile Environment

We follow the model presented by Stahl in [11] where the collaborative knowledge building process was broken down into a set of phases centred around two cycles regarding personal understanding and social knowledge building. To validate this model in a mobile environment, it is extremely important to reflect on the temporal and spatial factors of the collaborative activities carried out by the users.

To consider these aspects in a collaborative knowledge building process we have extended Stahl's model, taking into account how the on site experience, through perception stimuli, can modify a student's beliefs and thus his/her cognitive state. We call this model the mobile Knowledge Building Process (mKBP).

The use of mobile devices can support students in positioning themselves both in the physical space and in the community space, making public statements that, thanks to the mobile devices, can include not only textual but multimedia contents. We hypothesize that, in a mobile environment, the knowledge building process can be analyzed on the basis of three spaces: social, information and geographical. The social space represents the social interactions between students

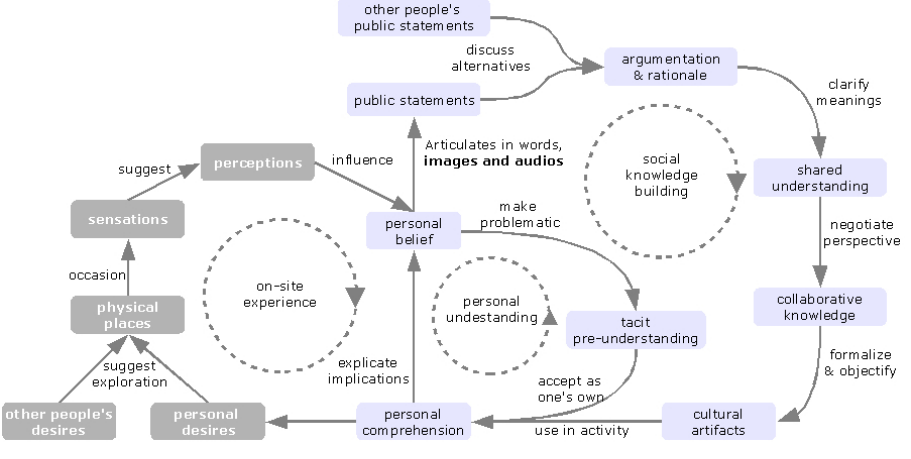

Fig. 1. The mobile Knowledge Building Process (mKBP) model

which occur in the knowledge building process; the information space concerns the cultural artefacts and the public statements produced by students as a result of their learning experience; finally the geographical space represents the physical places. Each of these spaces has a specific relation with the phases of the knowledge building process shown in Fig. 1. Each phase may be more or less related to one space rather than another depending on the activity stimulated by that phase. However, the whole knowledge building process crosses all three spaces.

To understand the evolution of this process we can observe the following data:

- the information produced by the students, for example the wiki pages edited, the notes taken, and so on;
- the geographical places visited and the points of interest crossed;
- the social interactions which take place.

We can describe this mKBP as a trajectory in a space defined through the use of three variables: information, geographical and social spaces.

When we consider the community mobile Knowledge Building Process (cmKBP) we obtain an ensemble of these trajectories, one for each participant. In Fig. 2 we sketch these trajectories in the cmKBP box. The data analysis

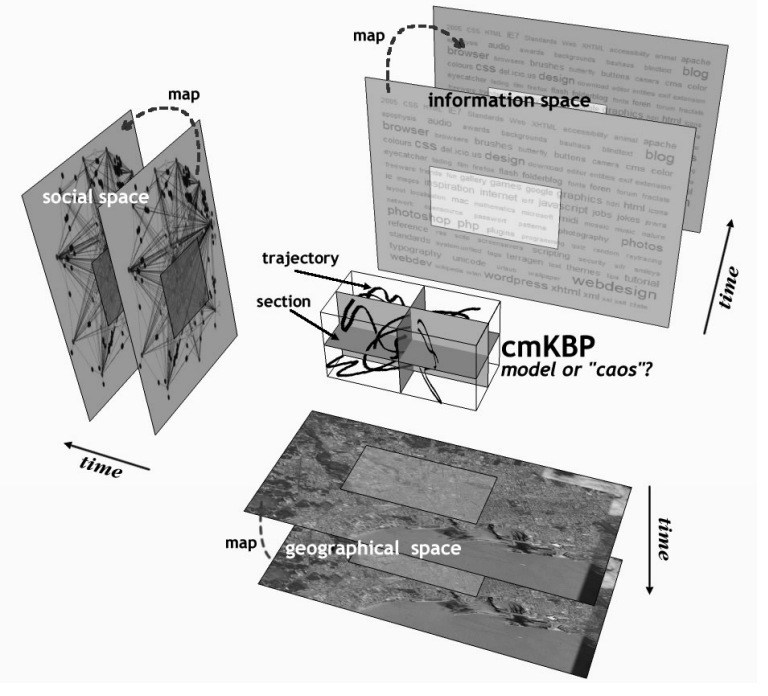

Fig. 2. The community mobile Knowledge Building Process (cmKBP)

