MOBILE CSCL APPLICATIONS SUPPORTED BY MOBILE COMPUTING

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ABSTRACT

This works proposes the design of mobile CSCL applications supported by Mobile Computing through wireless linked PDA's for children on second year of elementary school. The applications use the mobility property of the PDA's to facilitate the social interactions of the users, to create a dynamic re-configuration of the different groups and to make up a natural learning environment in which the participants are not located in only one single place behind the computer, but they can displace freely with the computer and moving them to wherever they consider it more useful. This paper describes two CSCL applications that are supported by Mobile Computing.

1. COLLABORATIVE LEARNING AND MOBILE CSCL APPLICATIONS

Paraphrasing Vygotsky (1979), knowledge is built up within a particular community. The Zone of Proximal Development represents the different activities and knowledge that a person can learn with the guide or together with other people. From this point of view, in a community of learners, the learning process occurs when people actively interact with asymmetric roles and share their experiences (Rogoff, 1994), generating, consequently, the theory of Collaborative Learning. (Vivekanandan, 1995). Collaborative Learning (CL) deals with methods whose aim is to promote learning though collaborative efforts among the students who work on the same task. Generally speaking, in face to face CL applications, collaborators move around to perform the corresponding social interactions. This property offers a natural learning environment to collaborators. According to Trent (1995), within certain contexts, there exists a greater value in a class with CL than in a traditional one, because the students are motivated and active, and therefore, willing to learn.

CL, supported by computing technology, originated the area of Computer Supported Collaborative Learning, CSCL (Roschelle & Teasley, 1995; Salomon, 1995; Vivekanandan, 1995). Computer technology made up of different PCs provides the environment and the mediating elements of the interaction with the rest of the group of collaborators, demanding that the collaborators are behind a desk. This situation leads to a loss of mobility of the collaborators witch restricts their social interactions. This situation produces in CSCL, diverse artificial mechanisms to support social interactions, for instance awareness and others man-computer interface metaphors. Such mechanisms and metaphors have been, some times, the main obstacles that have geniously overcomed to maintain students motivated and active

A natural learning environment is therefore the one where people can move freely together with their PC. Mobile Computer (MC) paradigm can offer this possibility. According to Luff & Heath, (1998), there is no much research related to the incorporation of MC in schools, as a support to educational activities. Few researchers, like Imielinsky & Badrinath, (1994) and Jing, (1999) suggest the need of reconsidering the use of Mobile Computing (MC) to build up mobile CSCL applications.

Imielinsky & Badrinath (1994), explain that anywhere connection and PDA's encourage better ways of collaborative computing. Local networks of limited access can be supported by technologies of diverse wireless communication such as ATM wireless/mobile, third generation of Cellular telephone, the IEEE 802.11 wireless LAN, Bluetooth, etc. Each of them presenting diverse characteristics of interoperability, security, band width, etc. that can be adapted to the CSCL application requirements.

2. DYNAMIC CONFIGURATION OF GROUPS

Research on effective collaborative environments (Vivekanandan, 1995; Slavin, 1990) confirms improvements in social interactions and the students will to achieve successful CL, thanks to the right association of collaborators. In these associations, depending on the application, the collaborators can have the same level of knowledge or a different one. Research performed by Azmitia (1988) with mixed novice and expert children collaborators in a model construction task, demonstrated that all of them improved considerably in comparison to those sharing equal skills. It is not clear how the student mix should be since it depends of the different domains of application, the collaborators` features, the experimental design, etc. For this reason, it seems necessary that in CSCL applications dynamic configuration of groups occurs (Rogoff, 1991).

3. CHILDREN, COMPUTING TECHNOLOGY AND CSCL

Children, a considerably great and important population, since they are 6 years old have enough cognitive capacities to use different computing technologies (Maturana & Varela, 1984; Piaget & Inhelder, 1967; Staats, 1971). According to Yasmin (1996), PDAs are the first ones to be used. Today, there is a great amount of software and portable computer technologies (Gameboy, PlayStation, PDA, etc.) addressed for children, used in many applications, such as entertainment, educational, etc. At the same time, there is experimental evidence that under certain conditions, CSCL applications with children between 5 to 7

years old, produce a greater learning performance compared to individual training (Doise & Mugny, 1984; Dillenbourg, Baker & Blaye, 1996), controlling independent variables such as size and composition of the collaborators, nature of the task, etc.

