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Intelligent Networking:

New Opportunities for Effective Time Management in e-Learning Settings

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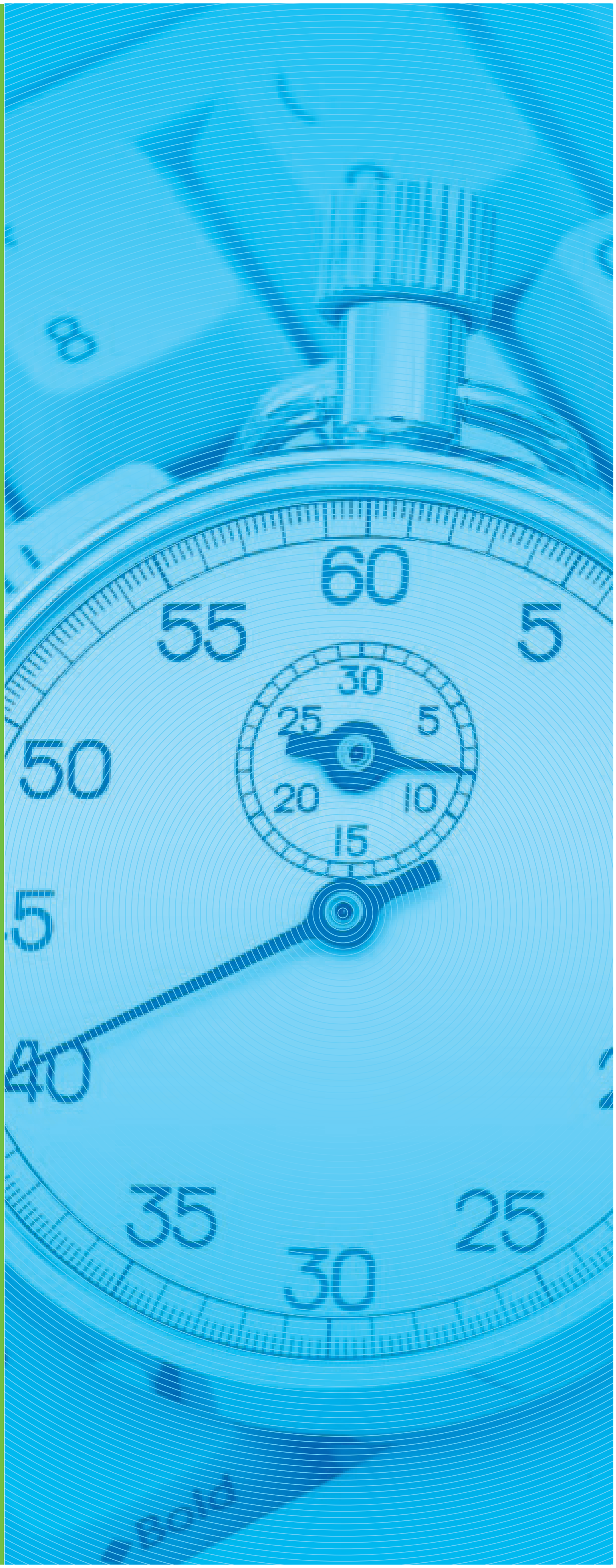

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INTRODUCTION

Virtual campuses and educational organisations are experiencing a shift from the traditional sharing of learning material and applications as the main purpose of e-learning systems to an emergent paradigm, which locates learners at the very centre of networks and exploits the value of learners' connections and relations. Mobile and Web 2.0 technologies, among others, have come to play a major role in this context by enabling a new generation of social networks and communities for e-learning and dramatically changing the way all the actors involved use and interact with Web-based learning systems. In particular, intelligent networking opens up new opportunities for time management in the learning process from traditional time constraints and becomes an important factor to consider.

The aim of this issue is to respond to the need for methodologies and tools that support intelligent networking focusing on time as an important factor in the e-learning context. To this end, this issue comprises six articles selected for their originality, significance, and clarity of exposition that tackle current issues and challenges related to time in intelligent networking for e-learning. The six articles are organised in two sections, as follows:

From a methodological perspective, this issue distinguishes three relevant elements in relation to time within a networking environment. In Kordaki's work, time is considered as a context dependent factor and influences the role that online teachers undertake as researchers and model builders of learners' needs. Then, Casillas, in his work, considers time as an important element of effective collaboration in online platforms, by presenting an approach that analyses different temporal behaviours shown during collaborative learning, in particular participants' responsive immediateness to contributions made by their partners. Finally, Feidakis, in his work, incorporates time as an important factor in influencing the way feedback strategies should be constructed in order to address aspects of emotion and affect assessment more effectively.

From the technological perspective, the time factor is also investigated from the use of several technologies that support networking in e-learning. Pérez-Mateo et al., explore how wiki-based tools may favour the acquisition of key competences associated with a virtual environment in terms of interaction, organisation and planning and construction of knowledge. In addition, they study how the wiki can promote effectiveness in a networking environment and facilitate time management when students construct knowledge together. In his contribution, Moore identifies the need to personalise educational provision in a mobile context along with developing Web 2.0 technologies and provide anytime-anywhere e-learning networking, which forms an important component within an e-learning environment to provide a basis for collaboration on educational matters as well as social networking at times to suit the selected study times. Finally, Mora et al., introduce a new type of Learning Object called Collaborative Complex Learning Object (CC-LO) embedded into an innovative tool named Virtualized Collaborative Sessions (VCS) aiming at providing support to networking from both collaborative and social learning and the interrelations between the two. The time factor is implicitly incorporated in the VCS by providing just-in-time conversion of live collaborative sessions into an animated CC-LO so that learners can observe and receive immediate feedback of how people collaborate and socialise and how networking is produced and consolidated.

We hope that the readers find this issue fruitful and that it helps them accomplish their research goals. We hope you enjoy reading this issue!

Barcelona, Spain, November 2011

Santi Caballé
Thanasis Daradoumis

#01

Kordaki, M. (2011). Adopting the role of online teacher as a researcher and model builder of learners' needs to approach time as a context-dependent factor within networking settings. *eLC Research Paper Series, 3, 05-15.*

ADOPTING THE ROLE OF ONLINE TEACHER AS A RESEARCHER AND MODEL BUILDER OF LEARNERS' NEEDS TO APPROACH TIME AS A CONTEXT-DEPENDENT FACTOR WITHIN NETWORKING SETTINGS

Maria Kordaki

Department of Cultural Technology and Communications, University of the Aegean, 81100, Mytilene, Greece

Adopting the role of online teacher as a researcher and model builder of learners' needs to approach time as a context-dependent factor within networking settings

ABSTRACT

This study adopts a context-based approach to the issue of time within networking learning settings. To approach time as a context-dependent factor, the role of online teacher as a researcher and model builder of learners' needs is suggested. Specifically, an online network of mathematics teachers has been formed in the context of an online course aiming to prepare these teachers to introduce the use of educational software in their teaching practices. To form this network, the 'constructivist teaching experiment' methodology (Cobb, Wood, & Yakel, 1990) was used. A specific curriculum was designed for the participants in this e-learning network. During this experiment, the course was adapted to take into account the specific learning needs of the aforementioned teachers, who were mainly investigated through synchronous communication via informal conversation. The data collected provided evidence that time is perceived by learners as a context-dependent factor. The results also suggest that, using the aforementioned methodology to formulate an e-learning network, learners needs can be better acknowledged to succesfully meet the aims of the course within the time limits scheduled for the whole procedure.

KEYWORDS

Time Issues; e-Learning Networks; Context; Teacher As Researcher; Online Teaching Experiment

1. INTRODUCTION

The advantages of Information and Communication Technologies (ICT) in teaching and learning have been acknowledged by many researchers (Harasim, Hiltz, Teles, & Turoff, 1995; Jonassen, 1999; Maureen, 2000). In fact, these technologies can be used to establish constructivist and collaborative learning contexts (Jonassen, 1999; Dillembourg, 1999). Specifically, online collaborative learning situations can provide a natural setting for demanding cognitive activities (Dillenbourg, 1999), as well as great opportunities for learners to be motivated in order for them actively construct their knowledge, enhance their diversity and their understanding of the concepts being learned, as well as acquire a sense of belonging online (Scardamalia, and Bereiter, 1996). In addition, the benefits are acknowledged of establishing networks to help individuals and/or institutions to pursue shared goals that could not be accomplished independently (Karl, 1998b). Within successful online learning networks, individuals and/ or institutions can interact cooperatively by sharing information based upon a shared expertise or passion for a joint enterprise (Harasim, Hiltz, Teles, & Turoff, 1995). Karl (1998a) also suggests that the strength of networks lies in their exceptional ability to enhance and deepen critical thinking and creativity through dialogue and exchange, to bring people together for common causes while respecting diversity, to transcend isolation and strengthen local action; to link organizing efforts and structures; to facilitate participation; to be flexible and respond quickly to new and challenging situations.

Online education is also supported by the idea that ICTs can help learners to overcome barriers of space and time. When learners participate in online learning settings, they can learn in their own time and space by exploiting the asynchronous capabilities of ICTs and the easy access to a considerable amount of learning resources from their own location. However, participation in e-learning courses therefore, however flexibly presented, will still require some coordination between the learner´s personal time and the time schedule of the course. In fact, online learning may be taken up at the study times preferred by the learner, while the length of study time may be left to the discretion of the teacher. Lacking the immediate guidance of a teacher, online learners may spend more or less time on tasks than was intended and sometimes postpone study until just before the deadline for assessment (Thorpe, 2006). Online learners might also need extra time to overcome possible information overload, as well as to acquire the necessary technical skills to appropriately participate in online courses (Hiltz & Turoff, 1985).

Where time is concerned, the emphasis has been on building in individualization. This is not done through imposing a strict pace but by drawing on the use of asynchronous technologies (Garrison and Baynton, 1987). However, there seems to be some contradiction between individualization in terms of when students study and how studying is paced and what constitutes effective support for learning (Dieumegard, Clouaire and Leblanc, 2006). In fact, despite trying to adapt the online course to fit with each learner's life style and preferences within online learning settings, learners' activities can still become unsynchronized. Thus, in spite of the remarkable features of the technologies available, a key factor in achieving great learning effects is the way in which online teachers and co-learners interact to help each other organize their own learning tasks and study times (Dieumegard et al., p. 219). Another crucial factor that negatively affects the outcome of an online course is possible mismatch between the course designers' perceptions of the amount of time intended for each course and the learners' perceptions of the tasks in question, as well as their cognitive development, personal lifestyles and needs (Thorpe, 2006). It therefore seems that e-learning can both ease time constraints and also introduce new time restrictions. On the whole, it seems that time remains a strategic issue in online learning; an issue that requires explicit attention on the part of online teachers and designers of online courses, as well as online learners.

To this end, it is worth noting that time and learning are inter-related historically. Time is implicitly connected with learning success as the latter often has to be measured within time constraints. Time can be conceived as straightforward, because it can be measured objectively and in the same way for all students. Nonetheless, students experience time subjectively, influenced by their estimations of the expected study time and workload of the tasks in question, as well as their perception of the way these tasks fit within the other activities in their lives (Thorpe, 2006). For the aforementioned reasons, the perceptions and behaviours of teachers and learners that hinder learners' ability to meet the scheduled deadlines have to be carefully examined. Factors that may influence learning are related to how learners manage their study time, how much study time they expect to be required and whether the pacing and quantity of study time expected by the educators match the pacing and quantity of study time on the part of the learners (Thorpe, 2006). In addition, learners' perceptions about how long a learning activity will take are affected by whether they find this activity interesting and the context. Students' learning approaches (be they 'deep' or 'surface' approaches) also affect the total time they need to perform the assigned tasks (Trigwell, 2006; Lockwood, 1992). There is also evidence to support the idea that study time is influenced by why learners are studying, by the teaching approach used, as well as by how the learners perceive this approach (Lawless, 2000). On the whole, it seems that there is no simple causal relationship between study workload and learner response: the whole learning and teaching context seems to play important role (Thorpe, 2006).

It is therefore necessary to adopt a course design and teaching model that can acknowledge the importance of time within the whole context of each online course, while also taking into account the learners' perceptions regarding all the aforementioned time-related issues. A course designed with these elements in mind will help learners to effectively cope with their time difficulties and successfully meet its aims. Here, it is worth noting that some strategies have been proposed (Thorpe, 2006) to help students catch up when they fall behind in their study time, namely: (a) not setting new tasks the week before assignment deadlines, (b) building in reading or review weeks, (c) establishing study-free weeks, especially during national or public holidays, (d) providing information about estimated study times, and (e) grouping study tasks into blocks of time that are clearly indicated.

However, the previously mentioned strategies are not enough to provide courses that can deal accurately with the wide variety of learner needs and study time approaches. For this reason, the 'teacher as a researcher' approach (Cobb & Steffe, 1983) within a 'constructivist teaching experiment' (Cobb, Wood & Yakel, 1990) is considered appropriate in a networking context. According to this approach, the teacher does not rigidly follow his/her teaching plan but acts as a researcher attempting to form models of his/her students' knowledge. Next, the teacher transforms his/her teaching plan and intervenes to create an encouraging environment for the students to improve their knowledge according to their needs. In the online context, this approach could be used by empowering the online teacher to act as a researcher, trying to form models of her/his students' knowledge and their learning approaches, intentions and reasons for learning, as well as their perceptions regarding the time issues related to the learning context as a whole and their individual needs. By forming such models, the teacher can effectively transform the flow of the course and help her/his students to overcome time management issues and make progress in their learning.

Taking the above into consideration, an e-learning course was designed for the education of maths teachers. The main aim of this course was, firstly, to familiarize teachers with the well-known educational software Cabri-Geometry II (Laborde, 1990) used to teach a range of geometrical concepts, and subsequently introduce it into their teaching practices. The formation of this course was based on the theoretical background of constructivist and social theories of learning (Jonassen, 1999; Vygotsky, 1978). A network was set up of teachers participating in this course, based on the aforementioned 'constructivist teaching experiment' methodology. The aim of this study is to explore the role this methodology played in helping participants estimate and overcome the time-related issues that emerged during the course. To date, there has been no report of such methodology used to estimate and overcome time management issues within networking settings.

The following section of this paper presents the context of the study, the specific aims and the curriculum designed for this e-learning course, followed by an analysis of the data collected. Subsequently, the data are discussed and conclusions drawn.

2. THE CONTEXT OF THE STUDY

A Mathematics Teacher E-Learning Network (MTELN) was designed to function within a wider e-learning context (Chlapanis & Dimitrakopoulou, 2004) whose aim was to familiarize teachers with ICTs and help to introduce these into the everyday teaching practice of secondary and primary teachers. Educating these teachers to appropriately integrate ICTs into their real teaching practices was considered essential due to the fact that the great capabilities of ICTs in establishing constructivist and collaborative e-learning settings are widely accepted (Koschmann, 1996; Jonassen, 1999). In fact, it was acknowledged that appropriately designed computer learning environments can catalytically and positively affect the whole learning context in terms of learning content, learning activities and the roles of teachers and learners (Scardamalia & Bereiter, 1996).

E-learning has been considered appropriate for teacher education as it provides them with opportunities for lifelong learning, which is necessary to improve their teaching. Without doubt, teacher education using traditional face-to-face educational settings is extremely difficult, not only because it involves adults who have problems arranging a mutually acceptable lesson time but also because they are scattered over different geographical regions. Thus, the e-learning context seems to provide great opportunities for teacher education as it can help them balance learning inequalities created by time, space and physical health (Maureen, 2000).

AIMS OF MTELN

The main aims of MTELN were, firstly, to familiarize its participants with the tools of Cabri-Geometry II (Laborde, 1990) and, secondly, to train them in employing its advantages in their teaching practices. Cabri-Geometry II has been selected for teacher education because: (a) it has been designed for the teaching and learning of a variety of Euclidean geometrical concepts, (b) it can effectively support teaching and learning in the context of modern social and constructivist learning theories, and (c) its effectiveness on students' learning of mathematics has been acknowledged by many researchers (Mariotti, 1995; Holzl, 2001; Kordaki & Balomenou, 2006).

