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A Generalized Framework to Support Field and In-class Collaborative Learning

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***Abstract*— Field activities and collaborative learning are both modern and promising approaches to education. We purpose to integrate different state-of-the-art technologies in a common framework to provide a seamless learning environment that provides assistance for collaborative learning both indoor and outdoor.**

Keywords- Mobile learning; Computer Supported Collaborative Learning (CSCL); Interactive surfaces

I. Background

Field activities and collaborative learning are both modern and promising approaches to education. In Computer Assisted Learning, both approaches can be addressed through the use of various technology devices. For example, mobile devices have been excellently employed to facilitate outdoor learning, and so have desktops and laptops for indoor collaborative learning. But the use of laptops and desktops for group activities has some limitations like the support for a limited number of learners only who can use the device together, the reduced usefulness of gestures in collaboration settings where users share a device, and only one active user at a time. But now interactive multi-touch tables with a shareable interface and a larger view area have been developed with a chance to overcome these limitations. We purpose to integrate this state-of-the-art technology (among others) in a common framework to provide a seamless learning environment that provides assistance for collaborative learning both indoor and outdoor.

A literature review illustrates that in recent years, the main focus of the research in mobile learning has been on 'field-trip' scenarios. Some examples are [1], [2], [3], [4], [5], [6], and [7]. An example area that has been widely investigated is language learning. Lots of work has been done in this particular field, including [8], [9], [10], [11], and [12]. On the other hand, multi-touch interactive tables with larger view areas and support for multiple inputs bear promises for enhanced support for collaborative learning [13], [14], [15]. But till now, the research on use of mobile devices for outdoor learning activities and use of multi-touch table for indoor collaborative tasks are progressing in parallel. What we propose is to integrate these technologies in a general framework to provide a ubiquitous environment for supporting learning.

II. Goals of the Research

The key objective of our research is to develop a framework for a ubiquitous learning environment that supports collaborative, cooperative and individual learning by integrating features of multiple technologies for various tasks. On one hand, features provided by small mobile devices, like mobility, small size, and wireless connectivity make learning possible *anywhere anytime*. On the other hand, devices such as large interactive tables or whiteboards can act as platforms for collaborative and cooperative learning by providing a face-to-face setting and support for simultaneous inputs from multiple learners. Our goal is to combine these devices in a single framework to facilitate learning processes that take place both in traditional classroom environments and outdoors.

A general framework should be useful in multiple ways and in various situations. So another important goal is to keep the system flexible enough to be employed in multiple domains by allowing an easy adaptation of existing learning contents and developing new contents for different devices. Another important goal is to make the system useful for all the participants of class, i.e., both for students and for teachers. That is, it the framework should not only be helpful for students to fulfill their tasks, but it should also provide assistance to teachers for designing exercises and learning activities for students and for assessing students' progress and results.

III. Current Status and Preliminary Results

We have completed an in-depth literature review in the fields of mobile learning (M-Learning) and Computer Supported Collaborative Learning (CSCL). This review essentially showed that small mobile devices have made their way into educational research and have successfully been employed for field activities. Some reported usage scenarios include the use of mobile devices before and after the field [1,3,4] but the main goal of all these systems for mobile devices is to facilitate field work. On the other hand, CSCL literature shows that all kinds of technology (desktop, laptop, projector, interactive white board, smart phone, and tablet PC) have been used to facilitate collaborative learning with success - but these devices still often possess some limitations like small displays, support for single input at a time only, and ignoring body language (gestures) of participants. Research shows that non-verbal communication through body language plays an important role in collaboration and should be supported [16]. New technologies such as multi-touch interactive tables with shareable interfaces and the ability to take simultaneous input from multiple users show promises for enhanced support for collaborative learning by overcoming these shortcomings of other devices.

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Now that technology is available to support both indoor and outdoor collaborative learning activities, we purpose to build a general framework for learning technology that incorporates all these devices (small mobile devices, multi-touch table and interactive white board) and combines their features to provide an integrated learning environment which supports learning process in and out of the classroom and facilitates collaboration.