4. ELEMENTS THAT PROMOTE SOCIAL INTERACTION AMONG COLLABORATORS

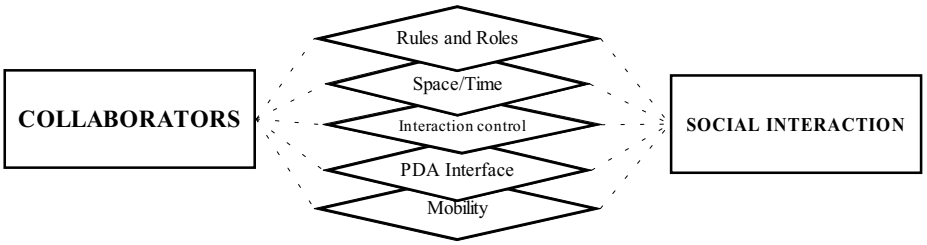

Figure 1. Influence within Social Interaction and Collaborators

Many theoreticians, since Vygotsky (1978), establish the importance of social interactions among individuals. According to Vygotsky (1978), high level cognitive functions are originated through the interactions among individuals. Even though PCs traditionally have been used as individual tools in CSCL applications. MC, thanks to its mobile property, can provide the necessary support so those collaborators can socially interact with freedom.

Rules and roles of CSCL applications, space criteria (same place, different place), time criteria (face to face or synchronous, asynchronous), the control mode of interactions, plus the mobility that MC can offer are very important aspects to achieve a natural social interaction among collaborators, see Figure 1. To make it possible for PDA´s to support social interactions, it is necessary to count on the corresponding design of its interfaces to distribute the different activities and to support the collaborative activities.

5. A MODEL OF MOBILE CSCL APPLICATIONS

CSCL applications supported by PDA's are based on the 8th model of CL proposed by Davison & Worsham (1992), by the type of interaction offered, the number of participants supported, the type of solution to the problem or collaborative objective that is supported and formalism of CL offered.

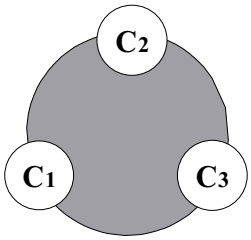

Figure 2. CL Model

This model (Figure 2) supports social interaction in CL groups of 3 to 5 Collaborators (Circles C1, C2 and C3) heterogeneously grouped in a reduced environment. Formalism supported to achieve a successful CL include positive interdependence, individual responsibility, group processing, face to face communication among collaborators, as shown in the gray circle of Figure 2.

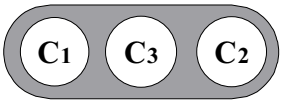

Figure 3c. CL Mobility

Considering that the interaction control of CSCL applications will be active, i.e., active in the analysis and dynamic control of the configuration of groups, this model can support the mobility of its collaborators. Collaborators can move within their environment to favor the social interactions among them. Figures 3. shows a second physical possible configuration of collaborators from a CL set of possibilities.

A CSCL Mobile application is built introducing to the CL model of Figure 2 a PDA support to each of the collaboratos. The movement property of the applications is maintained. Each of the collaborators has a PDA, with which he or she extends his or her area of communication through the wireless networking; additionally the collaborator can move and displace her/his PDA. Not only can collaborators socially interact among themselves, but they can also do it with their PDA's. At the same time, PDA's can intercommunicate bi-directionally and wirelessly among themselves for an active and dynamic control of the CSCL application. In this way the users physically collaborate in the dark gray area of Figure 4., which is extend to the light gray area through the PDA-wireless communication support.