The specific aims of MTELN, formulated by analyzing its main aims, were to help the participants: (a) to cooperate through MTELN in order to conceptualize modern social and constructivist learning theories in the context of Cabri-Geometry II, while at the same time exploiting its features to design learning activities which would be appropriate within the context of the Greek mathematical curricula, (b) to prepare teaching plans integrating the activities they designed, (c) to teach lessons using the teaching plans they formed, and (d) to evaluate these lessons. The MTELN work was mainly managed through synchronous communication via chat. All teaching processes in MTELN took place exclusively using the available networking facilities by Microsoft Sharepoint™ Portal Server 2001, namely: (a) uploading and downloading learning materials, and (b) communicating via forum, chat and email.

PARTICIPANTS, DATA RESOURCES AND RESEARCH METHODOLOGY

Seven Secondary Education mathematics teachers participated as learners in MTELN. The duration of this course was 9-weeks, to suit the teachers' needs. The data collected from this 'online teaching experiment' consisted of the learning materials provided to the participants, the course plan, the learners' work, the synchronous communication logs via chat and the logs of asynchronous communication via forum. At the end of the course, the participants in MTELN were also asked through clinical interviews performed using telephone calls to '*express their opinion about the most important factors that kept them in line with the aims of the course and successfully encounter the tasks given within the limits of time scheduled during the whole procedure*'. The data collected from these interviews were analyzed and then classified into categories according to topics that emerged from them. In terms of methodology, this research is a qualitative study (Cohen & Manion, 1989) and especially a case study aiming to investigate the role of the 'online teaching experiment' methodology on the learners' commitment to the aims of the course and on their ability to manage the tasks assigned to them in a timely fashion during the whole procedure.

The MTELN curriculum

A primary curriculum of MTELN was designed before the course began and was organized into 4 learning units. Despite the fact that the duration of each learning unit was expected to be 1 week, this was extended to 2 weeks to facilitate learners' needs, upon the decision of the researcher, who acted as a teacher of MTELN, as she exploited the feedback given by the learners during chat sessions. The transformation of both curriculum and course schedule emerged from the interpretation of the feedback given. Thus, the duration of the course came to be 9 weeks: 4X2=8 weeks for the completion of the activities included in the total of learning units, plus 1 week for final conclusions. Each week, the learners were provided with a study topic and a main question for discussion. The content of each Learning Unit (L.Unit) - in its final version – was as follows:

- **L.Unit 1:** Introducing all the participants to MTELN. Presenting the aims and the outline of the course and discussing the features of Cabri-Geometry II. Forming learner-groups and assigning the following project to each group: 'Design at least one learning activity in the context of Greek secondary education mathematics curricula by exploiting the features of Cabri and taking also into account modern social and constructivist theories of learning' (2 weeks were needed).

- **L.Unit 2:** Correcting and improving the activities designed during the work performed in the context of Unit 1 to make them more consistent with modern theories of learning and to exploit fully the features of Cabri II. This work was completed through small group and whole class discussions and negotiations of the opinions of all the participants in MTELN. Next, each group was given the task of writing a report of their work and publishing it in the designated dedicated virtual place (1 week for the design of learning activities and 1 week for improvements).
- **L.Unit 3:** Designing a teaching plan accompanied by a pupil work-sheet. All participants of MTELN were asked to perform this task individually while at the same time exploiting the work performed in the previous units. This work was also completed through small group and whole class discussions and negotiations of the opinions of all the participants. Next, each individual was given the task of publishing his/her own teaching plans and pupils' work-sheets in a specific dedicated virtual place. (2 weeks were needed).
- **L. Unit 4:** Actual teaching using the learning materials constructed. Assessment of teaching and learning as well as writing and publishing a final report demonstrating the work performed in the context of all learning units by each participant. Final discussions, negotiations and conclusions (3 weeks were needed).

3. DATA ANALYSIS AND DISCUSSION

The results emerging from the analysis of this 9-week experiment and from the participants' interviews gave us evidence about the following issues considered as essential for the learners commitment to the aims of the course and their ability to meet deadlines: (a) motivation about the learning subject in question, (b) trust in teacher's knowledge, (c) excitement about online learning, (d) acknowledgment of the participants' previous knowledge and professional experience, (e) encouragement to move ahead during the course, (f) a sense of belonging to a friendly and active network, (g) participation in active and collaborative learning, and (h) acknowledgement of learners' scientific needs and personal limitations. In the following section, these issues are further discussed.

- **Motivation about the learning subject in question:** Here, it is worth noting that all the participants voluntarily participated in the MTELN network because they had an interest to learn about the use of technology in their teaching practices. They also reported that their interest was reinforced by their realization of the advantages of Cabri as seen throughout the course, by watching the teacher of MTELN and other researchers derive a positive experience from using the software. Future prospects for the use of ICT in the classroom were also considered as encouraging motivation.
- **Trust in teacher's knowledge:** All participants in MTELN emphasized that their trust on their teacher's knowledge about the subject matter in question and their appreciation on her communication capabilities to create a warm and encouraging atmosphere during the course fuelled them to be committed to its time schedule and its aims.
- **Excitement in online learning:** Participation in this online course was an innovative learning approach for all the members of MTELN who expressed excitement and curiosity towards the e-learning capabilities.
- **Acknowledgement of the participants' previous knowledge and professional**

experience: Here as well, all the participants expressed that they felt appreciated and respected as professionals during the course. In fact, an attempt has been made to maintain a positive and respectful atmosphere among the participants by: (a) respecting each member of MTELN as a professional as well as a different personality, (b) acknowledging all the opinions expressed, (c) focusing on the positive points presented, (d) treating the negative points expressed by the participants as opportunities for fruitful discussions, (e) asking learners to reflect on their previous knowledge and experience, and (f) entrusting them with investigational activities while at the same time providing support and constructive feedback.

- **Encouragement to move ahead during the course:** All the participants expressed that they stayed committed to the aims of the course within its time limits due to the fact that they were encouraged to participate and move ahead. In fact, a serious attempt was made to invite all participants to participate and also move ahead towards the fulfilment of the aims of the course by: (a) assuaging their worries fears regarding the use of Computer Mediated Communication, (b) encouraging them to externalize their difficulties regarding the use of the proposed educational software in their teaching practices, (c), challenging them to focus on the positive effects of the proposed educational software in their teaching practices, (d) encouraging all participants to contribute within the network by asking each one - and especially those who remained silent - to communicate their ideas with the whole e-class, (e) externalizing the e-teacher's personal experience, including both positive experiences and negative thinking, such as fears and difficulties and how these were overcome through real practice, and (g) encouraging progress by providing constructive feedback to each participant.
- **A sense of belonging to a friendly and active network:** All the participants also expressed that their feelings of belonging in a friendly and active network helped them to be committed to the time scheduled and the aims of the course. Actually, an effort has been made for cultivation of a vital, warm and friendly atmosphere by: (a) exchanging information (in the form of text and/or images) about personal issues, family situation, job issues, (b) using informal but accurate language, (c) using humor, and being on a first name basis, (d) the teacher entering the chat-room first and welcoming each member of the network (the teacher also wishes goodbye to each member of the network and leaves the room only after all the other members have left), (e) no question or opinion being left without discussion and negotiation, (f) scheduling chat-meetings regularly (two chat-meetings per week) and (g) defining specific tasks, discussion and reflection topics each week.
- **Participation in active and collaborative learning:** In fact, the participants were encouraged to: (a) Collaborate each other by asking them to form groups during chatting and then discuss their work with the other members of each group, (b) take initiative. That means freedom in choosing both the specific topic of each learning activity and the persons to cooperate with when dealing with each activity. In addition, the participants were encouraged to share the new knowledge they acquired during the experiment to their colleagues in schools, (c) reflect and discuss about the learning activities they designed during the course as well as after their implementation in real classrooms.
- **Acknowledgement of participants scientific needs as well as their personal limitations:** Here, various scientific topics coming from the participants own needs were addressed, namely: (a) Limitations in introducing Cabri to every day educational practices in terms

of: infrastructure, curricula, educational system, good examples and personal strengths in introducing a novelty to the curriculum, (b) Absolutist and constructivist epistemological perspectives of Mathematics and the role of Cabri-tools in changing the whole context of mathematical learning including learning activities and the roles of teachers and learners, (c) Didactics of Mathematics within the context of modern social and constructivist theories of learning and the catalytic role of Cabri-tools in teaching and learning Geometry, (d) Design, realization and evaluation of a teaching event using ICT, and (e) The role of the mathematics teacher in the context of ICT as facilitator of learners encouraging them to be actively involved in their learning. The role of life-long education in both personal and professional teacher development was also acknowledged.

Finally, the participants of MTELN acknowledged the effect that cooperatively defining specific deadlines via chat-meetings had in helping them stay on track and meet course aims and deadlines. The time and the length of each chat-meeting were also tailored to suit the needs of the participants.

4. CONCLUSIONS

This study presented the role of the 'constructivist teaching experiment' methodology within the online context -where the online teacher acts as a researcher and model builder of learners' needs- in the successful formation of an e-learning network aiming at the familiarization and the introduction of the well-known educational software Cabri-Geometry II to the everyday practice of mathematics teachers in secondary schools. The theoretical background of the network was based on modern constructivist and social theories of learning. This methodology gave opportunities for the development of an open, safe, flexible and friendly communication environment where the participants' scientific and personal needs were acknowledged. Within this environment, the participants were encouraged to successfully meet the aims of the course according to the time limits established. The data emerging from this experiment demonstrated that, through the participants' eyes, the time issue within an online learning environment is situated within the whole learning context and it is influenced by various factors such as: (a) motivation about the learning subject in question, (b) trust in teacher's knowledge, (c) excitement in online learning, (d) acknowledgment of the participants' previous knowledge and professional experience, (e) encouragement to move ahead during the course, (f) a sense of belonging to a friendly and active network, (g) participation in active and collaborative learning, and (h) acknowledgement of learners' scientific needs and personal limitations. However, due to the fact that the sample of participants in this study was limited, further studies with bigger number of subjects are needed to validate the role of the aforementioned methodology to estimate and overcome time issues within the online context.

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ESTIMATING TIME BETWEEN CREATION AND ACHIEVEMENT OF KNOWLEDGE OBJECTS

Luis Casillas

Computer Science Department
University of Guadalajara
Mexico
Revolución 1500,
módulo “O”, planta baja.
Guadalajara, Mexico.
luis.casillas@red.cucei.udg.mx

Estimating time between creation and achievement of knowledge objects in learning groups through social network analysis

ABSTRACT

Networked collaboration performed over specific platforms designed for such purposes can provide knowledge about roles, intentions and effects regarding participants, their interaction among themselves and the interaction with the available knowledge objects. This study aims to propose a mechanism for discovering temporal behaviour underlying the raw data collected in log files from e-learning activity in specific platforms. The proposal is based on measuring and, subsequently, estimating time spans through social networks analysis (SNA). The main focus of this work is to match different temporal behaviours, shown during collaborative learning, with formal profiles identified inside a complex network of interactions. The final goal is to define a concrete mechanism to measure the response of participants, from the perspective that knowledge objects have been created by the partners in the same learning group.

KEYWORDS

Collaborative Learning, Temporal Analysis, Time Series, Social Networks.

1. INTRODUCTION

The analysis of collaborative learning in virtual environments has become a significant task when supervising and monitoring the performance of learning groups. Regular interactions (face-to-face) for collaboration include a diversity of communication elements beyond the spoken language. This complex "message exchange" would imply, hopefully, a synchronization of minds, which is supported by a "shared" network of beliefs and concepts.

The experience of being present *in situ* when collaborating, provides a complete feeling of situation-awareness (Endsley, 1995). Collaboration in virtual environments does not provide this rich experience of having a (full) situation-awareness. Limited channels of communication restrict the full transfer of the messages generated by each member of the learning group. Collaboration analysis is then oriented to discover the intentions and effects of every primitive collaborative action (Carroll et al., 2006). It is evident that mutual understanding among peers is the first step to solve any problem that may appear when different people are involved in the search for a solution. Besides, it is a fact that the Web has become a highly social environment that is sustained by social structures that generate content in networking fashion (Anklam, 2009). Every member of the group might have a different approach to the problem and its possible solution. Although in networking there is no formal and ordered process to follow, the initial stages must be clearly oriented to model a common structure of concepts regarding the problem and its solution.

The main task is to discover the knowledge that is hidden among the large volume of data stored in virtual environments (supporting the networking). This should be performed during collaboration analysis. Hence, the specialists performing the analysis must collect and process data through mining techniques and do the required inference for filling in those indicators defined for measuring the networked collaboration. As explained in Casillas and Daradoumis (2008), the current work is oriented at gathering temporal information from the very same interactions already analysed in previous studies.

2. RELATED WORK

The temporal analysis of social networking activity in specific environments implies an effort with regard to the complexity of gathering knowledge from the raw data stored by these platforms. In particular, the work performed by Soller and Lesgold (2000) has been oriented to carry out an analysis from data coming from a networked collaborative environment to study the interaction which is organized in a temporal structure. Hence, it has been possible to compare current behaviours by matching them with expected behaviours.

Another interesting approach for performing collaborative analysis is presented by Soller and Lesgold (1999), which presents a Model of Effective Collaborative Learning as a framework that provides meaning to collaborative learning acts by classifying the primitive actions into skills, sub-skills and attributes. This model depends on the use of certain "sentence openers" that express the intentions of the collaborators; however, this restricts the flexibility of collaboration due to the mechanization of communication. Nevertheless, it is clearly understandable that the complexity of free-style human communication is an important challenge for current computational approaches. This trend of collaboration analysis has been maintained in subsequent research work by Soller (2001, 2004), focusing on the search for specific messaging structures.

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Using models for analyzing collaborative learning is becoming a key aspect. A model gives coherence to the study of collaboration phenomena by classifying primitive acts in predefined slots, and gathering semantics in the process. The study developed by (Daradoumis et al., 2006) deals with the collaboration analysis through a layered model, which breaks down the analysis goals into different levels. The lower level is related to raw events generated by a CSCL tool, whereas the higher level is related to abstract networked collaboration analysis. The problem with this approach is the increasing complexity when trying to infer abstract behaviours from the very raw data collected in log files from CSCL tools. Nevertheless, collaborative analysis under such circumstances is more flexible, though flexibility is always harder to implement.

Another approach for performing an analysis of collaborative learning is presented in the 2006 study by Daradoumis and Casillas that looked at the problem from a neural network perspective. Log files are consumed through a mechanism that classifies information using a *sui generis* neural net. This approach can offer useful information inbetween the structure of the neural network and not only in the output layer (as usually happened with conventional neural networks). Every element in this neural net has information regarding an indicator of collaboration activity, while, at the same time, the indicator feeds some of the neurons in the next layer; this process prepares the indicators of the following layer.

This paper proposes performing a social network analysis (SNA) in two stages. The first deals with collecting and processing raw data from a CSCL platform, and applies a quantitative analysis method to fill up a series of indicators. This stage is already satisfied in Casillas and Daradoumis (2008). The second stage – the focus of this paper – sets out to discover the response profiles (from a temporal approach).

3. GATHERING KNOWLEDGE FROM SOCIAL NETWORKING ACTS

The essence of the task is to develop a precise and useful approach for the analysis of the collaborative interactions of participants in a networked environment, involving different analysis dimensions. According to the experience acquired through the review of several cases, we identified different strategies to approach the SNA. These strategies range from the simple collection of data and results in spreadsheets, queries to data bases, data mining and decision trees, to the use of agents with specifications that satisfy different criteria for measuring the networking activity. Naturally, simple approaches are easy to design and implement, but their results are usually weak and they lack some way of automatic interpretation. Developing a more advanced solution implies extra effort, but the benefits are manifold, since we can obtain a variety of in-depth, quality results that provide a more powerful tool for decision making and interaction monitoring.