Based on these finding of the literature review, a conceptual model of such a general framework is developed. Following are the essential elements for the framework:

A. Hardware

Hardware devices are categorized into three following classes:

1) Classroom Technology: includes mainly devices with large displays and support for group activities like interactive white boards and multi-touch interactive tables.

2) Field Technology: small devices like smart phones and tablet PCs, best for being used in outdoor activities like field work and data collection.

3) Home Technology: includes typical single person non-mobile personal computers like desktops

B. Communication Infrastructure

The fundamental requirement for the general framework is to provide a smooth communication infrastructure between different devices and between users of system through devices. This communication structure is defined on two levels:

1) Logical Structure: The system will provide a separate space for each curriculum element that is accessible to the students and teachers that deal with this element. This logical space is further divided into three major categories.

- *Public space* is accessible to all participants with restricted rights: readable and copyable for all but not editable or deleteable except for owner´s or teachers.
- *Individual's Space* is a private space assigned to every learner. That space is only accessible to the owner.
- *Group Space* is the working space of a group of learners who are working together on some collaborative task, accessible to the members of the particular group only.

All these logical spaces are stored on a server. Fig.1 shows the logical division of these spaces and their users.

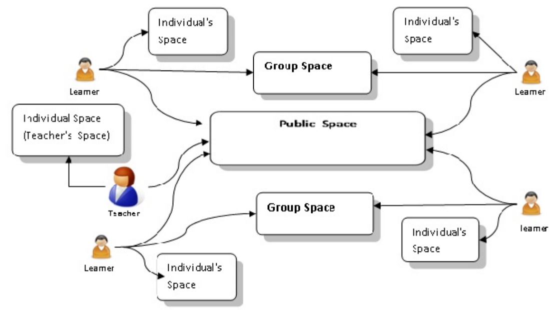

Figure 1. Logical Structure of the communication: public space is accessible to all participants of class; individual space is accessible to owner only while group space is accessible to all member of that group

2) Physical Structure: This layer will cover all the aspects of actual data transfer between logical spaces through various devices and synchronization of logical spaces when accessed from different platforms. Synchronization and user-intended data sharing are two distinct activities in this layer. Synchronization is the process, performed by the system, to keep data up-to-date in different logical spaces regardless of the devices through which it is created or edited. Data sharing is an activity that a user might want to perform. Fig. 2 shows these two data transfer activities, where dotted lines represent synchronization and solid lines represent user-intended data transfer.

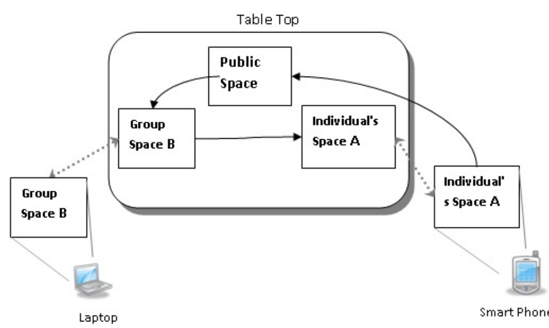

Figure 2. Synchronization and user-intended data transfer. Dotted lines represent synchronization while solid lines represent user intended data transfer

C. Software

Software applications for this framework can be classified with respect to two important factors, *device independency* and *domain independency*. Based on these dependencies, software to be used within the framework can be categorized into following division:

1) Device and Domain Independent: Some tasks are common in multiple domains and should be supported through any device. Examples include reading and writing text, viewing pictures or playing audio and video, and sending messages. So application support for these kind of tasks should be provided on all devices and for all domains.

2) Device Dependent and Domain Independent: This class covers tasks that are feasible for some devices but not for all, like collecting location data through mobile devices on a field trip, regardless of the domain (as field work is used in many different domains).

3) Device Independent and Domain Dependent: This class of software covers domain-specific learning contents and some manipulation toolkit, like a map reading or GPS data manipulating toolkit for geography class, regardless of the hardware platform.

4) Device and Domain Dependent: This class provides support for the tasks are both domain-specific and device dependent.

5) Teacher's Toolkit: this class is special in that it provides a platform for teachers to develop learning contents, assignments and exercises for students and for assessing students' work.