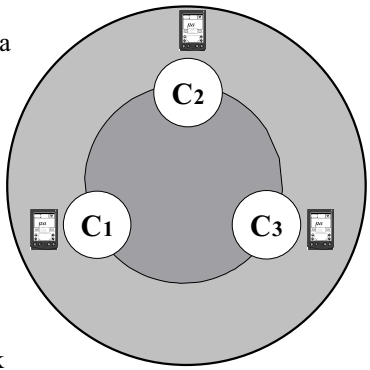

Figure 4. CSCL Mobile Model

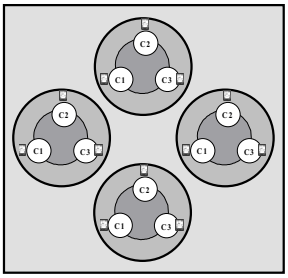

Figure 5. CSCL Mobile System

Finally, in a classroom with 15 to 20 students, it is possible to form diverse groups as shown in Figure 5. In such case, it is possible to perform the dynamic reconfiguration of groups supported by PDA's which communicate among. Figure 5 shows a model in which the gray square represents the System or CSCL environment supported by MC. According to the concepts of grouping (Jesse, 1997), it is not necessary to send (receive) information to (from) all the PDA's, but only to the participants of one single group. PDA's will be able to receive (send) all the messages from (to) the others.

According to Vivekanandan (1995), MC can offer a natural learning environment for the development of CSCL applications, according to the postulates of Ubiquitous Computing (Weiser, 1991). This can originate a new class of collaborative applications, as well as those distinguished by time and space. This new class of applications would be identified by the type of supporting computing technology: Mobile Computing and Computing supported by PCs.

6. DESCRIPTION OF COLLABORATIVE APPLICATIONS AND LEARNING CONTENTS

A CSCL Mobile application was built for supporting the teaching of language and math for 2nd year elementary School. According to Vivekanandam (1995), the command of language learning is inherently supported by CL; and according to Holmes (1999), computing technology may serve effectively as support to the teach numbers reason why these topic was chosen.

The contents of each of the application are the following ones:

LANGUAGE	MATHEMATICS
Objectives: Recognize words from a visual analysis and a phonic and structural analysis. **Minimum Contents**: Decoding. **Activities:** To make up families of words for a frequent usage based on their roots, suffixes and prefixes. (p. 70-73 of NB1).	**Objectives:** To interpret, produce and communicate quantitative information. **Minimum Contents:** Natural Numbers. **Activities:** Make up sequence of numbers (from 1 in 1, from 2 in 2..., from 10 in 10) until 1000. (p. 92-98 of NB1).

The implementation of the Mobile CSCL applications were designed according to the following principles:

- The students that are members of class will be divided into groups of 3 to 4 children and, depending of the size of the class, it is possible to form between 6 to 10 groups.
- Each PDA will be identified and associated univocally with its corresponding user.
- A clear definition of all the rules of the collaborative activity, of the children and of the teacher, was given.
- A clear definition of all the roles of the collaborators, plus evaluation criteria based on objectives achieved, was given.
- Each PDA receives and transmits information corresponding to its work group and to the rest of the PDA´s for dynamic reconfiguration purposes of the groups of collaborators. Diverse criteria were analyzed: children with high learning results together with children with low learning results; children with normal social attitudes together with those who present conflictive social relations; children who are extrovert together with introvert ones, etc.
- PDA's process the responses of the groups of collaborators jointly, assigning evaluation scores, correcting wrong responses and sending (receiving) messages with information for the possible reconfiguration of groups. PDA's carry a record of the individual and group activities.