One may initially consider that the complexity of performing SNA on online human interaction via a computational solution to be apparently low due to restrictions of the communication channels available, which reduce the amount of information elements produced. Indeed, the restrictions in transferring information could erroneously imply that a rather simple solution would suffice; however, it is precisely the absence of certain information elements that is the cause of the complexity, due to the need to fill a number of important gaps. These gaps refer to certain messaging elements that complement the regular communication pieces that constitute the whole human communication system, such as non-verbal messaging. Some of these non-verbal communication elements could help understand a number of collaborative issues; therefore, special effort must be made to discover some of the participants' interests and intentions lying beneath their collaboration acts.

Taking these considerations into account, we first need to carry out a preliminary process so that we can understand the way networking interaction evolves and then build a method for gathering higher-level semantics indicators from primitive collaborative actions. To this end, we developed temporal schemata capable of working as an abstract framework for

Table I. Temporal schemata for measuring collaborative actions

AXIOM	FORMULA
Let X be any raw action; there is at least one Y which is an interpreted activity resulting from X. Raw actions enable interpreted activity, which are complex behaviours beneath specific sets of raw actions.	∀X (rawAction(X) → ∃Y intdActivity(Y))
Every raw action generated in the past implied a subsequent interpreted activity.	■ (rawAction → ◆ intdActivity)
All raw actions in the past, implied current interpreted activities.	■ rawAction → intdActivity
All raw actions in the past will imply interpreted activities at some future moment.	■ rawAction → ◇ intdActivity
Some raw actions in the past implied current interpreted activities.	◆ rawAction → intdActivity
Some raw actions in the past will imply interpreted activities at some future moment.	◆ rawAction → ◇ intdActivity
Raw actions perfd in the previous moment implied current interpreted activities.	● rawAction → intdActivity
Current raw actions will imply interpreted activities in the next moment.	rawAction → ○ intdActivity
Current raw actions will imply interpreted activities at some future moment.	rawAction → ◇ intdActivity
Current raw actions will imply interpreted activities in the future.	rawAction → □ intdActivity
Future raw actions will imply interpreted activities at some future moment.	□ (rawAction → ◇ intdActivity)
Every raw action performed by any collaborator (Agent) implies an interpreted activity performed by the same collaborator in the same moment.	∀X ((rawAction(X)∧perfd(X,Ag0,t0)) → ∃Y (intdActivity(Y)∧perfd(Y,Ag0,t0)))
A sequence of raw actions performed by a collaborator (Agent) implies an interpreted activity performed by the same collaborator at some later moment.	∀X ((seqRawActions(X)∧perfd(X,Ag0,t0...t*n*)) → ∃Y (intdActivity(Y)∧perfd(Y,Ag0,t*n*+1)))
A sequence of raw actions performed by different collaborators (Agents) implies an interpreted activity performed by the same collaborator at some later moment.	∀X ((seqRawActions(X)∧perfd(X,groupColls (Ag0...Ag*n*),t0...t*n*)) → ∃Y (intdActivity(Y) ∧perfd(Y, groupColls(Ag0...Ag*n*),t*n*+1)))
A sequence of raw actions performed by different collaborators (Agents) implies a sequence of interpreted activities performed by the same group of collaborators at some later moment.	∀X ((seqRawActions(X)∧perfd(X,groupColls (Ag0...Ag*n*),t0...t*n*)) → ∃Y (seqIntdActivity(Y) ∧perfd(Y, groupColls(Ag0...Ag*n*),t*n*+1)))

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modelling the chronological phenomena that lie behind the networking activity, based on the temporal-logics tools proposed by Fisher (2006). Table I shows the axioms that involve the formulae used to express and measure the collaborative actions that occur and evolve over time.

Our study and perspective about networking has two dimensions. The first one is related to the analysis of tacit collaborative actions that result from the simple circuit of putting knowledge objects in shared spaces, which are then being accessed by other peers who have the required permission to participate in that shared space. Figure 1 shows a sketch of this networking approach. The second dimension is more oriented to detecting the temporal profiles shown by users throughout the semester. This paper includes some results from that part of the study, and they are considered to reach an integrated solution to the problem of analyzing collaborative interaction and awareness. To this end, we show some important results from of our study.

Our approach was applied in real collaborative learning situations that took place in the Basic Support for Cooperative Work (BSCW) platform (http://bscw.uoc.es/). The BSCW tool is able to record many types of primitive actions (interactions, transactions, accesses, etc.) performed by users in log files. The BSCW was used as a CSCL support. These data provide an important source of information in order to study both the individual and group performance in learning. In fact, there are thousands of data entries recorded from the interactions among users; more than 25 megabytes per semester. The central part of the quantitative-analysis stage consisted of processing the whole data stored in log files to build a social network based on the automatic detection of interactions according to the collaboration model shown in Figure 1.

Figure 1. When a Creation-Access circuit is completed, two networked collaboration models are manifested in a CSCL environment.

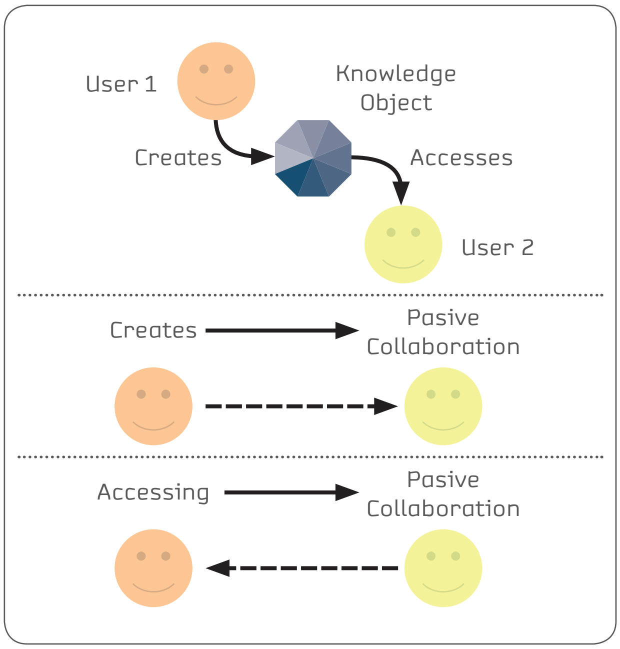
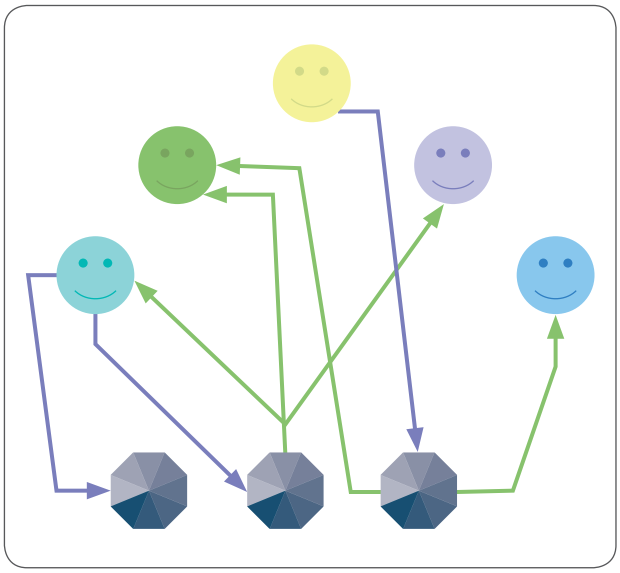


Figure 2. Knowledge objects are the elements which bind users as a social network.



The way of collecting and organising the information regarding the transactions made inside the BSCW provides important elements for building a social network. This network represents the users and the knowledge objects stored in the shared learning spaces by binding users (students) to those knowledge objects that they access. Students are organised in learning groups, which is an abstract social network. Our aim is to discover and analyse the interactions among these students using different SNA techniques. Figure 2 shows a plain perception of such a social network.

Since students may belong to more than one team and, thus, have access to a variety of shared knowledge objects, the social network developed for carrying out the quantitative analysis stage is not limited to isolated learning teams. Instead, we faced the challenge of building and managing a huge social network that functions as a knowledge

Figure 3. A schema for processing collaborative learning interactions from log files.

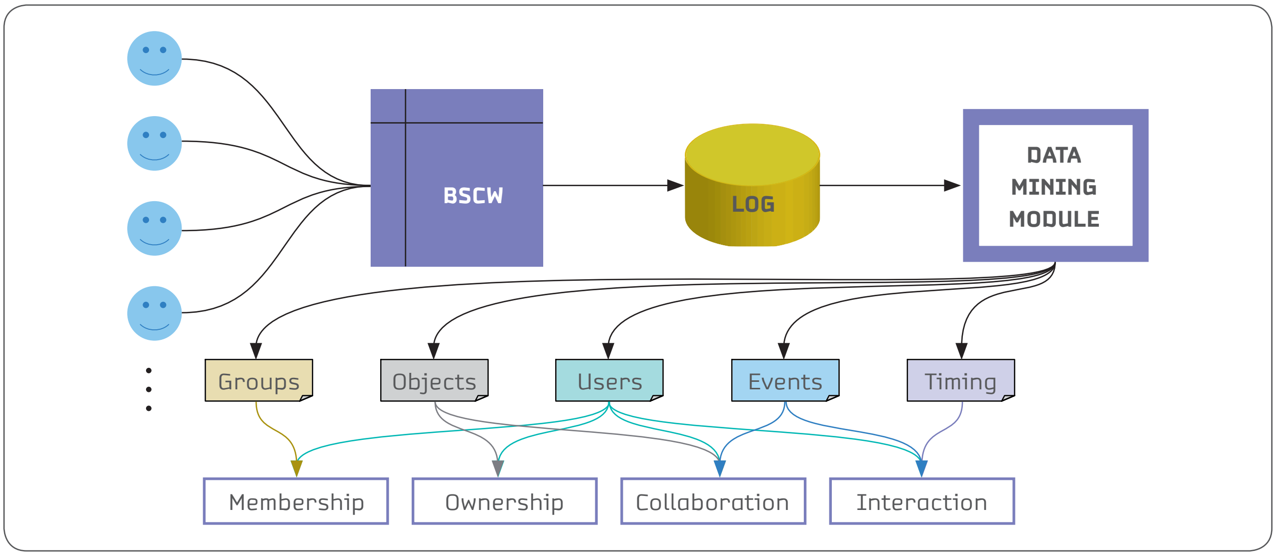
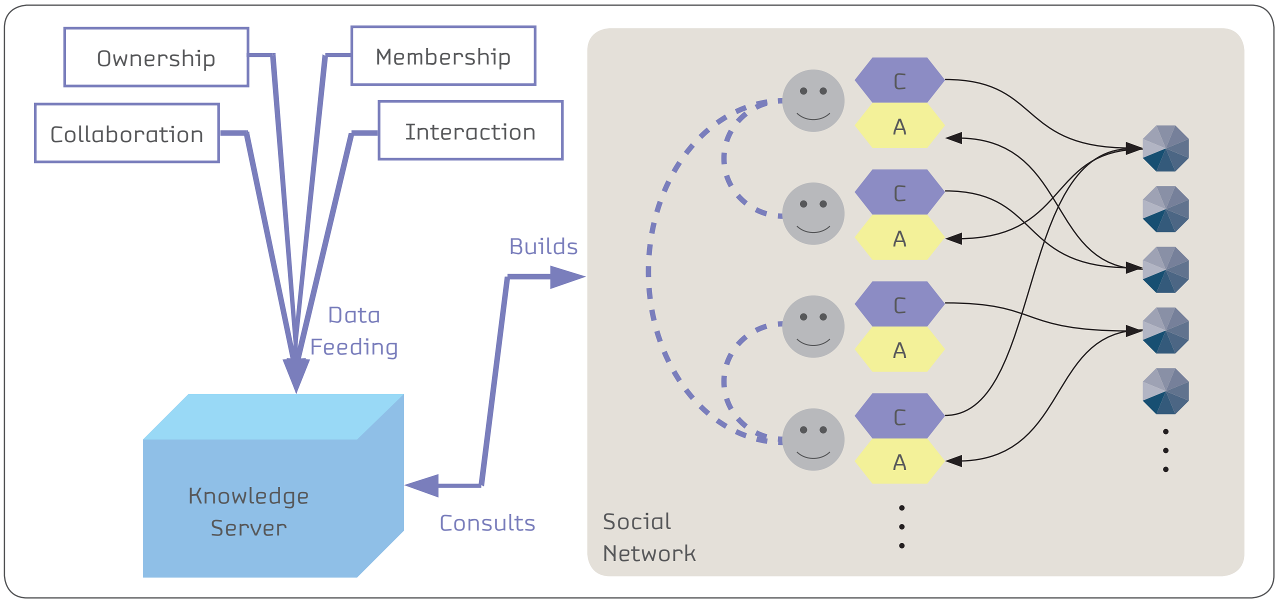


Figure 4. The Knowledge Server module is fed by the coupled model built from activity logs. In the social network, “C” stands for “creates” and “A” for “access”.



server and provider. In fact, the network itself represents a semantic model of the collaboration that takes place among the whole class of participating users. Figure 3 presents a simplified schema of the process used for gathering significant knowledge from the raw data stored in log files, which is a sub-process of the quantitative approach employed. As a matter of fact, the collaborative learning experience held in the BSCW produced a huge amount of raw data. These data were processed through mining techniques, in order to discover relationships, and through a model that handles the involved elements via multiple queries and coupling operations over the database. This allows us to relate users based on their accesses to knowledge objects.

Once the log files are processed, the information regarding collaboration is used for feeding the Knowledge Server, a module which first builds the social network that represents the collaborative activity among users and then exploits the social network data to model a variety of interaction phenomena *a posteriori*. It is possible to figure out the functionality of this module by reviewing the schema shown in Figure 4.

In particular, the Knowledge Server becomes the data provider for the agents that are further employed to fulfil the activity indicators, which explain different aspects and issues of collaboration according to specifications defined in an ontology that is specifically designed to support our approach of collaboration analysis.

4. TEMPORAL ANALYSIS OVER COLLABORATION

Our approach constitutes a natural extension of an ongoing effort to provide a rich representation scheme that supports collaboration analysis from CSCL, which started from the proposal of Soller and Lesgold (1999) and went through to the work suggested by Daradoumis et al. (2006). The studies from Casillas and Daradoumis (2008, 2009) provided the guidelines for discovering semantics from the collaborative learning acts, although some analysis over temporal performance is pending.

This analysis is not directly connected to any specific CSCL tool; therefore an additional mechanism needed to be inserted between the log-files database and the knowledge server. This inner mechanism was implemented using extraction-transformation-load (ETL) techniques, which unify, contract or expand the stored data in order to achieve the required format that matches them with the ontology.

At first, the understanding regarding time influence on the process was that the reaction period would be in between the global average time for reactions observed in the whole activity. This reaction refers to any act over a knowledge object after its creation. Nevertheless, this approach was not founded on any formal probe. The works from Casillas and Daradoumis (2008, 2009) were aimed at detecting another kind of behaviour, and studying the reaction time was not their main goal. This paper, however, does have such a goal. The initial hypothesis of this paper is that reaction time would vary throughout the semester according to the increase of time pressure over students. This specific phenomenon is clearly observed in students working in traditional academic environments. Thus, the question is:

Will participants in CSCL (organised as learning groups) vary their response according to the proximity of deadlines?

In order to deal with this matter, we have considered a time series analysis. The data from reaction periods have been collected from the knowledge server. This information was collected for the whole group and for specific learning groups. Due to non uniform presentation in timing data, two normalization steps were needed. The first was oriented at present dates and hours from events in a single data set. It was used an internal representation based on floating point numbers. This form is the same used by Microsoft Excel to handle timing information in numerical forms, i.e. the date "03/02/2003 08:16:47 p.m." is translated as "37682.8449884259". This representation has the capacity to maintain the distance among reaction events. The second normalization step consisted of calculating the average for the normalized timing, as well as the standard deviation these data were used to calculate:

$$z=(x-\mu)/\sigma$$

Where z is the normalized value to be calculated, x is the original form of the value, μ is the average of the whole values for x and σ is the standard deviation from those values of x.