aims to reconstruct the cmKBP by studying the relationships between these trajectories. A learning community would be expected to generate an ensemble of related trajectories whereas a class in which students all work independently would produce a quasi chaotic behaviour pattern; in this case the data generated at the instant t1 cannot be used to make inferences about the evolution of the process at the instant t2>t1.

The problem is how to reconstruct the model describing the cmKBP using the data generated at different moments. This is a very challenging task, but a preliminarily step in this direction is to gather data from real life experiences. However, the data collection must be based on a general framework like that shown in Fig. 2.

By fixing a particular instant of time we can reduce the dimensions of the cmKBP space to analyse and construct some suitable sections. The aim is to make a separate study of the data generated by the collective work in each of the three spaces, and using these results to reconstruct the cmKBP.

This procedure is similar to the standard construction of a "local transversal section" in the study of dynamical systems [12], but now we have a lot of trajectories and so we construct three sections, along the three spaces, to show at the fixed instant, the information gathered by the learners, the physical places occupied, and the social links activated.

The study of the intersections between the trajectories and these sections, at different instants, could enable us to capture some relevant characteristics of the evolution over time of the cmKBP.

We would like to emphasize that Fig. 2 is only a qualitative sketch of the cmKBP; in fact it is not easy to identify the geometric properties of the three spaces we have identified. The figure suggests it is possible to study the properties of the cmKBP by analysing the various elements activated in each space when these are considered separately. If the cmKBP is sufficiently regular, we can obtain a map from the elements activated at the instant t1 to the elements activated at the instant t2>t1, in analogy with the Poincar map used in the study of the solutions of a dynamical system [12]. The properties of this map give us important information on the general structure of the real cmKBP. The construction of an effective model describing the cmKBP could be based on more reliable data.

3 Methodologies for Data Analysis of a Mobile Learning Experience

In the following sections we present a mobile learning experience carried out in two schools in Palermo, Italy within the MoULe project and make a preliminary analysis of the resulting data.

In particular we present the methodologies and the tools used to analyse the data according to the model proposed in the previous section.

3.1 The MoULe Experience

The MoULe project was tested over a period of four mouths, from February to May 2007, and involved fifteen teachers of different subjects (science, arts, languages, and so on) and about eighty students from two secondary schools, one specializing in pedagogical subjects and the other in tourism.

Two fourth year classes from each school were selected to participate and all the students performed both on site and classroom tasks.

The teachers were involved throughout the learning processes and designed the activities to carry out with the students. The educational activity carried out by the first school was to explore Palermo's historical street markets and create a wiki site describing their artistic, sociological, and anthropological features. The other school was involved in the construction of an on line tourist guide to the Baroque cultural heritage in the centre of Palermo using the wiki.

In the MoULe project we have integrated the Moodle Learning Management System with specific functionalities to design, set up and manage the mobile learning activities. The MoULe system creates an integrated environment in which on site learning activities can be alternated with classroom learning activities, so the knowledge building process is supported in both learning contexts.

The use of mobile devices to communicate and interact with other users who share the same experiences means that social interaction moves increasingly from the classroom to everyday places where real life experience is an unbeatable stimulus to learning.

The mobile devices used in the MoULe project are supplied with a GPS aerial in order to link all the activities carried out by the students with a specific location in an area of interest. The goal was to track students during the whole collaborative knowledge building process and reconstruct their physical exploration.

Moreover, during the on site experience the students collected geo-referenced visual/audio/textual notes to be used in the construction of the wiki pages.

In this way the student activities create an augmented space consisting of physical objects as well as the didactic objects/items they produce. The augmented space, which is represented through a geo-conceptual map, enables the transformation of a city tour into a real educational experience.

3.2 Preliminary Data Analysis

First of all, to analyse the cmKBP, we considered each space separately. The first projection in the social space was created using a sociometric graph. The students were asked to complete a sociometric questionnaire to investigate the relationships between the members of each class before beginning the activities.