Table 1 summarizes some student tasks with respect to both their device and domain dependencies. The next step is to develop a prototype system based on this conceptual model and to conduct a first field study. So the next research goal is to conduct scenario-based field studies, involving direct observation and semi-structured interviews of pupils and teachers, about the prototype application and analyze the data.

Table 1. Task categories according to device and domain dependency

	Device Independent	**Device Dependent**
Domain Independent	• View Data (reading text file, playing audio and video, viewing pictures) Share Data • Communication (Messages, Notice Board,) • Class Schedule • Text Editor	• Data collection → Taking Photos → Making Videos → Recording Voices → Taking Text Notes • Collaborative Task → Making Presentation
Domain Dependent	• Voting • Developing Learning Material (Lichen data Base,) • Reading map	• Accessing GPS • Assessments • Working on Map

IV. Methodology

The project will employ a qualitative research approach, more specifically scenario-based ethnographic field studies, involving semi-structured interviews and direct observation of teachers and students both from primary and high school about the prototype application. We will follow an iterative approach for the field study and the system implementation and refinement.

V. Issues to be Discussed During Conference

Integrating various devices in a general framework with harmony to create a ubiquitous learning environment poses some challenges that need to be addressed with great care. Some concerns at hand are as follow:

A. Generality Vs Extensibility:

The objective of the system to be of assistance in larger scope (in multiple domains and class grades) poses contradictory demands. Generality demands to avoid fixating on needs of a particular domain, device, or learner group, but the system cannot be beneficial for learning within a specific domain without addressing these particular needs. So the dilemma is to keep the system’s scope wide yet to provide valuable assistance for peculiar needs of different domains. One possible solution is to develop the system with the flexibility to support plug-ins for various tools and applications needed for different domains.

B. Synchronization between different devices and logical spaces:

Another important issue is to provide a smooth and seamless synchronization between various hardware platforms and logical spacees. Initially, all the data transfer activities, both synchronization and user-intended data sharing is planned to be accomplished through 3G to keep the system general and simple. But all the devices in the system also have with other wireless connectivity like Bluetooth and Wi-Fi. These facilities needed to be exploited more for data transfer requirements as 3G connection might not be available (e.g., field work on a remote area) or required (e.g., all the devices are in same building). So the system should be able to choose best path for data transfer.

C. Toolkit for Teachers:

The third issue is to develop a powerful toolkit for teachers to develop learning contents, activities (collaborative, cooperative or individual) and assessment tests for the learners in various scenarios (indoor and outdoor) and to support an assessment of learners’ work and contributions. The toolkit should be useful for multiple domains, learning setting and learners group. That requires a detailed literature and field study of pedagogical methods practiced in different curriculum domains of schools.

[1] M. Sharples, P. Lonsdale, J. Meek, P. Rudman, and G. N. Vavoula, "An Evaluation of MyArtSpace: a Mobile Learning Service for School Museum Trips," Proc. Conf. Mobile Learning (mLearn 2007), Melbourne: University of Melbourne, 2007, pp. 1-7.

[2] P. D. Bitonto, T. Roselli, V. Rossano, L. Monacis, and M. Sinatra, "MoMAt: a Mobile Museum Adaptive Tour," Proc. IEEE Conf. Wireless, Mobile, and Ubiquitous Technologies in Education (WMUTE 10), IEEE Press, April 2010, pp. 156-160, doi: 10.1109/WMUTE.2010.31.

[3] M. Rost and L. E. Holmquist, "Tools for Students Doing Mobile Fieldwork," Proc. IEEE Conf. Wireless, Mobile, and Ubiquitous Technologies in Education (WMUTE 08), IEEE Press, Mar. 2008, pp. 74-81, doi: 10.1109/WMUTE.2008.14.

[4] A. Giemza, L. Bollen, P. Seydel, A. Overhagen, and H. U. Hopp, "LEMONADE: A Flexible Authoring Tool for Integrated Mobile Learning Scenarios," Proc. IEEE Conf. Wireless, Mobile, and Ubiquitous Technologies in Education (WMUTE 10), IEEE Press, April 2010, pp. 73-80, doi: 10.1109/WMUTE.2010.38.