Once the data from reaction time were normalized, we started the regression analysis for the time series. The equations used for the calculation were:

$$m = \frac{n\sum(xy) - \sum x \sum y}{n\sum(x^2) - \left(\sum x\right)^2}$$

$$b = \frac{\sum y - m\sum x}{n}$$

$$r = \frac{n\sum(xy) - \sum x \sum y}{\sqrt{[n\sum(x^2) - (\sum x)^2][n\sum(y^2) - (\sum y)^2]}}$$

Where n is the quantity of data available in the time series, x refers to the time events occurred, y refers to the time measurements (reaction period) corresponding to the events in x, $y=f(x)$, and finally the constants m (slope) and b (y-intercept) of the equation $y=mx+b$. In additionl, r is the correlation coefficient between x and y. The indicators m, b and r are calculated for the global performance collected from the activity in the BSCW in the Spring 2003 semester (a semester with high activity levels in different dimensions). The results from this action are rather interesting. Table II shows the main data and results for this calculation.

The slope is clearly flat and the correlation is almost void. At this point, there is no apparent influence of the date or proximity to deadline, over the period to react after a knowledge object has been created in a shared space. Nevertheless, the data is insufficient to draw immediate conclusions. The different spaces are bound to different subjects and every subject has its own rules, according to the academic programme.

Hence, the same calculations were carried out on the data collected from specific learning groups. Unfortunately the results are very similar to the results in the analysis conducted on the global data. One of these analyses is shown in table III.

Though there are significant differences regarding the volume of data analysed and the intermediate results, the relationship discovered by the linear regression shows no significant changes from the performance shown by participants during the whole experience.

On the one hand, there is no apparent influence from the passage of time and/or closeness to deadlines in the performance of participants' reactions. The flatness of the slope in both cases, global and local to workgroup, indicates that response will not vary with time in the social network. On the other hand, although there is no linear model, $y=mx+b$, to predict the performance, there is indeed the confidence to use the average reaction span, gathered from global behaviour, to measure specific reactions in learning groups and even specific

Table II. Main data and results for the calculation to build a linear regression in the time series for the global events performed in the BSCW tool considering the collaboration through objects in shared spaces. Specifically, this time series is bound to the period stated from the creation of the object, until the moment in which it is accessed.

n	$\sum x$	$\sum y$	$\sum(xy)$	$\sum x^2$	$\sum y^2$	$(\sum x)^2$	$(\sum y)^2$
87670	130662.5617	44539.19186	71995.9945	23345917.3	110285.984	17072705021	1983739612

m: 0.000242545	**b:** 0.507670815	**r:** 0.003941674

Table III. Main data and results for the calculation to build a linear regression in the time series for the events performed by one workgroup in the BSCW tool. This was calculated considering the collaboration through objects in the shared space. Specifically, this time series is bound to the period stated from the creation of the object, until the moment in which it is accessed.

n	$\sum x$	$\sum y$	$\sum(xy)$	$\sum x^2$	$\sum y^2$	$(\sum x)^2$	$(\sum y)^2$
1036	-0.000143194	-1.25762E-08	82.588223	1035	1849.70442	2.05044E-08	1.58162E-16

m: 0.079795385	**b:** 1.1017E-08	**r:** 0.05968934

participants. The measuring can be performed irrespective of which part of the semester is being observed.

5. CONCLUSIONS

This paper presents an approach for analysing online collaborative learning through social networks by integrating different strategies for coping with a variety of issues of the problem using mainly a quantitative technique.

This paper focuses on the quantitative method of time analysis which was based on SNA and consists of building a network using the information stored in log-files. The social network is the kernel of a Knowledge Server which is capable of answering different queries involving performance, interaction and collaboration for distributed problem solving in e-learning situations.

Temporal logics were defined to measure collaborative learning actions, whereas the ontology represents and classifies the primitive actions performed by participants. By imposing order on primitive events and applying semantics to specific sequences of primitive actions, collaboration analysis acquires a formal basis.

Finally, there is no apparent influence from the time span and/or closeness to *deadlines* in the performance of participants' reactions. The flatness of the slope in both cases, global and local to learning groups, indicates that response will not vary with time. Although there is no linear model, ***y=mx+b***, to predict the performance, there is indeed the confidence to use the average reaction span, gathered from global behaviour, to measure specific reactions in learning groups and even specific participants. The measuring can be performed irrespective of which part of the semester is being observed.

This is an interesting point. The first studies conducted on these data used an average of the reaction time, but a time series analysis was needed to determine whether there was a trend behind data. Now, it has been verified that reaction span is not bound to time passage or closeness to deadlines. Users of the CSCL will tend to follow regular behaviours during collaborative experience in social networking, which is more bound to personal customs regarding access to the Internet. Hence, the average for reaction time had been used correctly, although it was restricted to specific circumstances; now this has been proven to be the case.

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EMOTIONAL SCAFFOLDING WITH RESPECT TO TIME FACTORS NETWORKING COLLABORATIVE LEARNING ENVIRONMENTS

Michalis Feidakis

Department of Cultural Technology and Communication (D.C.T.C)
School of Social Sciences,
University of Aegean
Mytilini, Greece
e-mail: mfeidakis@sch.gr

Emotional scaffolding with respect to time factors in Networking Collaborative Learning Environments

ABSTRACT

With regard to learning, emotional considerations have been included in the research agenda for a long time and literature offers a variety of studies evaluating the role of emotions in different settings (class, tests and exams, studying at home, etc.). This knowledge and experience has tentatively begun to endow intelligent network systems with emotion assessment and affective feedback capabilities, although the process is still in its infancy. This paper reviews emotional aspects in learning and affect recognition as well as feedback strategies. In the described strategies, the need for considering the time factor is also stressed.

KEYWORDS

Emotion awareness, Affect detection, Affective feedback, CSCL, Social Networks, Time Factor

INTRODUCTION

Advances in Computer Supported Collaborative Learning Systems (CSCL) and Social Networks enable students to select their own teacher (schoolteacher, another peer, another system, etc.), their own curriculum, their own "assessors" (Laurillard, 2009). Due to the vast development of Networks and Telecommunications, users are able to form either small or large groups with common targets and needs, developing a kind of *Collective Intelligence*, a shared or group intelligence that emerges from the collaboration and competition of many individuals.

However, just because an environment makes it technologically possible, this does not mean that social interaction will necessarily take place. Perhaps, innovative Human Computer Interactions (HCI) models focus exclusively on cognitive factors, and are often unable to adapt to real-world situations in which affective factors play a significant role (Kort & Reilly, 2002). Humans have strong emotions emanating from deep instincts of survival *with*, as well as *against* others. Emotions strongly influence human behaviour in social conditions and must be seriously considered when forming collaborations.

Kreijns, Kirschner, & Jochems (2003) identified the main pitfall in CSCL environments as a tendency to restrict social interaction to educational interventions aimed at cognitive processes, while social (psychological) interventions aimed at socio-emotional processes are ignored, neglected or forgotten. Students need to trust each other, feel a sense of warmth and belonging, and feel close to each other before willfully engaging in collaboration and recognizing collaboration as a valuable experience (Rourke, 2000).

This process requires time. In building challenging social interactions and effective networks, time limits work obtrusively.

Appropriate affective scaffolds entail sacrifices in immediate academic performance, and this is something common in expert teachers. Should expert systems do the same?

If we wish to build real personalisation systems, it is necessary to consider not only user preferences, but also the user's emotional/ affective state (Picard, 1997). There is a need to build intelligent network systems that are sensitive to the user's emotions, and which intelligently respond to these emotions, in real educational settings and with sufficient time. We need to address research questions about the association of properties of users' networks (size, density, timing) with expression of emotions in their social interactions. We need to conduct studies that will search for possible associations between the users' emotions (joy, sadness, etc.) in their social interactions and their engagement in learning over time.

Incorporating emotional awareness (sensing and responding to the user's emotions) into Computer Systems and Networks can offer a more interactive and challenging learning environment, satisfying the learners' demands for empowerment, social identity, and an authentic learning experience.

In the last two decades, there have been different updated endeavours to model the management of emotions and affectivity in Intelligent Systems. A thorough testing of user's emotional transitions over time may lead to more precise results.

CONSIDERING EMOTION

Emotion, together with cognition and motivation are key components in learning (D'Mello et al., 2005). A purely cognitive approach that does not take into consideration emotions, motivations, and the like, paints an artificial, highly unrealistic view of real minds. Minds are neither purely cognitive nor emotional; they are both and more (LeDoux, 2000). We learn from sources of information that we bother to pay attention to (Davou, 2000).

NEUROLOGICAL EVIDENCE

There is extensive literature on the study of emotions, with a wide range of perspectives: evolutionary, behaviourist, componential, socio-cultural and now, neuro-scientific (Afzal & Robinson, 2007). Neurology provides us with a neuro-biological approach to emotions, focusing on the emotional operations of autonomous and basal neurotic systems (e.g. the limbic system). The latest research findings point to activity in different brain areas, when positive, as well as negative emotions are experienced.

For example, Davidson, Scherer & Goldsmit (2003) indicate that the Dorsolateral Pre-Frontal Cortex guides decision-making through positive emotions (joy, hope, pride) and is critical for goal achievement decisions, while negative emotions such as threat, fear or anger reveal activity in the amygdala in the Limbic System.

J. Ledoux's (1996) systematic research underlines the privileged position of the amygdala; a point where everything converges. Sensory signals move from the hypothalamus to the amygdala in 15 milliseconds and from the hypothalamus to the cortex in 25 milliseconds. A stimulus is firstly, and above all, appraised if it is a threat (Goleman, 1995). As a result, negative emotions such as fear or anger are triggered before the Pre-Frontal Cortex has even received the signal to be processed. Negative emotions take precedence in perception over positive ones.

The amygdala has limited pattern recognition capabilities compared to the cortex, and performs "a quick and rough" pattern recognition and response. A stimulus is firstly, and above all, appraised if it is a threat. The amygdala has presumably been structured in answer to one critical question for survival: "*Do I eat it or does it eat me? The brain is able to sense fear before a human can think of it" (Daniel Goleman).*

POSITIVE VS. NEGATIVE EMOTIONS

Despite evidence of the beneficial effects of a positive mood and emotions there are no clear rules such as: positive emotions foster learning, and negative emotions are detrimental (Hascher, 2010). A student with a positive disposition would see an F on a math test as evidence that he needs to work harder, while another may see it as evidence that he is stupid (Goleman, 1995). In general, there are no adequate empirically proven strategies to address the presence of emotions in learning, especially negative ones. A theoretical background has been built upon theoretical foundations of pedagogy/affect, as well as recommendations made by pedagogical experts (D'Mello, et al. 2008).

According Pekrun's, et al. (1992, 2006) findings, a positive mood fosters holistic, creative ways of thinking. Harmful effects can only be expected in situations, where students are in a good mood and the learning topics are of less importance to them. In this case, a positive emotion might detach them from learning.

Negative emotions, however, in most cases direct students' attention to themselves. Necessary attention for learning and task solving is lacking, because they try to find ways to get rid of the bad feeling (Hascher, 2010). When negative emotions create a pessimistic perceptual attitude, they divert the learner's attention to aspects irrelevant to the task, activating intrusive thoughts that give priority to a concern for wellbeing rather than for learning (Boekaerts, 1993).

Nevertheless, negative moods proved to enhance an analytical, detail-focused way of processing information. Curiosity and puzzlement may lead to investigate problems and frustration may lead to action, despite their negative valence (Heylen et al 2004). A state of confusion is sometimes considered positive for learning because students will be motivated to overcome the source of their misunderstanding. In literature, uncertainty is encountered as an "opportunity to learn" (Forbes-Riley & Litman, 2009).

Robinson, McQuiggan & Lester (2009) state that although, in general terms, students have a strong tendency to remain in the same affective state across time, when transitions to alternate affective states did occur, they followed interesting patterns. For instance, frustrated learners were very likely to transition to confusion or fear and were particularly unlikely to enter a positive state such as flow or excitement. Students experiencing a positive state of flow were likely to transition to confusion, which is still considered positive for learning and were unlikely to transition to the more negative state of frustration. Interestingly, confused learners were equally likely to transition to flow and frustration. These findings suggest that the affective state of confusion and its antecedents and consequences need additional study to determine which factors contribute to a positive transition to flow or a negative transition into frustration.

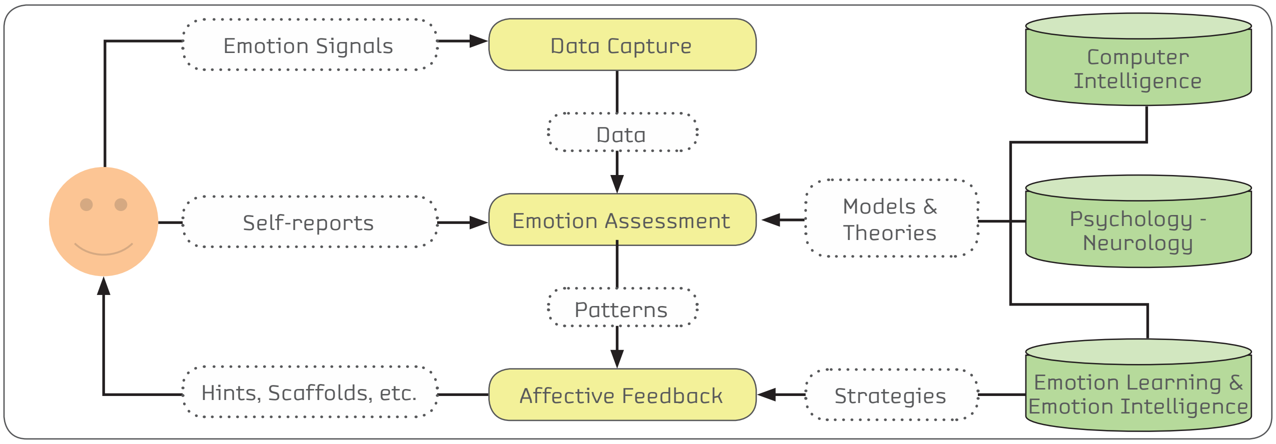
AFFECT RECOGNITION AND FEEDBACK

AFFECT DETECTION

Students are known to effectively engage and learn in their favourite social networks, where they exchange information and experiences with peers. These experiences are predominantly emotionally coloured. Social sharing of emotions occurs frequently in platforms such as Twitter and Facebook (Kivran-Swaine & Mor, 2011). People are compelled to share emotions shortly after they experience them, and find the sharing relieving.

Affective Computing (or Emotion Oriented Computing) has been focused on automated detection of affective states in a variety of contexts and it has shown promising results. By exploiting Computer Intelligence techniques, researchers are aiming at eliciting accurate automatic classifications of affective states and patterns, mostly in network interactions.

Figure 1. Emotion-assessment computer intelligent model



Consequently, affect measurement is usually grouped into three areas (Picard, 1997; Zimmermann, Guttormsen, Danuser, & Gomez, 2003):

- Psychological-Profiling tools (verbal/ non verbal self-reports, conductive chat, rating scales, standardized checklists, questionnaires, semantic and graphical differentials projective methods).
- Physiological signals-use of sensors (skin conductance-SC, electrodermal activity-EDA, electrocardiogram-ECG, blood volume pulse-BVP, electromyogram-EMG, respiration, pupillary dilation)
- Behavioral (facial expressions-face reader, voice modulation/intonation, hand tracking, body posture, motor behaviour-mouse-keyboard movements from log files, corrugator's activity).

In the majority of the studies, multimodal integration is applied (a combination of the three methods).

Computer intelligence can provide data-mining/ classification algorithms that can be trained by input data and emotion signals and through cluster analysis can produce accurate emotion classifiers. Classification categories like Neural Networks, Decision Trees, Bayesian Networks, Fuzzy Systems, Genetic Algorithms, etc. are mostly used. Table 1 below, evaluates the three areas of affect detection, describing benefits and drawbacks.