A network analysis tool was used to examine the results of this questionnaire and identify some important features of the social structure of the classes; in particular, it was possible to identify relationship patterns between people who belong to the same social network.

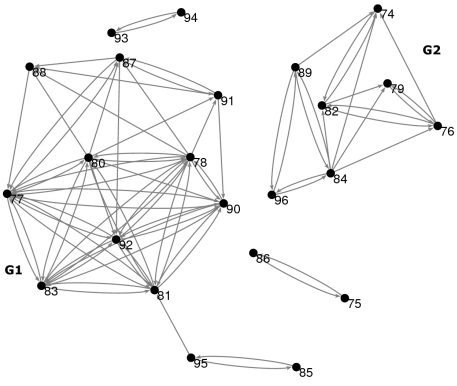

Fig. 3. An example of a sociogram

The tool provides a visual representation of the connections between members and reveals clusters and other features such as density, centrality and betweenness [13] that provide an indication of the cohesion of the social network.

As an example, in Fig. 3 we present the sociogram of one of the classes involved in the MoULe experimentation; from the figure we can immediately identify isolated participants (e.g. the students 75, 86) and the existence of subgroups (e.g. G1 and G2). Moreover, the sociogram reveals that some students (e.g. 77, 83 and 92) play a central role in the pattern of interactions.

The projections in the information space were extracted by analysing the items of knowledge created by the students during their learning experience. The environment allows users to produce different types of contents such as wiki pages, notes taken during the visiting experience and messages in the forum discussions. In table 1 we summarize data of user activity in the information space. These data reveal differences between the students from the two schools regarding their participation and preferences in the use of the different tools to create the information space.

In particular, in our experience, school 2 appears to have worked more intensively on the wiki activity, as shown by the number of pages edited and the percentage of students that used this tool. The notes were used extensively in both schools, and an average of 13/14 tags were made by each student. The geographical area covered appears significant, as we will discuss below. Regarding the use of the forum tool, at school 1 we observed the highest number of messages but the activity was carried out by 63% of the students, while at school 2 the activity appears less intensive but more widely used (80% of students). These data and the behaviour observed during the experience show that students made great use of the tools available, with a preference for notes.

Finally, we would like to highlight the fact that it is also possible to analyse this space using a network tool to reveal the relationships between the different items of knowledge. As an example, it is possible to extract the relationships

Table 1. Descriptive results of the experience in the two schools

School 1			**School 2**		
Topic: Tourist guide to the baroque cultural heritage			**Topic:** Historical street markets of Palermo		
students	total	41	students	total	39
	class A	23		class A	17
	class B	18		class B	22
Wiki usage			**Wiki usage**		
users	22	54%	users	29	74%
wiki pages edited	total	23	wiki pages edited	total	62
	pages/user	1.04		pages/user	2.14
access to wiki	total	483	access to wiki	total	1994
	accesses/user	92		accesses/user	69
Notes usage			**Notes usage**		
users	34	83%	users	34	87%
notes created	total	483	notes created	total	445
	notes/user	14		notes/user	13
Area covered by notes		59%	Area covered by notes		62%
Forum usage			**Forum usage**		
users	26	63%	users	31	80%
messages	total	136	messages	total	93
	mess./user	5.23		mess./user	3.00

between the wiki pages, or the relationships between the wiki pages and the notes that are inserted in them.

The geographical space represents the physical area in which the students' activities took place. In the geographical space we identified the boundaries of the areas of interest and the specific points of interest of the learning activities as well as the paths followed by the students during their visiting experience. To represent these data we needed a reliable representation of the physical places, and we selected Google Earth as the most suitable tool for this purpose.

Fig. 4. A distribution of notes in the experimentation area

Each of the methods and tools of analysis presented here has been used to study the knowledge building process along each of the three spaces separately. To find correlations between the different spaces in the cmKBP, we needed innovative methods and tools.

For example, as mentioned above, all the activities carried out by the students were associated to a geographical location through the use of GPS devices; these data can be used to relate the information and geographical spaces. This relationship was in fact analysed using the Google Earth tool as shown in Fig. 4.

To obtain this figure the notes taken by the students during their on site tours were located on the map by means of a solid histogram with the heights proportional to the frequencies of notes in each region. In this way we were able to show the relationship between the elements activated in the information space, represented by the notes, and the elements activated in the geographic space, represented by the physical location on the map. Moreover, to establish the relationship between the information space and the social space it is possible to construct a network that relates wiki pages and the students who edited them. By analysing this network, the elements activated in the information space can create new relationships among the elements in the social space, represented by the students or groups of students.