[5] Y. S. Chen, T. C. Kao, G. J. Yu, and J. P. Sheu, "A Mobile Butterfly-Watching Learning System for Supporting Independent Learning," Proc. IEEE Conf. Wireless, and Mobile, Technologies in Education (WMTE 04), IEEE Press, Aug. 2010, pp. 11-18, doi: 10.1109/WMTE.2004.1281327.

[6] Y.S. Chen, T.C. Kao, and J.P. Sheu, "A mobile learning system for scaffolding bird watching learning," Journal of Computer Assisted Learning, vol. 19, Sep. 2003, pp. 347-359, doi: 10.1046/j.0266-4909.2003.00036.x.

[7] J. M. Hsu, Y. S. Lai, and P. T. Yu, "Using the RFIDs to Construct the Ubiquitous Self-Learning Environment for Understanding the Plants in the Schoolyard," Proc. IEEE Conf. Wireless, Mobile, and Ubiquitous Technologies in Education (WMUTE 08), IEEE Press, Mar. 2008, pp. 210-212, doi: 10.1109/WMUTE.2008.25.

[8] L. H. Wong and C. K. Looi, "Mobile-Assisted Vocabulary Learning in Real-Life Setting for Primary School Students: Two Case Studies," Proc. IEEE Conf. Wireless, Mobile, and Ubiquitous Technologies in Education (WMUTE 10), IEEE Press, April 2010, pp. 88-95, doi: 10.1109/WMUTE.2010.26.

[9] H. Ogata, C. Yin, M. M. El-Bishouty and Y. Yano, "Computer supported ubiquitous learning environment for vocabulary learning," International Journal of Learning Technology, vol. 5, No. 1, 2010, pp. 5-24, doi: 10.1504/IJLT.2010.031613.

[10] S. A. Petersen and J. K. Markiewicz, "PALLAS: Personalised Language Learning on Mobile Devices," Proc. IEEE Conf. Wireless, Mobile, and Ubiquitous Technologies in Education (WMUTE 08), IEEE Press, Mar. 2008, pp. 52-59, doi: 10.1109/WMUTE.2008.17.

[11] C. Yin, H. Ogata, Y. Tabata, and Y. Yano, "A Language Exchange SNS in Ubiquitous Environment," Proc. IEEE Conf. Wireless, Mobile, and Ubiquitous Technologies in Education (WMUTE 10), IEEE Press, April 2010, pp. 189-191, doi: 10.1109/WMUTE.2010.8.

[12] M. Li, H. Ogata, B. Hou, S. Hashimoto, N. Uosaki, Y. Liu, and Y. Yano, "Development of Adaptive Vocabulary Learning via Mobile phone Email," Proc. IEEE Conf. Wireless, Mobile, and Ubiquitous Technologies in Education (WMUTE 10), IEEE Press, April 2010, pp. 34-41, doi: 10.1109/WMUTE.2010.9.

[13] R. Fleck, Y. Rogers, N. Yuill, P. Marshall, A. Carr, J. Rick, and V. Bonnett, "Actions Speak Loudly with Words: Unpacking Collaboration Around the Table," Proc. Conf. Interactive Tabletops and Surfaces (ICT 09), Nov. 2009, pp. 23-25, doi: 10.1145/1731903.1731939.

[14] T. E. Hansen and J. P. Hourcade, "Comparing Multi-Touch Tabletops and Multi-Mouse Single-Display Groupware Setups," Proc. Conf. Mexican Workshop on Human Computer Interaction (MexIHC 10), Nov. 2010, pp. 36-43.

[15] A. N. Antle, A. Bevans, J. Tanenbaum, K. Seaborn, and S. Wang, "Futura: Design for Collaborative Learning and Game Play on a Multi-touch Digital Tabletop," Proc. Conf. Tangible, embedded, and embodied interaction (TEI 11), Jan. 2011, pp. , doi: 10.1145/1935701.1935721.

[16] W. M. Roth, "Gestures: Their Role in Teaching and Learning," Review of Educational Research, vol. 71, no. 3, 2001, pp. 365–392, doi: 10.3102/00346543071003365.