AFFECTIVE FEEDBACK

An ITS that is privileged with Affective Feedback capabilities, is able to send appropriate affective or cognitive signals to the user, in response to their affective state detection, thus ensuring their emotional safety and their engagement or persistence in the learning experience. In line with Hatcher's emotion's quality criteria (2010), the "appropriateness" of the response is further analysed in the following:

- ***Valence* of the response:** positive e.g. encouraging hints or neutral e.g. task-based feedback or no feedback at all. The case of negative response e.g. to reflect on user's confusion for activation purposes, requires quite high speculation and caution.
- ***Arousal* of the response:** activating, e.g. a drumbeat or de-activating like spiritual music or a short story.
- ***Timing* of the response**: immediately or after a fragment of time.
- ***Duration* of the response:** short e.g. a very short sound revealing success like in computer games or long e.g. a funny animation clip.

Affective feedback techniques also incorporate knowledge of student group characteristics (e.g., profile of cognitive skills, gender), to guide interference. In their experiment, Woolf, Burelson & Arroyo (2007) develop an agent tutor that customizes the choice of hint type for individual students based on their cognitive profile, gender, spatial ability, and math fact retrieval speed.

Although not extensive, there are remarkable studies that test methods and techniques of computer mediated affective feedback in network collaborations, and the impact that they have on users. A rough classification includes:

- *Dialogue moves* (hints, prompts, assertions, and summaries).
- *Immersive simulations* or *serious games.*
- *Facial expressions* and *speech modulations.*
- *Images, imagery, cartoon avatars, caricatures* or *short video-audio clips*

In some research studies, affect-adaptive computer tutors have been evaluated within

Table 1: Critical Review of Affect Detection Tools

Classification: 1st-Class	Psychological		Physiological					Motor-Behavioral				
2nd-Class	Verbal	Non-Verbal	EEG	ECG	BVP	EMG	EDA	Facial	Vocal	Body position-Gestures	Mouse-Keybord activity	
Criteria: Subjective	←	←	→	→	→	→	→	→	→	→	→	Objective
Obtrusive	→	→	←	←	←	←	o	o	o	o	→	Unobtrusive
Invasive	→	→	←	←	←	←	o	→	→	o	→	Noninvasive
Out of Task	←	o	→	→	→	→	→	→	→	→	→	With task
Expensive	→	→	←	←	←	←	←	←	←	←	→	Inexpensive
Expertise	→	→	←	←	←	←	←	←	←	←	→	No-expertise
Language & Culture-bound	←	→	→	→	→	→	→	→	o	→	→	Cross-cultural & language free
Noisy	→	→	←	←	←	←	←	←	←	←	←	Clean
Nonaccurate	o	o	→	→	→	→	→	→	o	→	o	Accurate

Range:
- ← Left Column
- o Neutral
- Right Column →

Classification criteria (adopted by Zimmermann, Guttormsen, Danuser, & Gomez, 2003; Wong 2006):

- **Objective/Subjective:** Relates to the degree of consciousness of the emotion that is experienced.
- **Obtrusive/Unobtrusive:** User's experience of the medium.
- **Invasive/Non invasive:** Realistic use in education setting.
- **Out of Task/In task:** Measurements are taken in parallel with user's task or not.
- **Expensive/Inexpensive:** The cost of the equipment needed.
- **Need Expertise/ No expertise:** In order to capture emotion signals.
- **Language & Culture-bound:** Cannot be used universally.
- **Noisy/Clean:** Data collected is "noisy" and need clarification or not.
- **Non-Accurate/ Accurate:** Additional variables must be considered.

a "Wizard of Oz" scenario, where a human "wizard" performs system tasks such as speech recognition, natural language understanding, and affect detection (Forbes-Riley & Litman, 2011). Machine learning optimization algorithms are applied in searching for policies for individual students, with the goal of achieving high learning and positive attitudes towards the subject.

Woolf, Burelson & Arroyo (2007) have used a variety of heuristic policies to respond to student's emotion. They measured how feedback variables interact to promote learning in context (characteristics of the learner, aspects of the task). Instructional feedback is varied according to type (explanation, hints, worked examples) and timing (immediately following an answer, after some elapsed time) (Shute, 2006). The socially intelligent system was found to yield increased student learning as compared to the control system. Wang et al. (2008) implemented a model of "socially intelligent tutoring" that achieved significant learning improvements, based on politeness theory in an online learning system.

TIME FACTOR-AFFECTIVE CHRONOMETRY

Emotions are not instantaneous, turning on or off at any particular point in time (Parkinson, 1995), but are dynamically changing over time. An emotional experience can last for only a couple of seconds up to several hours or even longer (Verduyn, Van Mechelen, & Tuerlinckx, 2011).

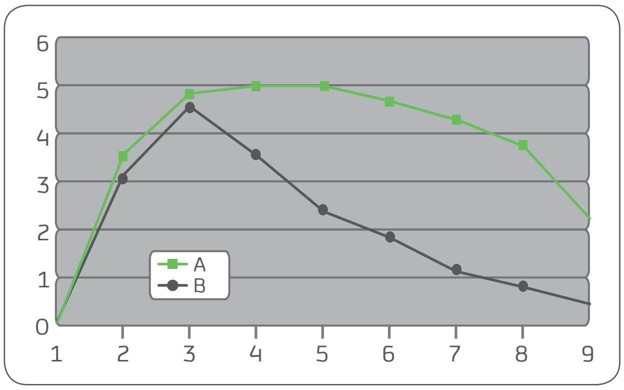
A sound understanding of emotions in network collaborations requires the study of emotion-dynamics in established groups. Emotions unfold over time, however, individuals are likely to differ dramatically in the time they need to recover from a negative emotion, for example, this can be seen in most network interactions, such as anger. There is neurological evidence that "time course modulation in affective responding, particularly for recovery, is one important component of what Prefrontal Cortex does" (Davidson, 1998).

Individual differences in emotional reactivity or affective style can be fruitfully broken down into more elementary constituents, such as threshold for reactivity, peak amplitude of response, rise time to peak and the recovery time. The two latter characteristics constitute the components of affective chronometry. The duration of an emotional episode can then further be defined as the amount of time between this onset point and the first moment the emotional experience is no longer felt (Verduyn, Van Mechelen & Tuerlinckx, 2009).

In order to classify emotions, different conceptual models of emotions usually adopt the following dimensions (Hascher, 2010):

- *Arousal* (deactivating/activating),
- *Valence* (negative/positive)
- *Intensity* (low-intense)
- *Duration* (short-long)
- *Frequency* of its occurrence (seldom-frequent);
- *Time dimension* (retrospective i.e., relief, actual i.e., enjoyment, prospective i.e., hope).

Figure 2. Affective chronometry of two different individuals in response to an emotionally arousing stimulus. Adopted by http://e-book.lib.sjtu.edu.cn/iupsys/Proc/stock1/spv1ch16.html

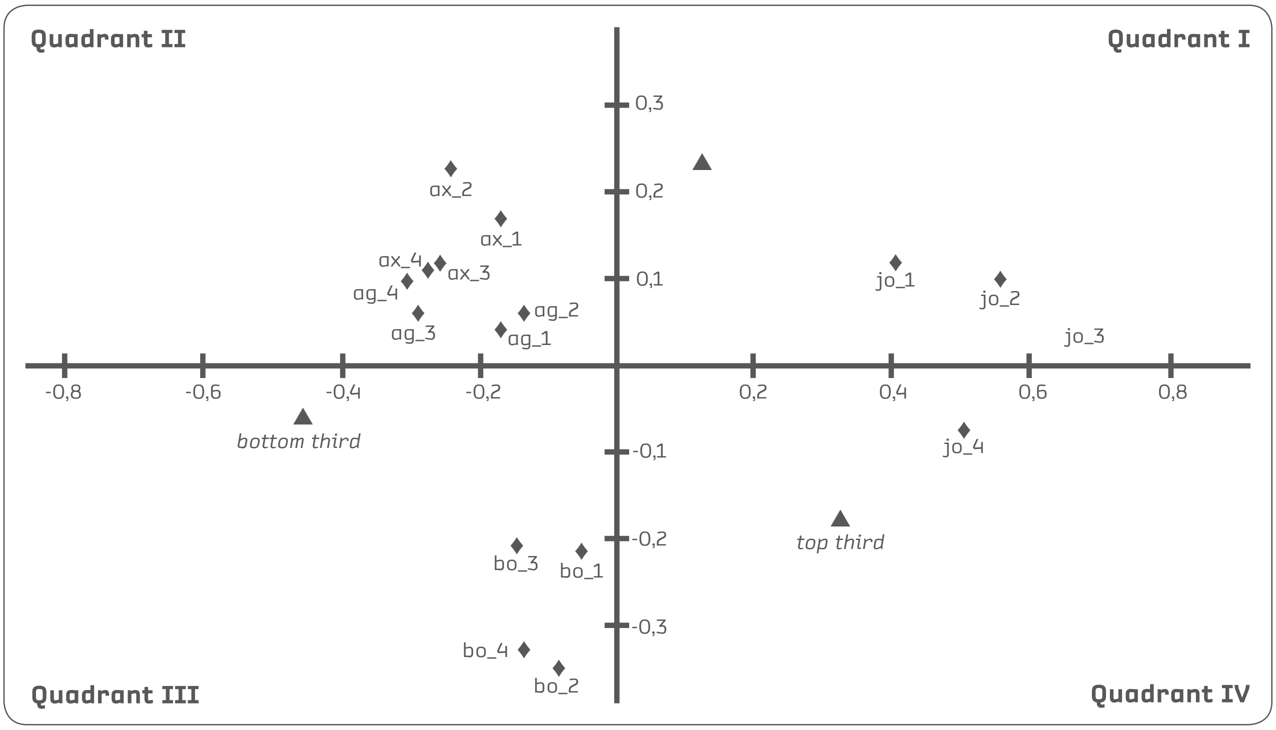


Pekrun (1992) supports that *time constraints for tasks* constitute another important variable that moderate learner's affective states. When time for task completion is limited (as in examinations), negative cognitive effects cannot sufficiently be compensated for by enhanced effort, thus rendering anxiety effects negatively. On the other hand, if cognitive processing impairment can be compensated for by extra hours of work (as in long-term preparation for an exam), the net effects of anxiety on achievement may well be positive.

Although quite few in number, studies that evaluate users' affective state with respect to *emotion duration (short-long)* and *time dimension (retrospective, actual, prospective)* can give us more precise views of emotions. For example, P. Verduyn and his colleagues (Verduyn, Van Mechelen, & Tuerlinckx, 2011) examined the extent to which covert intrapersonal actions (cognitions both related and unrelated to the emotion-eliciting stimulus) as well as overt interpersonal actions (social sharing) account for variability in emotion duration. According to their findings, one may also shorten the duration of an emotional episode by diverting attention away to topics unrelated to the emotional event, provided that the valence of the distracter is opposite to the valence of the emotion. Social sharing also prolongs episodes of joy and gratitude whereas shortening and prolongation effects of thoughts were also found for joy.

With respect to *time dimension (retrospective, actual, prospective)*, Kleine, et al. (2005) indicate that students do experience different levels of positive (joy) and negative (anger, anxiety, boredom) emotions according to their level of academic achievement in mathematics (bottom, middle, high), in short time periods (before, during, after the test).

Figure 2. Correspondence analysis for emotions experienced during a mathematics test. ♦= emotion (ag – anger, ax – anxiety, bo -boredom, jo – enjoyment). _1 = before the test; _2 and _3 = during the test; _4 = after the test. ▲ = achievement group. Adopted from Kleine, et al. (2005).



T. Hatcher has conducted several long-standing studies to test the development of wellbeing in school (e.g. changes in enjoyment at school during primary and secondary education, Hascher, 2010). According to her findings, there is a negative spiral of learning and emotion, which might be one important reason for insufficient learning outcomes and the high amount of inert knowledge developed during schooling. Learning enjoyment decreases over the years at school, and the decline seems to be caused by the characteristics of the organization of school learning, like a poor fit between students' interests and needs and the learning environment (Hascher, 2010).

Finally, time factors can also be considered during the affective feedback process, in which various heuristic policies are applied in response to user's emotions (Woolf, Burelson, & Arroyo, 2007). Shute (2006) is classifying instructional feedback according to type (explanation, hints, worked examples) and timing (immediately following an answer, after some elapsed time). One general recommendation is that immediate feedback helps low achieving students. Delayed feedback is suggested for high achieving students, especially for complex tasks.

DISCUSSION AND CONCLUSION

Although, CSCL researchers evaluate group activities and network systems that describe impact on the cognitive aspects of activities, almost no experimental research has been performed to evaluate the affective aspects of these group activities (Calvo, 2009). Just placing students in networked groups does not guarantee collaboration (Kreijns, Kirschner, & Jochems, 2003). Maintaining a level of student engagement in the tutoring process should be a priority. Enhancing students' attention and willingness to continue may imply sacrificing students' learning at times. If the long-term goal is to have students learn and 'stay' in a system, it may be important to sacrifice immediate learning by interleaving multimedia 'adventures,' for example, when observing signs of boredom or confusion to recover students' engagement with the system. (Woolf, 2007).

Our focus is on fortifying existing Learning Environments and ITS with the necessary emotion-aware strategies to address the affective states of the learner. The use of sensors to detect student's affective state may face obstacles (mostly financial but also spatial). However, the use of standard devices such as mouse-keyboard and PC camera to capture subjective, unconscious motor-behaviour patterns by testing contextual variables (correct/incorrect attempts, time in session, number of hits, etc., derive from log files (Aroyo, 2009).

Interventions include emotional scaffolds that encourage student's positive attitude towards learning and empathetic strategies that assure student's emotional safety and foster their meta-cognitive and meta-affective skills. We must develop effective production rules that preserve successful affective learning sequences, in line with educational design patterns. Feedback will be enriched by practices that have been tested and evaluated for years in Social-Emotional Learning (SEL) applications.

Walther (1992) argues that research has not taken into account the effects of the time needed to accumulate the socio-emotional cues necessary to develop their personal impressions of others. Time appears to be an important factor that positively affects development of an affective structure and, therefore, community building. If we take into consideration that even face-to-face groups need time for group forming and establishing an affective structure the 'time' we are talking about here, is- in fact- extra time needed due to the limitations of Network Computing. He suggests for the design of sociable CSCL environments aimed at providing non-task contexts that allow social, off-task communication (e.g. casual communication).

What the user-student really wants and feels in a specific time and space is appraised as valuable information that can lead into real personalised computers systems. Emotional scaffolding in CSCL has in fact led to significantly greater persistence and student engagement (Aist, 2002). Real and challenging collaborations need emotion awareness (detect and respond). And emotion consideration cannot be evaluated independently from the time factor.

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Pérez-Mateo, M. & Guitert, M. (2011). How to promote effectiveness in terms of time in networking processes. *eLC Research Paper Series, 3, 37-47.*

HOW TO PROMOTE EFFECTIVENESS IN TERMS OF TIME IN NETWORKING PROCESSES

Maria Pérez-Mateo & Montse Guitert

eLearn Center
Open University of Catalonia

How to promote effectiveness in terms of time in networking processes

ABSTRACT

Because time is present in all learning activities it is important to consider how to optimize it. This is even more important in e-learning given the virtual student profile, most of them adults who do not have time. A tool that seems to favor time management is the wiki. The aim of this article is to analyze how the wiki can favor efficiency in networking processes. The general context is the "ICT skills" course by the Universitat Oberta de Catalunya. Starting from a qualitative methodology, the paper analyzes how students working in small groups carry out a virtual project through a wiki. In terms of encouraging effectiveness by using a wiki in a networking context, data show that it is important to consider three elements: the time required to learn how the tool works, organizing the process and optimizing usage of the tool. The paper provides some key elements along these lines.

KEYWORDS

Networking; Time Factor; Wiki; E-Learning; Virtual Project.

Pérez-Mateo, M. & Guitert, M. (2011). How to promote effectiveness in terms of time in networking processes. *eLC Research Paper Series, 3, 37-47.*

1. INTRODUCTION

The internet facilitates collaborative work and networking. More and more proposals try to facilitate the acquisition of skills through collaboration and teamwork among students. Following Anklam (2009), it is important to differentiate between collaborative work and networking concepts. In her own words "It boils down to whether the emphasis in the network is to make connections to *share* experiences, contacts, ideas; or to collaborate, engaging in activities to *produce* something. It's not an either/or, of course. Web 2.0 has made us aware of the vitality of that comes from socially-generated content – comment streams on blogs, activity streams in microblogging, and so on – which can be precursors of collaborative activity". In this paper we deal with networking processes in a learning environment.