7. DESCRIPTION OF THE INTERFACE OF MOBILE CSCL APPLICATIONS

Figure 6 shows the interface of 3 PDA's (one for each collaborator) of the Mobile CSCL language application. To achieve the participants` mobility, each PDA has a syllable to be combined with the others to form as many words as possible. Each collaborator contributes with his or her ideas, promoting a discussion with the others, besides using his or her PDA with the others` PDA, to perform their word formation. The upper right part of the interface of the group of collaborators identify a set of collaborators (a butterfly in Figure 6). In case a collaborator changes to another group, this drawing is changed according to the group he or she has to work with. The collaborators can move one next to

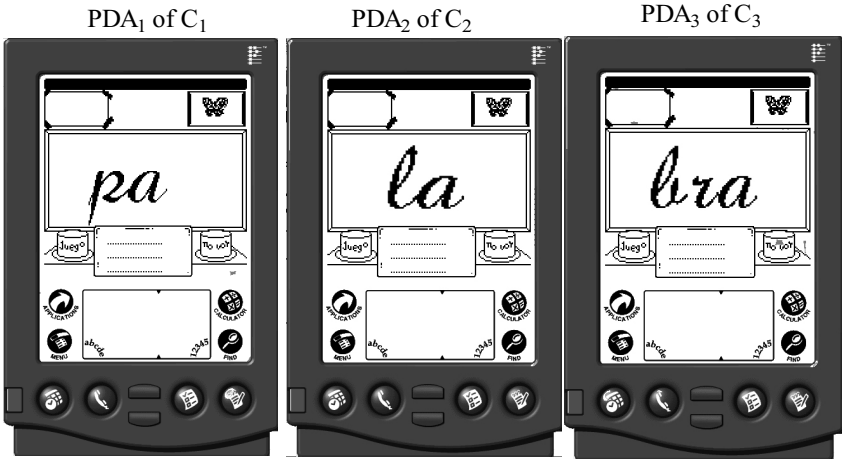

Figure 6. Initial view of CSCL Mobile application interface - Language

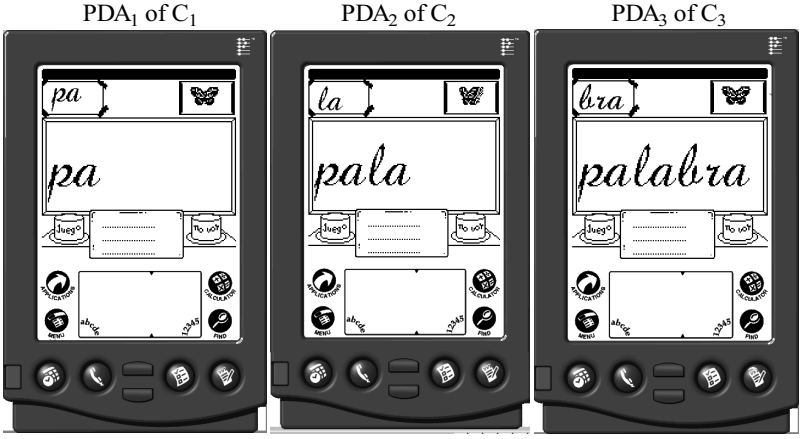

Figure 7. Words formation of CSCL Mobile application - Language

the other according their will to form a word with the syllables of their PDA's. Once collaborators agreed upon the word to be formed, they dispose of two buttons to form the word in a sequence. The button "juego" (play) of the down left part of the PDA's window of Figure 6., makes it possible to chose the syllable, and the button "no voy" (I pass), corresponding to the down right part, does not consider the syllable as the right one to form a word. Figure 7 shows a possible configuration of 3 PDA´s, after on each of them the button "juego" has been pressed in the sequence: C1, C2 and C3; in this case, the three views correspond to one collaborator at a time, but in three different time states, according to the way the syllable were chosen by each collaborator. In Figure 7 it can also be seen that each syllable of the PDA moved to the upper left part and in the central part, the word is formed. If the word formed is correct, i.e., stored in the PDA's Database, each PDA of the collaborators will show this (Figure 8), with the corresponding formed word. After this point, there is the option to continue forming more words, by using the "si" (yes) buttons, on the left, or "no", on the right, provided that all of the collaborators agree on the same action. If they do not agree, PDA's will have to show the disagreement and require that an agreement is built before, returning to a configuration such as shown in Figure 6., in which, again, it is possible to begin forming other words. Other word "labra" (carve) is formed when collaborator C2 press first the button "juego", then, the button "play" of C3 is pressed, and finally C1 has to press the button "no voy". C1 can press the button "no voy" in any order within the sequence of word formation. Those words which are correctly formed will be displayed in the booklet in down central part of Figure 8., allowing collaborators to remember all the words they have already formed. This application has modules to configure the correct words to be formed according to the syllables that are given to the group and the complexity of the syllables and the words to be formed are defined by different criteria: common words with two-letter syllables up to lees usual words with syllables with more than two letters, etc.