4 Conclusions

The term "knowledge building" is becoming more and more common in many different fields and it is approached by various perspectives. Its description as a complex process, involving a lot of dimensions, actors, and organizations, is turning into a paradigm spread over the literature dedicated to education and learning. The main concern is how to observe the knowledge building process and which tools and methods could be developed in order to evaluate the process in progress. These difficulties arise since explicit and tacit actions occur at the same time during the knowledge building process, and while the former actions can be assessed it is difficult to evaluate the impact of the tacit habits on the whole process. In this paper we have analysed a collaborative learning experience where the knowledge building process occurs through the use of handheld devices by students engaged in on site activities. In this particular case we have to consider several variables that can influence the process; amongst the others, the social relationships in the class; the technology at hand and, consequently, the type of information available; the geographical location of the relevant information; and so on. During the reported experience the students have been required to learn a specific topic while visiting an area of the town, and implicitly have been influenced in enforcing and modifying their social network to achieve their educational goals. The researchers could observe the students' behaviour and gather only data on their explicit actions during the activities; from these data, they had to reconstruct the whole process and realize how it was carried out.

In this paper we have proposed a theoretical model to cope with these problems; specifically, the aim of the model is to suggest some procedures for

gathering and analysing data which can be used to describe the knowledge building process in a mobile learning environment. The model is based on an holistic approach where the data interpretation is possible only by crossing data coming from different sources and belonging to different spaces, and that can be analysed by means of different tools (e.g. statistics, social network analysis, content analysis tools, and so on).

To illustrate the model and some of the tools developed to analyse the gathered data, we have presented some examples based on the data gathered during a real experience conducted in Italy that involved 80 students from two high schools in Palermo. These examples, based on a sub-set of the whole data, have been selected in order to highlight the potentials of the model and show some of the developed analysis tools. In a forthcoming work we foresee to illustrate our approach using the complete data gathered during the experience, and to give an overview of all the analysis tools.

References

1. Zurita, G., Nussbaum, M.: Computer supported collaborative learning using wirelessly interconnected handheld computers. Computers and Education 42(3), 289–314 (2004)
2. Bruner, J.S.: Culture of education. Harvard University Press, Cambridge (1996)
3. Vygotsky, L.S.: Thought and language. MIT Press, Cambridge (1962)
4. Vygotsky, L.S.: Mind in Society: The Development of Higher Psychological Processes. Harvard University Press, Cambridge (1978)
5. Hutchins, E.: Cognitive artifacts. MIT Press, Cambridge (1999)
6. Brown, A.L., Campione, J.C.: Guided discovery in a community of learners, pp. 229–270. MIT Press, Cambridge (1994)
7. Brown, A.L.: The advancement of learning. Educational Researcher 23, 4–12 (1994)
8. Nova, N., Girardin, F., Dillenbourg, P.: The Underwhelming Effects of Automatic Location-Awareness on Collaboration in a Pervasive Game. In: Proc. of International Conference on the Design of Cooperative Systems, May 9-12. Carry-le-Rouet, Provence, France (2006)
9. Lipponen, L.: Exploring Foundations for Computer-Supported Collaborative Learning. In: Stahl, G. (ed.) Proc. of 4th CSCL: Foundations for a CSCL Community (CSCL-2002), Colorado, LEA, NJ. USA, pp. 72–81 (2002)
10. Silander, P., Sutinen, E., Tarhio, J.: Mobile collaborative concept mapping - Combining classroom activity with simultaneous field exploration. In: Proc. of 2nd IEEE International Workshop on Wireless and Mobile Technologies in Education, Jhongli, Taiwan, March 23-25, pp. 114–118. IEEE Computer Society Press, Los Alamitos (2004)
11. Stahl, G.: A model of collaborative knowledge-building. In: Proc. Of the Fourth International Conference of the Learning Sciences (2000)
12. Abraham, R., Marsden, J.E.: Foundations of Mechanics, 2nd edn. The Benjamin/Cummings Publishing, Reading, Massachusetts (1979)
13. de Laat, M., Lally, V., Lipponen, L., Simons, R.-J.: Investigating patterns of interaction in networked learning and computer-supported collaborative learning: A role for Social Network Analysis. International Journal of Computer-Supported Collaborative Learning 2(1), 87–103 (2007)