A key element of networking processes is the time factor. As Bullen (2010, in Bates *et al.*, 2010) states, learning, by definition, requires time. Indeed, the time factor is present in any learning activity. This fact is even more evident in a virtual environment, an environment which exists independently of the time factor, ensuring flexibility in the learning process (Bates, 2010, en Bates *et al.*, 2010). According to Barberà (2010:13) "this "temporal dimension in e-learning" is considered as a real tool which is always present and which spreads out into the planning and implementation of online education".

Although good time management is crucial for the good functioning of online learning (Barberà, 2010), in practice this issue is often forgotten. Furthermore, students waste time in developing learning processes, especially when they work in groups, because they rarely have guidelines in this respect. That is why the time factor is becoming more important due to its influence on teaching - learning processes (Gros *et al.*, 2010).

There are currently different tools which may facilitate and improve joint learning in a virtual environment. That is the case of the wiki. This tool also seems to be a good choice in order to promote time management. A wiki is a collaborative website that can be edited by multiple users and consulted through a history of actions (Bruguera & Gil, 2008). According to Deumal & Gil (2009), the wiki allows to create, modify, edit, link or delete the contents of an electronic document easily and quickly. Wikis do not aim to regulate self-publication but rather to structure a set of information through successive new contributions. It therefore becomes a work in progress which is continuously being added to (Deumal & Gil, 2009).

As noted by Barberà (2009), the wiki may be one of the most "academic" tools among those related to web 2.0. That is why studies on its educational use have recently increased[1]. According to Martín & Alonso (2009), wikis enable students to construct their own learning through interaction with the environment as well as with other students participating in the wiki, producing a real exchange of knowledge. Creating in a wiki involves editing together, adding to information by peers and supplementing or modifying it according to common learning objectives. Wheeler *et al.* (2008) state that wikis enhance the architecture of participation.

Research in this field shows that wikis have the potential to improve the collective construction of knowledge in academic contexts (Elgort, 2007; Raman, Ryan, & Olfman, 2005) and achievement (Robles *et al.*, 2009). However, some studies (e.g. Cole, 2009) show that not all experiences developed through wikis are positive, while further exploration is required in this area. Indeed, experts stress that it is a complex virtual tool (Giménez & González, 2009; Raman, 2006).

In terms of the time factor, in this paper we try to address how wikis can facilitate networking processes when students work in small groups.

2. METHODOLOGY

This study focuses on how wikis can promote effectiveness in a networking environment from the point of view of the time factor.

We adopt an interpretative methodological approach to supplement studies of the time factor, which are mainly based on a quantitative approach (Reimann, 2009; Gros *et al.*, 2010).

In keeping with the interpretative paradigm, we adopt a qualitative point of view that aims to "understand people" and to interpret the point of view of social players. The study also takes some quantitative issues into account.

Specifically, we have used the case study (Stake, 1998, Yin, 2003) as an approach for our own study.

Starting from the general objective, we deal with the following research questions:

- *What elements can promote effectiveness in the context of networking?*
- *How do wikis facilitate time management when students construct knowledge together?*

2.1. SCENARIO

The educational environment which becomes the general scenario for our research is the Open University of Catalonia (UOC[2]). The UOC is a fully online university with a Virtual Campus where all learning activities and communication take place. Its aim is to facilitate lifelong learning.

Within the UOC, our study is carried out on the "ICT skills" course. This is a cross-curricular course common to all UOC undergraduate programs. For this study, students from Computer Engineering and Psychology were involved.

"ICT skills" aims to initiate students in the use of ICTs for learning purposes and to gradually support the development of a specific competence defined by the UOC: the "Use and application of ICTs in academic and professional development". The recommendation is to take this course in the first semester of the online program, when students first come into contact with the learning environment.

The "ICT skills" course allows students to develop knowledge and skills for a responsible, efficient, informed and productive use of digital technologies. The students on this course form small groups of 3 to 4 participants. The methodological approach for the course is project-based learning (Railsback, 2002). Students choose a topic of interest related to their discipline at beginning of the course. This subject is then discussed and collaboratively developed throughout the learning process. As a result of this process, each group carries out its own virtual project. As they carry out this process, students progressively acquire ICT skills.

Groups use a wiki as the main tool to produce their content. We chose the wiki as a tool that fosters interaction in content creation, as well collaboration within a shared and openly accessible digital space, and because it provides an architecture for participation (Wheeler *et al.*, 2008).

In this study, the 14 rooms of the "ICT skills" course for Computer Engineering and Psychology were involved. The average number of students is 60.

2.3. DATA COLLECTION AND ANALYSIS METHODS

Different data collection methods were used in order to provide in-depth overall knowledge of the reality under study, combining interactive methods of data collection (i.e. semi-structured interviews and a questionnaire) with non-interactive methods (such as group observation). These instruments complement each other, thus ensuring the holistic nature of the data analysis and providing a basis for their triangulation and the validity of the research procedure.

The observation was carried out in the rooms involved. Specifically, 4 rooms (two per program) were chosen in order to observe how students built their projects through the wiki. Within the classrooms, just teacher boards were analyzed. Through the teacher board, the teacher can offer guidelines, monitor the process, give advice, etc.

Among the four classrooms, different small workgroups were chosen as the specific analysis context. The choice of these teams was based on two main requirements: that the group should develop a successful dynamic in relation to the course objectives and should use the wiki to carry out their virtual project. Finally, 6 groups of Computer Engineering (3 per room) and 1 of Psychology were chosen. Each of them had their own UOC online working space composed of the following: Teacher board, Debate, File area, Wiki and Chat.

In order to complete the data from the observation, some individual semi-structured interviews were conducted with 14 students (two per workgroup), trying to focus on their perception of the group processes. Some of these questions also focused on the use of tools in order to acquire ICT skills. We also interviewed the teachers involved in the process (4 teachers).

An anonymous online questionnaire was also created in order to analyze the group work processes as well as the tools and the teacher's role. With the objective of collecting as much data as possible in order to support findings beyond the 4 cases, the questionnaire was sent to all classrooms (14) of the selected studies and answered by 192 students. The questionnaire was voluntary, anonymous and non-assessable. This research is based on two of the questions referring to tools: an open one and a closed one.

For a cross-sectional analysis we also used triangulation for the complementary nature of the data collection instruments used and contrasting data and players.

3. RESULTS AND DISCUSSION

Networking is characterized by the use of virtual tools that convey all the actions carried out. Networking is also based on asynchronous communication. These conditions highlight any need for repair in these tools: what elements should be taken into account, what their possibilities are and how to optimize them.

The data analysis shows that, in order to promote the effective use of wikis in networking, it is important to consider the following issues regarding the time factor: the time required to learn how the tool works, organizing the process and optimizing tool usage.

3.1. THE TIME REQUIRED TO LEARN HOW THE TOOL WORKS

According to Raman (2006), although wiki literature highlights the usability of the tool, practice shows that this may not be immediately intuitive. Indeed, it appears that:

- It requires learning; i.e. to find out what a wiki is and what its possibilities for networking are. One student stated in the questionnaire that "*The wiki seems like a good initiative, but it wasn't accepted as a whole. Probably because it requires some learning*". Another member stated "*we were very slow because we weren't familiar with it*".
- It requires time. Most of the groups that were unable to use the wiki or used it below its potential referred to the lack of time as the main cause. One student said in this respect "*we were very slow because we were not used to this tool".*
- It may be seen as difficult in terms of its usability. One interviewee said: "*Had the editing in the wiki been easier, maybe we would have done better. (...) I thought the tool was a little complicated to work with... to write there*". In the case of a group that used the wiki intensively, some aspects perceived as complicated were carried out by using text documents. In this vein, a student writes in the Debate: "*I have extended the planning that we had already begun in the wiki (...) Because I did it as a table, I don't know how to insert it in the wiki. So, you will find it in our File area*". Even though some groups worked with the wiki in order to carry out their work, they demonstrate this factor in the following comment: "*I personally won't use the wiki again because it is very complicated*".

Data show that there is a key element that influences their perception of the tool; the time spent learning how the tool works and its ease of use. Under the same conditions, and with the same guidelines and available tools, just one Psychology group worked with the wiki. On the other hand, all Computer Engineering teams included this tool in their work processes, albeit with different objectives in mind and, in some cases, edited only by one member. It is clear that Computer Engineering students are more likely to work with new tools than Psychology ones. Predisposition in the use of the wiki is therefore related to the student profile.

In any case, given that, for many students, using the wiki was a "***new experience***", it is important to plan an initial period of time in order to learn how it works and its potential. Indeed, all students involved in this experience reflected how the wiki was an innovation. One student even admitted that previously he "*did not know what the wiki was*".

3.2. ORGANIZING THE PROCESS

Planning and organizing individual and group work are important skills that students bring into play as a part of the course. In terms of the time factor, organizing the process before it's carried out becomes a key factor for both group and process success.

Previous studies have highlighted the relevance of organizing and planning the process (Guitert, Romeu & Pérez-Mateo, 2007). This study reveals the testimony of a group who emphasized the "*planning task*" as a key element to overcoming the obstacles occurring during the process.

In a networking environment, it is important to take into account the relevance of developing the skills required to organize group work; i.e. to take decisions associated with the process. At the same time, this will also promote time management. Below there are some issues related to initial networking organization from our classroom observation:

- The communication channel and how it will be implemented.
- How to use the different tools and each one's function.
- The information management process.
- Anticipation of conflicts, overlaps, etc.
- Establishment of roles related to promoting the process: animator, organizer, etc.

- Planning the process though activities and delivery dates (schedule).

It is also important to encourage preliminary organization so that this becomes a tool for carrying out the process. Guiding this stage, a teacher suggests: "*Be realistic and practical, taking into account what you have to do and which is the best way forward*". Another teacher highlights *"the relevance of planning in order to succeed"*.

In addition to the initial planning, teachers encourage groups to review their initial planning and organization as an instrument for the group. As one teacher says: "*As you progress in the project development, you should review and assess the group work process: communication and interaction, organization, information management, attitudes... So you will be able to make the appropriate adjustments*". Another teacher observes: "*I see that some of you groups are going on to the Final Project but at a slower pace than is advisable and more slowly than you planned yourselves, and I suggest you revise your planning".*

3.3. OPTIMIZING TOOL USAGE

For effective exchange within a networking environment, it is important to know how to use the tools available. In this area, data show that wikis facilitate time factor management as they help to optimize the process.

Specifically, data suggest that the wiki optimizes three key networking processes: the interaction between members, the organization and management of the process and knowledge construction.

A) Interaction between members

Interaction processes form the basis of networking. Students develop both group processes and skills through this interaction. However, for this to happen it is important to work on communicative skills and enhance their effectiveness. The data show that wikis can facilitate and optimize interaction between members in a group.

In some cases, students used the wiki as a space for exchanging opinions or discussing specific aspects of the project. A student reflected this feature when he claimed they had used the wiki as "*a forum that everyone can edit (...) the wiki was like a dynamic board that could be modified*".

Taking this fact into account, the wiki was also used from time to time for communication related to the social dimension, mainly in terms of asking for help and encouraging participation. In this respect, one student writes: *"I'm doing a test. Does anybody know how to use the wiki effectively and create our forum space for working?"* Another student says: "*I don't know what I can write here guys! Let's see if someone has any ideas ;-)".*

The data also show how the wiki fosters communication effectiveness while lowering the volume of interaction. Comparing the use of the wiki and debate for discussion, one student commented: "*In the debate you have messages like... "I agree", "I also agree"... You have many messages but no content. In the wiki you have few things but they are ideas so you save opening a lot of messages*".

Finally, the wiki facilitates the organization and localization of content ahead of decision-making. A student argues about the use of wiki: "*I realized the potential of the tool because... in the debate area, one person proposed a title for the project, another one added another thing, but that stays there... so when you access the group's debate area in order to get an idea of the titles that we've been discussing... I have to go through all messages and check them all by opening them one by one*".

B) Organization and management of the process

Another key issue in networking is the participants' ability to organize and manage the process as it develops.

Students point to the wiki's potential in order to control and monitor the process as it "*allows the group to be organized in a different and attractive way*". In this respect, one student noted in the questionnaire that the wiki was useful as "*a scheme of the work done and the work pending*". Another student referred to how, from the beginning, he tried to encourage his group to use the tool: "*For example, in relation to tasks... I listed the tasks and I noted with asterisks or with an "x" what we had to complete and I said: put your name down next to the tasks that you prefer*". Finally, a student said: "*In the debate you have to write down and to see, for example, which titles there are, how many times they have been rated... But in the wiki all the content was reflected or summarized*".

A very important use in relation to project management was the management of information generated in the process, because it helps to "*share the information immediately*". In this sense, we distinguish three related functions:

- The possibility to quickly and easily control different versions of the project. In the words of one student, the wiki becomes "*a powerful tool in terms of control*" because it allows you "*to add and modify content knowing who did it and when*". Indeed, it helps to modify "*just one document instead of taking it, modifying it on your computer and updating it again*". At the same time, the wiki also fosters content edition and update.
- As a digital information repository; in other words, to access, store and share the information generated during the process. As one student says, the wiki makes it easy to have information "*available, so you can quickly consult it. If you had a doubt it was easy to check it. In a document you had to look for it. And if you make a change everyone sees it immediately. You don't have to download it*".
- The display of content. As one teacher comments: "*work is seen immediately (...) and it is more attractive*". At the same time, as noted by a student, the wiki has more possibilities because "*if you preferred to, you could see the history of edits, or if you preferred, you could see the result*".

C) Knowledge construction

Another important skill developed by students on the ICT skills course is the construction of knowledge. As the data show, the wiki can improve this process given that it becomes its main function. The wiki becomes a space for "*working with the information*". Groups valued the tool as very positive, stating that "*the use of the wiki makes work easier*", making the process effective.

The wiki encourages the collaborative development of information given that it is "*accessible to all members*" and editable, promoting interaction and collaboration (Toker et al., 2008). Therefore, as Barberà (2009) stressed, the wiki tends to prevent participants from writing in parts, bringing them closer to a common reading and writing, taking into account that the group works "*on a single document and all of them can work on it directly*".

The wiki reveals the process of content production because content is shared as it is created. A student wrote in the Debate area: "*I'm doing some things and, instead of saving them on my PC, I put them on the wiki. In this way, you can see it too*". This fosters networking, through suggesting, sharing, participating, assisting,... the content development process.

It also helps to make changes to each other's contributions in the construction process (Giménez & Gonzalez, 2009). Given that all members know who is working on what and how, it becomes an important factor in terms of the effectiveness of the process, avoiding misunderstandings.

Related to the construction of knowledge, students stress the importance of the wiki as an organizer of ideas and content in order to facilitate decision-making. One interviewee said, in this respect, that the wiki had been very useful in *"reaching agreements (with brainstorming, for example)"*. He also referred to this usefulness as follows: "*Who is in charge of this task? He is... Which titles do we have? These ones... so it seems we have this title repeated several times, maybe this will be the one*".

4. CONCLUSIONS AND PRACTICAL IMPLICATIONS

Bearing in mind the findings presented above, we conclude that the time factor consistently appears in virtual teamwork dynamics and, as a result, has significant implications in developing online activities and the learning process.

In this paper we have analyzed how carrying out a virtual project through a wiki within a networking group may favor the acquisition of key skills associated with the virtual environment: interaction, organization and planning and construction of knowledge. In addition to managing these skills, the wiki enhances effectiveness in terms of the time factor.

However, it is important to consider two prior elements in order to use the wiki efficiently and thereby optimize time management. On the one hand, planning an initial phase in order to learn how the tool works. On the other hand, spending some time organizing the process as well as the tool; i.e. how students will achieve the objectives and which role the tool will play in this.

These results have noteworthy implications for educational practice.

First, we should stress the need to put into practice those skills associated with online interaction in order to develop networking processes. Indeed, encouraging teamwork development skills will facilitate and promote participation in informal networks as well as communication and more extensive knowledge construction.