Figure 8. Right result

Figure 9. Initial view of CSCL Mobile application interface - Mathematics

Figure 9 shows the interface of 3 PDA's in a Mobile CSCL Mathematics application. Each PDA shows a number, and the objective is to sort the three numbers. Collaborators can move with their PDA's to verify the order of the numbers or to place PDA in a given order they consider correct. When they finish this step, the child who has the lowest number in his or her PDA or the highest depending of they should sort up or down, press the button "juego". The rest of the collaborators consecutively press their button in their turn. If the sequence of the numbers has correctly been formed, the Mobile CSCL application will communicate it to the collaborators through the wireless network. In case the sequence is incorrect, then the group will be told that the answer is wrong, as it can be seen in Figure 10. To indicate the collaborators the formation order, in the upper left an animation of a number that goes up or down, as it corresponds, is presented. For proceeding to another sequence of numbers, it is necessary that

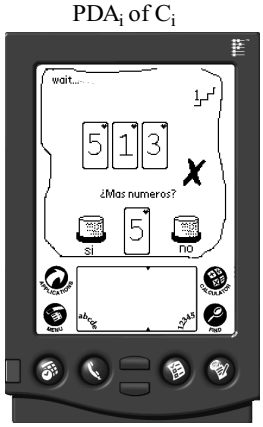

Figure 10. Wrong result

everybody agrees and that they press the button "si" (yes) in the moment that in each of their PDA's appears this option (Figure 10). The sequences of numbers can be configurated dynamically according to different factors, such as speed of answer, right responses, wrong responses, etc.

8. CONCLUSIONS

MC can generate possibilities of new ways of support to face to face CSCL environments. The present proposal aims at taking advantage of state-of-the-arts technologies to create effective mobile collaborative learning situations. A mobile local network (Frodigh, Johansson & Larsson; 2000) is used with PDA's for creating a mobile CSCL learning environment.

Both applications showed in this paper, involve physical movements from the children, or movements with their PDA's. This facility can not be achieved without a MC and the aim is to satisfy the active nature of children. (Staats, 1971). At the same time, interfaces have been designed to favor movements of the collaborators in their relationship interactions ones with the others.

10. BIBLIOGRAPHY

Adams, D. & Hamm, M. (1996). Cooperative learning: critical thinking and collaboration across the curriculum. Springfield, Ill. Thomas Publisher.

Alliende, F.; Condemarín, M. & Milicic, N. (1991). Prueba de comprensión lectora de complejidad lingüística progresiva: 8 niveles de lectura. Santiago: Ediciones PUC.

Arancibia, V.; Maltes, S.; & Alvarez, I. (1990). Test de Autoconcepto Académico: estandarización para escolares de 1ro a 4to año de Enseñanza Básica. Santiago, Chile : Ediciones PUC.

Azmitia, M. (1988). Peer interaction and problem solving: When are two heads better than one?. Child Development. Vol 59. p. 87-96.

Balcells, J. (1994). La investigación social introducción a los Métodos y técnicas. Poblagrafic. Publicaciones Universitarias. S.A.

Davison, N. & Worsham, T. (1992). Enhancing thinking cooperative learning. Published y Teachers College Press.

Dillenbourg, P.; M. Baker, A.; Blaye, A. & C. O'Malley. (1996). The evolution of Research on Collaborative Learning (postscript file) In Spada & Reimann (Eds.). Learning in Humans and Machines.

Doise, W. & Mugny, W. (1984). The social Development of the Intellect. Oxford: Pergamon Press.

