A Mobile Portfolio to Support Communities of Practice in Science Education

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Abstract. Practice activities are a key issue for science education students. Typically, these activities are carried out by a community of practice (practicing students and professors) using physical or centralized electronic portfolios. However, these alternatives are limited when the community members need to share the portfolio resources, any time and anywhere. This limitation is also present when support for high interactivity among these persons is required. This paper presents a new kind of portfolio which is able to work in autonomous, client-server, and peer-to-peer manners. This mobile portfolio is fully distributed; therefore, it improves the flexibility to conduct interactions or share portfolio resources among the members of a community of practice. The functionality and stability of the tool have been tested by the developers and the results obtained are encouraging. The use of this distributed portfolio is expected to help science students and professors to enhance practice activities, interactions and interchange of experiences and resources.

Keywords: Mobile Workspaces, Mobile Portfolios, Communities of Practice, Education.

1 Introduction

Practice activities are key issues in science education studies. These activities transform theoretical knowledge into specific actions. Dewey stated that theoretical knowledge and its application are strongly related; therefore the learning process takes place

D. Schuler (Ed.): Online Communities and Social Comput., HCII 2007, LNCS 4564, pp. 416–425, 2007.

mainly during practice activities [1]. This learning process involves identifying and overcoming the challenges that a community of practice (practicing students and professors) has to face in order to reach a significant goal. This learning approach is aligned with the situated experience theory [2] and social practice theory [3], [4]. In addition, the learning is part of the formative design processes usually applied in several professions [5].

The Universidad Catolica de Temuco, Chile, has used practice activities in early stages of the science education studies. The obtained results have been very positive [6]. These practice activities become more important in later stages of the students' studies, provided they are dedicated to these activities full-time.

Typically, these students work during 3 or 4 hours daily in an Educational Center assigned by the University. There, they put all their knowledge into practice and become more confident about their actions. A supervisor guides and monitors the activities of the practicing students (see Fig. 1). In this scenario the students can also use a senior teacher to validate their activities or interchange experiences. Interactions with peer students are useful to validate ideas or gain knowledge about a specific issue.

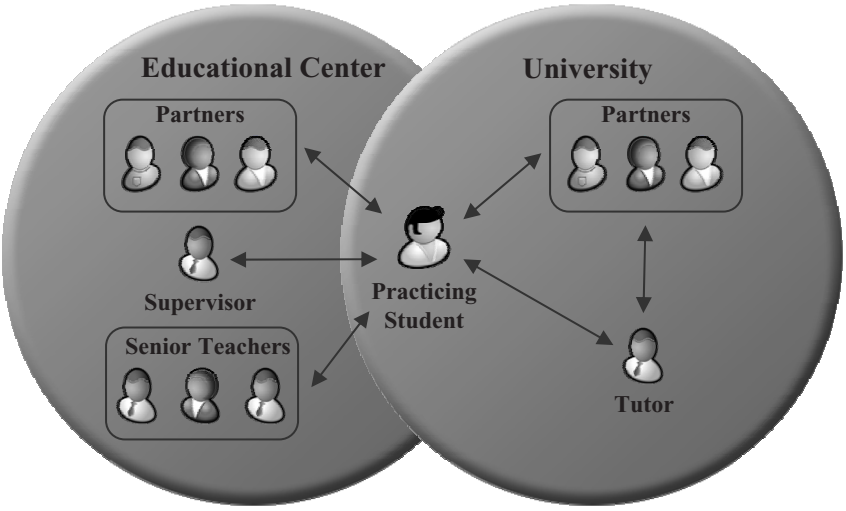

Fig. 1. Type of interactions between a practicing student and the rest of the actors

At the same time, these students can interact with peers and with their tutor in the university scenario. The tutor is the main person responsible for the practitioners' instruction and guidance. They are all part of a community of practice in charge of carrying out a global instruction process for a specific student group. These communities are characterized by a strong negotiation of the meaning of practical experiences [2], [9].

In order to show their progress in the practice activities, each student implements a "portfolio". The creation and maintenance of these portfolios involves: planning, activities execution, and creation of documents and records related to the performed activities [7]. All evidence that a student collects during the practice activities is

stored in said portfolio. This evidence is classified according to a national cataloging system [8].

Currently these portfolios are implemented as a physical file, which is the least expensive solution, more easily adopted by any organization or student. Unfortunately, the physical portfolios have several operative limitations in sharing the information they contain: making a copy of a document is not easy and it could be a slow process, delivering a document requires having the sender and receiver in a face to face situation, and the delivery process may also be unreliable and/or slow (e.g. post mail). These are just some of the reasons why sharing physical documents is not the best option. In order to overcome these limitations, the authors created a digital portfolio, following the client-server paradigm.