Second, to promote the effectiveness of the networking process, the pedagogical approach should provide an initial period in which users learn how the tool works. It might even be positive to develop an informal activity to introduce students to its use. This is especially important for some specific student profiles, e.g. those of Psychology, who are less predisposed to using the wiki and less proficient in the use of ICTs compared with Computer Engineering students.

The pedagogical approach should also allow a period of time to organize the group dynamics: how to use the tool, how each resource will be used, whether someone will be responsible for certain tasks or functions, how information will be managed, what key elements will be taken into account in the interaction process, etc. Indeed, the more elements that are anticipated from the start, the more effective the development. Considering these aspects of the process during its development will also become a key element in acquiring skills in a networking context.

Finally, encouragement and teacher guidance are important issues in order to acquire key networking skills. Teachers can also take advantage of the wiki for monitoring and assessing the group process. Indeed, it helps them to quickly visualize the status of the activity and to see to what extent each member is contributing (Giménez & González, 2009; Montenegro & Pujol, 2009; Trentin, 2009; Martin & Alonso, 2009). As one teacher argued, "*the best of all is you know exactly what everyone has done*".

Although, in this study, we analyzed the use of the wiki to carry out a virtual project in a networking environment, it is important to note that each tool has specific functions. So teachers should assess which ones are the most appropriate for each objective.

According to these elements, and within the context of the Digital Training Area at the UOC, we created a guide for using the wiki as a tool for carrying a virtual project in groups. It will also be important to analyze how teacher guidance and monitoring affect the time management factor.

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Footnotes

1. Among others, see: Elgort, 2007; Elgort, Smith, & Toland, 2008; Montenegro & Pujol, 2009; Parker & Chao, 2007; Ramanau & Geng, 2009; Trentin, 2009; Vratulis & Dobson, 2008; Zhang & DeLoose, 2008.
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ANYTIME-ANYWHERE: PERSONALISED TIME

Philip Moore

School of Computing
Birmingham City
University, UK
ptmbcu@gmail.com

Anytime-Anywhere: Personalised Time Management in Networking for e-Learning

ABSTRACT

Personalisation in the provision of higher education (HE) has gained traction driven by socio-economic, demographic, and employment changes in the student population. Concomitant with these changes is the evolving capability and ubiquity of mobile technologies. These developments have resulted in interest in e-learning to accommodate the diverse student population and leverage the power of mobile technologies. To address the changing educational demands 'anytime-anywhere' personalised e-learning utilising mobile technologies is becoming ubiquitous in the domain of HE, and increasingly e-learning is embracing Web 2.0 technologies to provide networking functionality at both a pedagogic and personal level. Personalisation requires the creation of an individual's profile (termed a context), a context defining and describing a user's current state. This article considers personalised e-learning in a university domain with consideration of networking (in a collaborative and social networking sense). Following consideration of the factors driving the interest in and take-up of e-Learning (in a mobile context) Web 2.0 technologies will be considered. The nature of context and related research is considered followed by a brief overview of the proposed approach which is designed to enable effective personalisation with constraint satisfaction and predictable decision support. The article closes with final observations and conclusions.

KEYWORDS

Personalisation, e-Learning, Web 2.0, Networking, Computer Supported Collaborative Learning, Intelligent Context.

1. BACKGROUND

The *'anytime-anywhere'* concept as it applies to higher education (HE) has grown out of the changing socio-economic, demographic, and employment conditions as experienced by students and universities nationally and internationally. Concomitant with these change are: (1) the developing capability and ubiquity of mobile technologies and the related wireless infrastructures, and (2) the improving availability and speed (globally) of broadband communications (Kismihoc *et al*, 2010). These developments have resulted in growing interest in the delivery of HE education using personalised e-learning anytime and anywhere.

The developing Web 2.0 technologies have arguably reached a critical mass – *facebook* have reported in excess of 750 million active users (facebook, 2011) with corporate, academic, and personal 'facebook' pages becoming increasingly popular as a means of personal, institutional, and corporate *networking*. As such Web 2.0 applications are being increasingly used by both universities and students and have reinforced the demand for, and the availability of, anytime-anywhere access to pedagogic resources and computer supported collaborative learning (CSCL) (Lin Hsiao, 2005) leading to personal and institutional networking.

The evolving socio-economic, demographic, and employment conditions, when taken with the technological developments and the popularity of Web 2.0 applications, has resulted in an increasingly diverse and distributed student population who are computer literate and accustomed to using social networking applications. This arguably represents a new HE paradigm; in this paradigm networking forms an important component and the design of the next generation of pedagogic systems should reflect these realities. To effectively provide HE in this evolving educational landscape the targeting of resources and collaborative activities – termed *personalised service provision* (PSP) – is an important requirement. Effective PSP demands that resources are matched to potential recipients (Moore *et al*, 2010a, 2010c). A resource can be either a physical resource (such as documents, multimedia files, links etc) or an interactive online collaboration (*networking*) (Moore *et al*, 2010b, 2010c). The matching of resources to individuals is termed *context-matching* (Moore *et al*, 2010b, 2010c). Context-matching requires the creation of a profile for the resource and potential recipients – termed a *context* (Moore *et al*, 2010b) (an *input* and *output* context respectively). A context is highly dynamic and must reflect, in the case of a resource (the *input*) the features that identify it (Moore, 2009); while for a user (the *output*) a context must reflect the user's current *state* (Moore *et al*, 2010b, 2010c). A state includes parameters that identify the users location at a given time (spatio-temporal data) along with h/her current study aims and objectives, needs, desires, beliefs, and interests (*contextual information*) (Moore *et al*, 2010b, 2010c).

Historically within university domain(s) e-learning has been achieved (generally) using *virtual learning environments* (VLE) such as Moodle (Moodle, 2009) implemented using both Internet and internet solutions (Moore *et al*, 2010b). The online presence has demonstrated positive (albeit often limited) benefits for students by providing learning *'on demand… anytime and anywhere'* as discussed in (Goh & Kinshuk, 2004; Rushby, 1998; MacKnight, 1998). HE delivered using computerised pedagogic systems have traditionally used internet and Internet based approaches to implement a VLE (termed *'e-learning'*). Over time developments in mobile technologies have resulted in a blurring of the distinction between the 'e-learning' and mobile learning ('m-learning') concepts, the terms frequently being used interchangeably (Coppola & Della, 2004; Kossen, 2005). In this article the term *e-learning* will be used to refer to both e-learning and m-learning. Research undertaken from an e-learning perspective has demonstrated the potential efficacy of the anytime-anywhere approach to empower learning; it has however failed to effectively address the demand for personalised educational provision. The concept of anytime-anywhere personalised e-learning utilising mobile technologies with intelligent context processing (Moore *et al*, 2010c) is proposed as an effective approach to enable personalised HE.

The hardware in the form of sensor and mobile technologies with the related wireless infrastructures and GPS etc are well developed; the issues lie in the development of intelligent context-aware systems capable of processing the available contextual information to enable PSP. The aim of the research is to provide a basis upon which effective usage of the available contextual information can be realised to suit the diverse student population in a range of pedagogic systems designed to address the changing HE landscape. In essence, the aim of personalisation using the proposed approach is to provide a basis upon which resources can be distribute and CSCL with personalised networking can be achieved based on a user's context.

2. THE HIGHER EDUCATIONAL LANDSCAPE

HE is characterised by dynamic change driven by: (1) socio-economic factors, (2) demographic factors, and (3) employment and employability demands. These changes are reflected in the changing student population along with their diverse aims and objectives of study. To illustrate this consider the following typical illustrative examples.

The traditional *'talk-and-chalk'* approach is characterised by a stable student cohort where personal student/student and student/tutor communication was generally face to face (generally) in a single location during (again generally) timetabled study periods. The socio-economic, demographic, and employment changes have resulted in a very different and diverse student population far removed from the original concept of a student cohort. This new student paradigm is characterised by a broad range of study patterns which typically fall into a number of types including: (1) the traditional degree, (2) distance learning, (3) lifelong learning (these studies are generally optional), and (4) where professional qualifications must be maintained there is a need for *'Continuing Professional Development* (CPD) (which is not generally optional as it is frequently a condition for retention of a professional qualification).

Consider a specific example: the UK based Open University (OU) (The Open University, 2011) which delivers distance learning nationally and globally. The OU approach uses both on-line delivery of HE with (albeit reducing) traditional paper course materials (access to computing facilities is however a requirement) to deliver a range of courses, modules, and degrees which include foundation courses, bachelor degrees, masters degrees, doctorates, and special interest modules. The OU employs an e-learning strategy with an (albeit limited) collaboration/networking facility using an online forum. This approach enables student/student and student/tutor contact and interactions and provides an effective basis for flexible study anytime-anywhere with learning opportunities available at a time and place to suit the student's time availability irrespective of location and time-zone where international students are concerned. Student/tutor contact is generally achieved using networked online contacts with *tutor marked assignments* (TMA) being submitted online and results delivered online and in hard copy format. This is an example of e-learning with a networking capability.

Time management is an important factor for many students where study times and locations are restricted to, in many cases, unsocial hours that do not comply with the traditional timetabled approach to HE provision. Consider a student in full time employment with family responsibilities taking a course designed to provide CPD; in such a case time management is an important constraint for pedagogic systems design. Similar constraints may apply in cases where students are studying on a part time of block release basis.

The scenarios and examples cited above identify the need to personalise educational provision and provide anytime-anywhere e-learning. Networking forms an important component within an e-learning environment to provide a basis for collaboration on educational matters and provide for social networking at times to suit the selected study times. Networked e-learning incorporating PSP can benefit the teaching and learning process, mitigate an often felt sense of isolation, and help to build a community of students.

In considering e-Learning and the related study materials there are three approaches identified in Stead & Colley (2008):

1. **Shallow or supplementary learning:** Typically, these may be SMS prompts, school generated podcasts, and mobile games. They are good as a supplement to other activities.
2. **Focused learning:** Typically, these resemble a mobile friendly version of classic 'e-Learning', with targeted nuggets of learning that can be engaged with while on-the-move possibly context-aware.
3. **Deep learning:** Deep learners are immersed in a mix of mobile technologies, as creators or originators as well as the more common consumers of mobile media, following a *constructivist* model.

While the categories defined by Stead & Colley (2008) are relevant in terms of approaches to learning in practice all three approaches currently utilise a broad range of content including tutor prepared content, a mix of Web 2.0 technologies – also referred to as *'disruptive technologies'* in Cochrane, (2010), and interactive online networked collaboration (in the form of queries relating to studies) using Internet and internet technologies. In practice, HE provision uses elements drawn from all three approaches (Stead & Colley, 2008). Accommodating these diverse content types calls for high levels of PSP to achieve the anytime-anywhere goal whilst enabling compliance with constraints, preferences, and academic/system policies. Realising this level of personalisation demands the profiling of each individual (students and tutors) – termed a *context*, the matching of an individual's context (an *output* context) with an *input* context (a resource), and reaching a Boolean decision as to the suitability of a student to receive the resource. The following sections address the approach proposed to enable effective personalisation.

To advance the aims for *networked* pedagogies the advent of cloud computing may offer significant benefits. Initially the outsourcing of email provision to, for example, *hotmail*, *gmail*, and *yahoo mail* are examples of embryonic cloud-based systems. An example of such an approach is the outsourcing of the student email system at Birmingham City University using the Microsoft Outlook Web App (MS Exchange, 2011). An added benefit of this new system (for all students) is the provision for life of a *@mail.bcu.ac.uk* email address which will aid the *networking* potential for present and post graduate students. The system provides the usual calendar functions which can be useful for time management. The 'moodle' VLE has been retained and provides limited e-learning capability with limited networking and mobile functionality.

The cloud computing paradigm offers significant additional *networking* potential where the availability of course materials is concerned; the ability to share files in, for example, *Google docs* and Microsoft *SkyDrive* systems reduces the computational overhead required to distribute physical files (useful in a mobile context where data download limits and related costs may be an issue). Consider the potential saving that can be made by using shared files to distribute resources with only notifications of new resources (file updates) being sent to students who are part of a *network* attached to a specific course.

The potential for *networking* is possibly at its maximum where research is concerned. There are many research projects which are conducted between research groups both nationally and internationally. The Web 2.0 – along with the extension termed Web 3.0 and mashups (Anjomshoaa *et al*, 2009) – provides immense scope for interactive *networking* with the ability to exchange a wide range of resources. This can only improve the collaboration between research groups.

3. WEB 2.0 TECHNOLOGIES

A growing trend in HE is the inclusion of the Web 2.0 technologies; this is exemplified by the number of universities which have corporate *facebook* page and the number of individuals (both students and tutors) who are subscribed social networking sites such as *linkedin* and have a personal facebook page linked to their academia.edu personal web page. Within e-learning systems the availability of Web 2.0 applications presents opportunities for *networking on demand* and *anytime-anywhere* as discussed earlier in this article. The limitations of course lie in the need for access to a computer, mobile communications, and good broadband infrastructure. The growing ubiquity of mobile communications and broadband (mobile and fixed) means that for e-learning the limitations are not (generally) an issue however for HE provision using personalised networked e-learning consideration of these limitations must form part of pedagogic design to avoid disenfranchising students who do not have the full range of mobile services or adequate broadband often not by choice but caused by limitations in the service infrastructures.

The Web 2.0 applications, along with email, enable *networking* which when effectively implemented has the ability to: (1) provide a basis for and communication between students and between student and tutors, (2) improve the teaching/learning experience, (3) provide a platform upon which a sense of community can be created, (3) mitigate the isolation often experience by students studying on a distance learning basis (such as when taking an OU course of study with often at most one weeks residential study) , (4) accommodate the three learning styles identified in Stead & Colley (2008) enabling students to learn at their own pace, and (5) provide for improved time management to enable learning and networking at a time and place to suit the students availability to study.

The limitations for networked e-learning lie in the process facebook (facebook, 2011) use to 'recommend' friends. In the absence of genuine personal contact of friendship the recommendation process is by association with little correlation between shared beliefs, desires, and interests. For personalised networked e-learning recommendation requires identification of potential 'friends' based on context implemented using the context-matching process (Moore *et al*, 2010b, 2010c).

The *networking* potential to be derived from the use of Web 2.0 applications does however have possible negative aspects which have a correlation with a VLE. As discussed in Weller (2002) teaching staff need to feel comfortable with the increased demands of a VLE [which are manifested in the need to monitor modules delivered in the context of a VLE and provide increased levels if interaction and feedback] for its use to be successful; this is not always the case which can be detrimental to overall process (Moore *et al*, 2010b). Clearly, given that collaboration and networking are arguably central to the use of Web 2.0 applications similar issues to those identified in respect a VLE may be experienced with negative connotations.

4. PERSONALISED E-LEARNING

Concomitant with the interest in PSP is the evolving capabilities of mobile devices (Moore *et al*, 2010b). Mobile devices fall into two broad classifications: (1) laptop and mobile computers (which whilst mobile are not generally useable 'on-the-move'), and (2) *wearable* computing devices (which typically include mobile phones, smart phones, and tablets (such as an iPad) with their burgeoning range and capability which can be used in a wider range of environments – albeit characterised by a diverse range of constraints – whilst 'on-the-move') (Moore *et al*, 2010b). There has been significant convergence in mobile devices and their capabilities resulting in a blurring of the distinction between the two classifications (Moore *et al*, 2010b) introducing increased complexity in the demands of mobile systems and applications.

There has been significant research targeting mobile learning; for example, Goh & Kinshuk (2004) observe that: *"from e-learning to m-learning, mobile learning is going to be the next wave in the evolution of learning environments"* and conclude that while 'm-learning' can compliment e-learning by creating an additional channel of access for mobile users to engage in learning *"anytime and anywhere"* many issues regarding mobile learning have not been exhaustively researched. The developments in mobile computing will "free users from the desktop" (Abowd *et al*, 1997); for example, Goh & Kinshuk (2004) have considered issues in the implementation of e-learning and observe: *"from e-learning to m-learning, mobile learning is going to be the next wave in the evolution of learning environments"* providing access for mobile users to engage in learning *"anytime and anywhere"*. To effectively implement personalised e-learning and leverage the power of mobile technologies context performs a pivotal role (Moore *et al*, 2010b), there being a natural alliance between learning as a contextual activity and personal mobile technologies: mobile learning being strongly mediated by its context. Personalised e-learning involves the targeting of resources and the matching of users in CSCL (Moore *et al*, 2010b, 2010c), this has a corollary in the provision of personalised services in related research which addresses issues related to the identification of entities based on their needs and preferences (Moore, 2009).