Frodigh, M.; Johansson, P. & Larsson, P. (2000). Formación de redes inalámbircas ad hoc – El arte de la formación de redes sin red. Ericsson Review No. 4. pp 248 – 263.

Holmes, N. (1999). The myth of the educational computer. Computers. September. IEEE.

Imielinsky, T. & Badrinath, B.R. (1994). Mobile Wireless Computing. Communications of the ACM. Vol 37. Nro. 10.

Jesse, A. J. (1997). Using Groupings for Networked Gaming. Game Developer. p. 12-48. WWW: http://www.gdmag.com

Jing, J. (1999). Client-Server Computing in Mobile Environments. ACM Computers Surveys. June. Vol. 31. Nro. 2.

Klemm, W.R. & Snell, J.R. (1995). Instructional design principles for teaching in computer conferencing environments. WWW: http://www.cvm.tamu.edu/wklemm/instruct.html

Luff, P. & Heath, C. (1998). Mobility in Collaboration. CSCW'98 Seathle Washington USA. ACM.

Maturana, H. y Varela, F. (1984) El árbol del conocimiento. Santiago: Ed. Universitaria.

McDonald, D. (1995). Improving student learning with group assignments. Retrieved from the WWW: http://fre.www.ecn.purdue.edu/FrE/asee/fie95/2b5/2b53/2b53.htm

NB1. (1996). Plan y Programas de Estudio para el Primer y Segundo Año de Enseñanza Básica. (Nivel Básico 1). La Reforma Educativa. Ministerio de Educación. República de Chile.

Nussbaum, M.; Rosas, R.; Rodríguez, P.; Sun, Y. & Valdivia, V. (1999). Diseño, Desarrollo y Evaluación de Video Juegos Portátiles Educativos y Autorregulados. Ciencia al Día. Vol. 2 Nro. 3.

Piaget, J & Inhelder, B. (1967). The Child's Conceptions of Space. Compton Printing Ltd.

Rogoff, B. (1991). Social interaction as apprenticeship in thinking: Guided participation in spatial planning. In Resnick, Levine and Teasley. Perspectives on socially shared cognition. p. 349-364.

Rogoff, B. (1994). Developing understanding of the idea of communities of learners. Mind, Culture and Activity, 1 (4), p.209-229.

Roschelle, J.; & Teasley, S. (1995). The construction of shared knowledge in collaborative problem solving. In C. O'Malley (Ed.), Computer-Supported Collaborative Learning. p. 69-97. New York: Springer-Verlag.

Salomon, G. (1995). What does the design of effective CSCL require and how do we study its effects? Paper presented at the CSCL Conference, Indiana.Retrieved from WWW: http://www.cscl95.indiana.edu/cscl95/outlook/62_Salomon.html

Silverman, B. (1995). Computer Supported Collaborative Learning (CSCL). Computers Educ. Vol. 25. Nro.3. p. 81-91.

Slavin, R. (1990). Cooperative Learning: Theory, Research and Practice. Prentice Hall.

Staats, A. (1971). Child Learning, Intelligence, and Personality. Principles of a Behavioral Interaction Approach.

Trent, B. (1995). Finding Value in CSCL. CSCL95. Indiana. Retrieved from the WWW: http://www-cscl95.indiana.edu/cscl95/outlook/26_Batson.html

Vivekanandan, S.K. (1995). Computer Supported Collaborative Learning. Retrieved from the WWW: http://www.cs.usask.ca/grads/vsk719/academic/890/project2/project2.html

Vygotsky, L. (1978). Mind in society: The development of higher psychological processes. Cambridge: Harvard University Press.

Vygotsky, L. S. (1979). El Desarrollo de las Funciones Psicológicas Superiores. Barcelona, Ed. Crítica.

Weiser, M. (1991) The Computer for the 21st. Century. Scientific American 265, N^{ro} 3. p. 94-104.

Yasmin, K. (1996). Software by Kids for Kids. Communications of ACM. April. Vol 43, N^{ro} 4. p. 38-43.