Fig. 2. Tutors' view of the online portfolios

This portfolio is a shared space where the students can store public and private digital information. Students' public information can be seen only by peers, tutors or supervisors. The information in the public space can be commented on and copied into the portfolio of any student, tutor, or supervisor. Fig. 2 shows the view of the tutors' functionalities implemented in the online portfolio.

Although this tool helps solve several problems of the physical portfolios, some important limitations can not be overcome. An example of this is the software capability to allow access to shared information if a server is not available. Flexibility is

an important requirement for any solution intending to be appropriate for supporting the interaction among the community members. Therefore, the solution should support the interaction almost anytime and anywhere.

Mobile computing technology and wireless networks could help community members overcome the current limitations in sharing experiences and accessing portfolio information. For this reason, this paper presents a mobile portfolio to enhance collaborative learning and interaction among communities of practices in science education.

The rest of the paper is organized as follows. Section 2 defines interaction problems among community members. Section 3 presents related work. Section 4 describes features of the implemented mobile portfolio that support interactions among these actors. Finally, section 5 presents the conclusions and future work.

2 Problem Definition

In science education, the student instruction process is characterized by a high degree of social interaction. Such interactions can be categorized as formal or informal.

Formal interactions. These interactions are carried out between the practicing student and the supervisor in order to determine the real progress in the student portfolio. They involve a supervisor and a group of practicing students. This type of interaction is also carried out in group meetings where the students share experiences. There, the supervisor helps students to understand specific situations or to organize the discussions. Formal interactions can also be carried out between the practicing students and senior professors that belong to the educational institution where the students are practicing. These professors help the student to understand and assimilate the lessons learned, and to make possible corrections in the practical activities the student is conducting.

Informal interactions. These interactions are present when a practicing student meets with his/her peers in the educational center. These interactions are usually focused on interchanging experiences and conducting a pre-validation of these experiences. Informal interactions are also conducted by the educational center's professors when they provide students with practical situations and lessons to be learned during the time period they instruct other students.

All these interactions could provide new material for the student portfolio, instances for sharing information or portfolio review. By analyzing the interactions among students, supervisor and tutors, and the diversity of places where such interaction can be performed, it is clear that a new supporting tool is required by the community members. The online portfolio [7] is not appropriate to support ad-hoc meetings. Provided that said solution depends on a central server that stores the students' portfolios, the distributed access to these resources depends on the server availability. However, having centralized information allows professors to get updated information about all the students' portfolios.

This paper presents an extension to the online portfolio in order to allow both centralized and decentralized access to and distribution of portfolio information. Each

portfolio is now an autonomous unit which can be connected to a server or the portfolio of any student on-demand. The coherence of the information is maintained through data synchronization operations, which are executed on-demand. This functionality extension is focused on supporting sharing information, because in face to face meetings, it does not make sense to use computer supported interaction tools except those for data sharing and data synchronization.

3 Related Work

Several experiences and instructional strategies have reported the use of portfolios to support instructional activities. However, most of them involve the use of physical portfolios. Advances in information and communication technologies have allowed translating the metaphor of physical portfolios to digital portfolios [11], [12]. Then, digital portfolios have been extended to virtual portfolios, allowing not only preparing and storing digital documents and records, but also supporting interaction among the actors of the instructional scenario [13]. These functionalities have an impact on the way that communities of practice carry out their activities. More and more groupware tools have been included in these portfolios in order to improve the flexibility of the work in these communities [16]. However, some key requirements such as the support for ad-hoc meetings are still pending.

The use of these virtual portfolios has overcome the limit of educational scenarios. Currently, it is possible to see experiences of using these products in work scenarios such as: police departments [14], K-12 educational institutions [15], and businesses [17], [18], [19].

Most of the available solutions implement virtual portfolios using centralized components [20]. However, distributed and ad-hoc access to the resources is required, for example, during a trip or while sitting in a waiting room, in order to provide more flexibility for interactions. The next section presents the virtual environment that was designed to provide more flexibility to interactions among practicing students, tutors and supervisors in both educational centers and universities.

4 Mobile Portfolio

The implemented virtual space is the result of the reengineering process done to the online portfolio shown in Figure 2. Although the look and feel of the tool is the same, it has been completely redesigned in order to support synchronous and asynchronous work of practicing students and professors (tutors and supervisors). The portfolio has been transformed into an autonomous and mobile entity which can be used in synchronous and asynchronous work scenarios. The portfolio information now has two master copies that need to be synchronized. A copy is stored in the server and the other in the mobile computing devices used by the student/professor/tutor. The information of both portfolio copies can be copied or shared with any other portfolio of a community member on-demand. A student can work offline on his/her desktop PC, Laptop or Tablet PC and then, he/she can synchronize the updated information with the master copy stored in the server. The online portfolio becomes mobile. Although

the information included in the portfolio can be in any digital format (e.g. PDF, gif, jpeg, .doc and .xls), each file has a XML descriptor that registers the metadata about the current version of the file and its cataloging information. These file descriptors are copied (as attached files) every time a copy of a portfolio resource is carried out.

The mobile portfolio allows students to share its information with other peer computers (of students or professors) without intermediary servers. It allows students to carry the portfolio all the time and meet with peers and professors in any place (e.g. coffee shops, parks or any other physical place) and at any time. It does not matter if there is network communication support or not. In such cases, the portfolio implements a Mobile Ad-hoc NETwork (MANET).

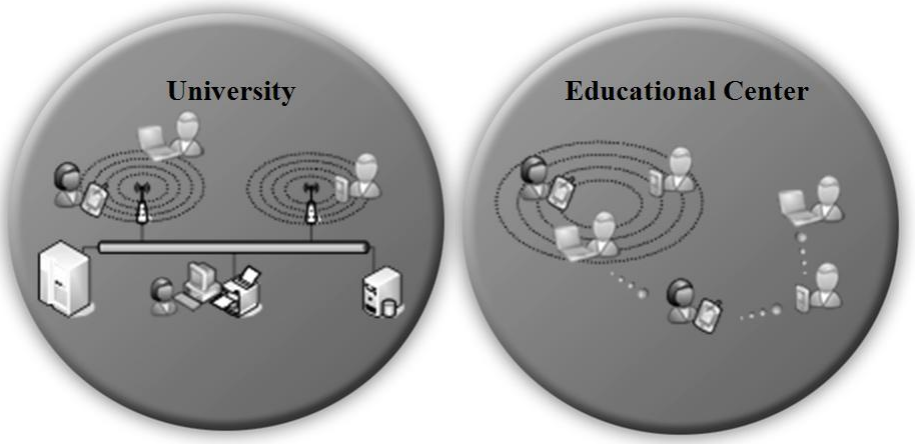

Fig. 3. Interaction scenario using the mobile portfolio

Typically, the work inside the university can be done in a synchronous or asynchronous way (Fig. 3). If the work is asynchronous, the XML descriptors are used to synchronize the portfolio information between the client and server. These descriptors can also be used to synchronize portfolio contents between two users. In case of synchronous work, an updated copy of the portfolio is always available in the server. Professors can use his/her portfolio module to access all public resources stored in the server.

When students are in the educational center doing practice activities they can use a local copy of the portfolio to record experiences, add/updates to the documents and conduct ad-hoc meetings with peers and professors (Fig. 3). The mobile portfolio implementation provides more flexibility to the students' work mainly when they are in scenarios without networking services. Provided that the portfolio is stored locally in the mobile devices, students and professors can be on the move as much as they need, and the resources will be available all the time. Provided that the mobile portfolio can store its resources into a mobile computing device (e.g. Laptop or TabletPC), the resources can be easily shared and distributed to other users, even if such users are not located in the same place or are working at the same time. These mobile portfolios can be used as intermediaries to support sharing information among users that are not co-located.

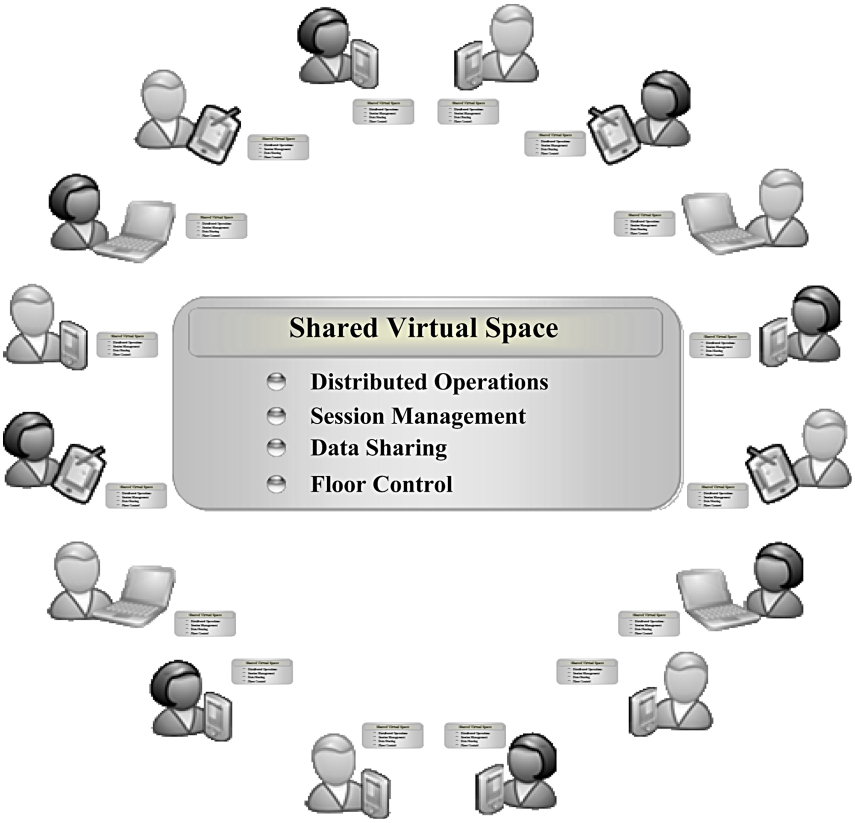

Fig. 4. Services provided by the mobile portfolio

The mobile portfolio implements five main services (Fig. 4): distributed operation, session management, data sharing, floor control management and on-demand synchronization. The *distributed operations* currently implemented are: annotations (comments) in shared PDF and MS word documents, presentations using PPT files. These operations require synchronous communication among the users involved in the interaction process.

The *session management* supports closed (private) and open sessions. They do not require the presence of a server. This functionality allows students and professors to carry out ad-hoc meetings almost anytime and anywhere. Each portfolio has a public and a private storage space. The private space can be accessed by the owner of the portfolio only. Usually, it contains unconcluded work or preliminary ideas. The public storage space represents the official portfolio. It includes all documents that are visible to other users. Functionalities to share and synchronize these documents are part of the portfolio *data sharing* capabilities.

Finally, the *floor control* functionalities allow users in a work session to follow a free (i.e. peer-to-peer) or master-slave (i.e. client-server) interaction protocol. This

functionality could be used, for example, to carry out a distributed presentation in an ad-hoc work meeting.

This strategy of integrating coupled and uncoupled portfolios facilitates the interaction among members of a community of practice. Wenger [2] defined three main features for a community of practice: common community goals (portfolio goals), committed community members and a shared repertory (public storage space). The mobile portfolio supports the third feature, which is the only one applicable to this product.

The mobile portfolio was implemented by using C# and reusing part of the functionalities available in the .NET framework and the OneNote libraries. It included the use of COM components to implement shared objects attached to shared documents, such as comments and synchronous data delivery (e.g. distributed presentations). Provided that the shared files are modified mainly by the authors, the data consistency of the public storage space follows the Unix semantic policy [21]. All functionalities of networking, data synchronization, and session management embedded in the mobile portfolio are the same as that implemented in the PASIR platform [22], [23].

The mobile portfolio has been tested in a simulated scenario at the University of Chile. Five persons (mobile users) from the Computer Science Department were involved in such tests. These activities wanted to identify capabilities and limitations of the mobile portfolio when it is isolated (disconnected), connected to a MANET or connected to an infrastructure-based wired/wireless network. The obtained results show the application is able to work in these three scenarios with an acceptable performance. The application functionalities were available at all times in the three scenarios. The data synchronization process worked well in client-server and peer-to-peer connections. These results are not surprising. They can be explained because the new functionalities of the portfolio were implemented mainly by reusing tested components that are part of PASIR. Therefore, the real challenge for the mobile portfolio is to show that it is useful and usable by members of communities of practice to support their practice activities in science education.

5 Conclusions and Future Work

One of the most important activities carried out by educational science students during the instructional process are the practice activities. These activities are more enriching and attractive when they are conducted through a community of practice. The use of portfolios is a common practice to support students' practice activities. These portfolios can be physical or computer-supported. The first ones have well-known limitations that have been discussed in the literature [11], [12]. The second ones are the evolution of the physical portfolios. The digital (or computer-supported) portfolios have tried to overcome the limitations of the previous ones. Unfortunately, most of these digital portfolios involve centralized components which limit its applicability when no communication infrastructure or access to a server is available.

This paper presents a mobile portfolio which can work in both peer-to-peer and client-server scenarios. The services provided by this platform allow members of a community of practice to interact almost anytime and anyplace. Provided that the mobile portfolios can locally store the resources they contain, the resources can be

easily shared with other users, even if users are not working at the same time and place.

Currently, the implemented application is stable, but no formal experimentations have been done with real practicing students or professors. However, several tests have been performed by the developers in order to validate the flexibility, availability and functionalities provided by the tool. The obtained results are encouraging. Although the system has shown good results during the tests (in terms of functionality and stability), its real contribution can only be defined by the final users. Therefore, the next step in this research work involves using the mobile portfolio to support real communities of practice in Educational Centers and Universities.

Acknowledgments. This work was partially supported by Fondecyt (Chile), grant Nº: 11060467 and by MECESUP (Chile) Project Nº: UCH0109.

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