While the evolving capability and scope of Web 2.0 applications has provided an effective basis for networking between students and tutorial staff, to effectively implement social networking functions into HE education *personalisation* is an important component. The use of social networking within HE requires that the traditional *person-to-computer interaction* (PCI) is extended to involve *person-to-person interaction* (PPI). As discussed in Gentile *et al* (2011) PPI is achieved using a *human-to-input technology-to-virtual representation-to-output technology-to-human* path. In the approach proposed in this article this process involves initially selecting suitable individuals (suitably qualified individuals for collaboration) with contacting identified individuals being the second stage in the *networking* process; the overall process being: (1) identifying individuals, and (2) contacting them to collaborate in a *networking* capacity. To visualise this process consider a scenario where a student requires help with a query related to a topic being studied. Initially, suitably qualified individuals (advisors) are identified; this requires the matching of the parameters that describe the students query (the *input*) with the related parameters that relate to the potential advisor (the *output*). This requires that a profile is created for the *output* and for each individual in the context-matching process. Such profiles are termed a *context* (Moore *et al*, 2005, 2010a, 2010b, 2010c). The following section considers the nature of context and consider the types of data that can be considered as *contextual information* (Moore, 2009) useful in the matching of *inputs* to *outputs* in resource distribution and networked interactive on-line collaborations.

5. CONTEXT-AWARE SYSTEMS

The first use of context in computer systems runs concurrently with the development of pervasive computing as envisioned by Mark Weiser in his seminal papers (Weiser, 1991, 1993) and the emergence of mobile computing components in the early 1990's. These developments have led to the desire to support computer usage in a diverse range of environments and domains. Context forms an important element in pervasive computing; for example, in location-based services (such as context-aware tour guides) context is a pivotal function (Moore *et al*, 2010b). This analogy clearly extends to personalised education in e-learning systems.

The goal for pervasive computing is on simplifying through digital environments that are sensitive, adaptive, and responsive to human needs; such a goal clearly has a correlation with personalised e-learning as discussed in this article . While research challenges remain in all areas of pervasive computing; all the basic component technologies exist today. In hardware, we have mobile devices, sensors, and even smart appliances. Supporting software technologies include digital signal processing and object-oriented programming. Advances in networking provide support for mobility management, and ad hoc routing with global reach (Saha & Mukherjee (2003). It is clear that effective implementation of personalized e-learning realized using context to achieve PSP lies not in the hardware (computing devices and mobile phones etc) but in software application(s) designed to realize intelligent context processing as discussed in Moore *et al* (2010c).

Central to pervasive systems is context-awareness. Context-awareness describes a concept in which the profile of an entity is defined by its 'context', an entity being defined in Dey & Abowd (1999) as: *"Any information that can be used to characterise an entity"* and *"a person, place or a physical or computational object"*. Context-awareness employs context to identify individuals to enable targeted service provision based on location, time, preferences and current needs with minimal user effort (Moore, 2009). Context is also pivotal in the matching of users in CSCL in interactive systems (Moore *et al*, 2010b).

Context is domain and application specific requiring the identification of domain specific function(s) and properties (Moore *et al*, 2010a). This is exemplified in 'e-learning' where the starting point in the definition of a context is the *"identification of the function and purpose in which we are interested"* (Lonsdale *et al*, 2003). A definition of the term *context* for a personalised e-learning system designed to enable resource distribution and CSCL is: *"Information consisting of properties that combine to describe and characterise an entity and its situated role in computer readable form"* (Moore *et al*, 2010b). A context is however highly dynamic and must reflect a user's current state (Moore, 2009). Location is central to context in mobile systems, context however includes more than just location (Moore *et al*, 2010b). As identified in Schilit *et al* (1994) a broad and diverse range of context factors combine to form a context definition, in fact, almost any information available at the time of an interaction can be viewed as contextual information including:

- The variable tasks demanded by users
- The diverse range of mobile devices and the associated service infrastructure
- Resource availability (connectivity, battery condition, display, network, and bandwidth etc)
- Nearby resources (accessible devices and hosts including I/O devices
- The physical situation (temperature, air quality, light, and noise level etc)
- The social situation (who you are with, people nearby etc – proximate information)
- Spatial information (location, orientation, speed and acceleration etc)
- Temporal information (time of the day, date, and season of the year)
- Physiological measurements (blood pressure, heart rate, respiration and muscle activity etc)

In summary, if data relating to a users state can be measured, codified, and digitized it can be considered to be contextual information. The range of contextual information identified demonstrates the inherent complexity of context, its domain specific nature, and the difficulty in defining and measuring it. This difficulty is exemplified in the need to accommodate two general types of context: ***static*** context and ***dynamic*** context (Moore *et al*, 2007, 2010a):

- ***Static*** context (termed *customisation*) relates to a use-case in which a users profile (context) is created manually, the user being actively involved in the process and having an element of control.
- ***Dynamic*** context (termed *personalisation*) relates to a condition in which the user is seen as being passive, or at least somewhat less in control. In such a use-case the system monitors, analyses, and reacts dynamically to a user's behaviour and *'state'* or *'situated-role'*.

The two types of context are reflected in the two principal ways context is used, these are: (1) as a retrieval indicator (a *static* context) and (2) to tailor system behaviour to match users system usage patterns (a *dynamic* context).

6. CONTEXT RELATED RESEARCH

Context-aware solutions have been applied in many diverse domains where the provision of personalised services mapped to an entities context is a system requirement. A detailed discussion on the related research is beyond the scope of this article however a detailed review of the related research with conclusions and observations can be found in (Moore *et al*, 2010b). The review of related research considers a number of areas including research from the early 1990's to the present day. Topic areas addressed include: context, context-aware systems, motion sensing systems, health monitoring systems (ECG and EEG), tourist guides, office applications, pedagogic systems, 'the application of context-awareness', 'personalization and adaptation in mobile systems', and' ad-hoc networks'.

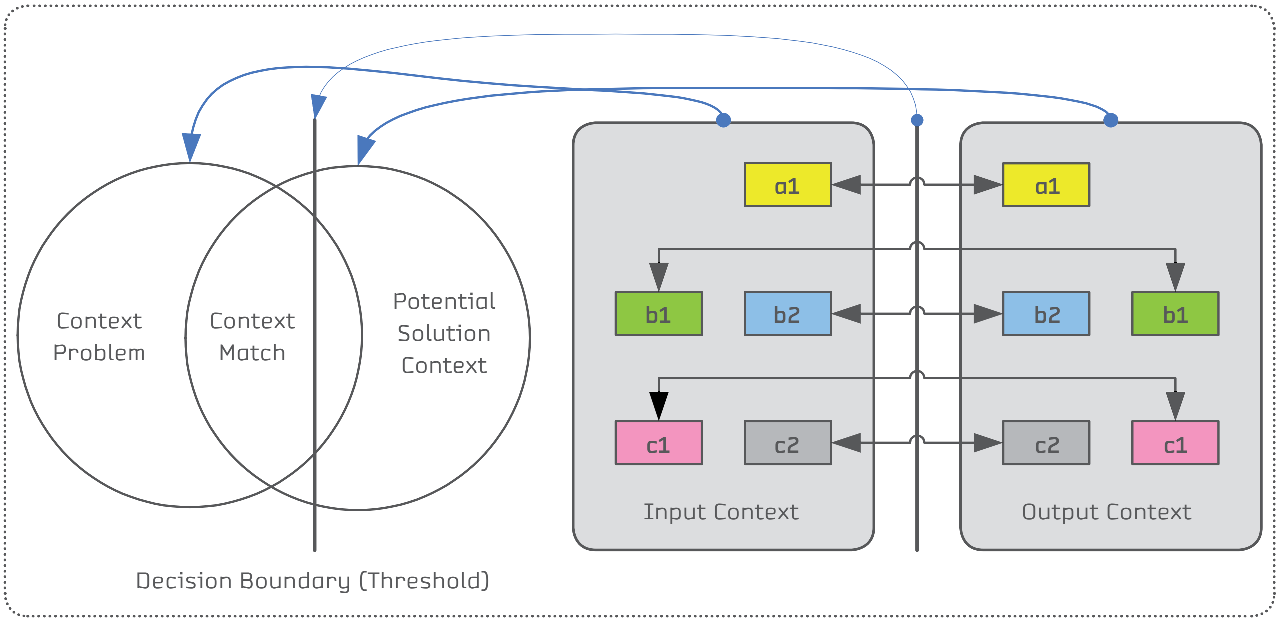
The research reviewed addressing *personalisation and adaptation in mobile systems* (Moore *et al*, 2010b) identifies the need to adapt the mode of delivery to suit the diverse range of mobile devices and their graphical interfaces. This is clearly a context related issue given the broad and diverse range of potential contextual information. An area not (generally) considered where context-awareness is discussed is *ad-hoc networks* (wireless networks where nodes – e.g., mobile phones – join and leave a network or change their state dynamically). Such networks are however context-aware having location, identity, and often proximate data to identify and locate the device, the user, and in a social context other individuals in close proximity. Proximate contextual information is potentially useful where networked collaboration can provide a basis for improved interaction between users of a context-aware pedagogic system. In considering personalised e-learning and the related networking capability accommodating and managing the demands of adaptation and the increasing use of wireless ad-hoc networks is becoming increasingly important where *anytime-anywhere* personalised networked e-learning is implemented in HE provision (Moore *et al*, 2010b).

An important conclusion drawn from the review of the related research addressing context-aware systems (Moore *et al*, 2010b) is the predominance of spatio-temporal and identity contextual information in mobile systems, this is (arguably) the result of the inherent complexity of context (as demonstrated in the broad range of potential context properties identified) and the difficulty in defining dynamically a users context (or state). Addressing these limitations demands the use PSP; the approach introduced in this article [as discussed in (Moore *et al*, 2010c)] in applying intelligent context processing has been shown to provide an effective basis upon which computational intelligence can be implemented and the inherent complexity of context leveraged.

7. INTELLIGENT CONTEXT PROCESSING

As identified in the preceding section context historically has (generally) focused on location and identity contextual information; while the available range of contextual information is being increasingly investigated (generally in

Figure 1. Personalization and the context-matching problem; shown is the partial matching problem with a decision boundary (threshold) used in the CPR and FECA rules algorithm [2][5]. Note: the proposed approach enables multiple thresholds in, for example, context-aware health monitoring systems [6] where multiple decisions (progneses) must be accommodated.



research projects as opposed to commercial applications) the generality of usage remains location and identity based. The *context-matching* approach attempts to provide a basis upon which the available range of contextual information can be accessed and processed in an intelligent context-aware decision support system that enables constraint satisfaction and preference compliance with decision support.

The proposed approach is predicated on the processing of contextual information using the *context-matching* (CM) process (Moore *et al*, 2007, 2010a, 2010b, 2010c); the *Context Matching* function is designed to create the *input* context and access the *output* context(s) definitions and using the context-matching algorithm to determine if the *output* context (properties) are an acceptable match with the *input* context (properties). Figure 1 graphically models the *context matching* problem, the partial matching issue, and the relationship between the *input* and *output* context properties the FECA rules algorithm is designed to address. Essentially, the context-matching process is one of reaching a Boolean decision as to the suitability of a specific individual based on his or her state (Moore *et al*, 2010b, 2010c IGI, CITEL). Given that a perfect match is highly unlikely the context-matching algorithm must accommodate the partial matching issue along with a number of related issues as discussed in (Moore *et al*, 2010c).

8. CONCLUSION

This article has considered personalised e-learning in a university domain with consideration of networking (in a computer supported collaborative learning and social networking sense). The factors driving the interest in and take-up of e-Learning in a mobile context have been considered along with the developing Web 2.0 technologies and their impact on the design of pedagogic systems for HE. Personalised e-learning has been considered. Context and related research has been introduced and a brief overview and introduction to the FECA rules approach has been provided.

The higher educational landscape is characterised by ongoing change which reflects the changing socio-economic, demographic, and employment conditions that impact individuals and the wider society. These changes reflect the new student paradigm where computer literacy and awareness of Web 2.0 services form a central role. Web 2.0 technologies have extended the networking capabilities of VLE's and pedagogic systems must reflect these realities and harness them along with the power of mobile technologies to provide fully networked personalised e-learning delivered *anytime-anywhere*. While the evolving capability and scope of Web 2.0 applications has provided an effective basis for networking between students and tutorial staff; to effectively implement social networking into HE pedagogic systems *personalisation* is important. The use of social networking within pedagogic systems requires that the traditional *person-to-computer interaction* (PCI) is extended to involve *person-to-person interaction* (PPI). This process involves initially selecting suitable individuals (suitably qualified individuals for CSCL) with contact being the second stage in the networking process; the overall process being: (1) identifying individuals, and (2) contacting them to collaborate in a networking capacity.

The implementation of personalised e-learning relate less to the hardware and mobile technologies with their related infrastructures than the operational software; the approach proposed in this article is designed to address the software issues and provide an effective basis upon which the intelligent processing of contextual information and enable personalised networked e-learning to the mutual benefit of students and universities.

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Mora, N. and Caballé, S. (2011). Collaborative Complex Learning Objects in Support for Social and Collaborative Just-in-Time Networking.*eLC Research Paper Series, 3, 60-70.*

COLLABORATIVE COMPLEX LEARNING OBJECTS IN SUPPORT

Néstor Mora and Santi Caballé

eLearn Center
Open University of Catalonia

Collaborative Complex Learning Objects in Support for Social and Collaborative Just-in-Time Networking

ABSTRACT

Two types of networks are considered with special interest for e-learning environments: social and collaborative networks. There is no consensus about the frontiers dividing the two types, though a set of common interrelated characteristics is found during any learning experience, such as social identity, interaction and empowerment. These and other characteristics may greatly influence the e-learning process when combined and addressed appropriately as well as overcome important limitations of current e-learning systems. For instance, isolation is a critical problem found in many virtual environments and it is directly associated with the lack of the learners' social identity and a low level of collaborative interaction with the environment. Isolation can thus be minimized by an innovative use of both types of networking in just-in-time fashion. These and other factors are considered and addressed in this paper to create adequate systems and tools to enable intelligent networking for e-learning. To this end, the requirements of virtual learning environments are analysed in order to meet social and collaborative needs. As a result, a newly-created tool called Virtualized Collaborative Session is described that includes and executes a new type of Learning Object called Collaborative Complex Learning Objects that allow learners to benefit from live sessions of networking with others and in turn leverage the knowledge constructed collaboratively. Eventually, this approach becomes an attractive learning resource so that learners become more motivated and engaged in the learning process.

INTRODUCTION

The "network" concept is crucial today in many fields, including social sciences, communications, computer science, physics, biology and ecosystems (Dorogovtsev and Mendes, 2003). Networks form complex systems, emerging in many forms in different application domains, and consisting of many aspects whose proper understanding requires contributions from multiple disciplines. (Camarinha-Matos and Afsarmanesh, 2005). Network management and networking can thus be understood as intelligent because it must make an efficient and effective use of the available networks. Intelligent networking is a concept that has migrated from the management of physical networks (Caballé et al., 2011a).

Virtual networks are at the moment the latest and most promising dimension (Camarinha Matos et al, 2005; Barabasi et al., 2003). Indeed, virtual networks are present daily in many areas and ways of life. Every area of life has a special place where different networks can be used in a specific proportion and way in order to achieve the expected goals. Virtual networks are a part of life for many people who share messages, experience and multimedia materials in *social networks* such as Facebook or Twitter. Moreover, *collaborative networks* have been adopted by a great variety of entities and organizations (Camarinha-Matos and Afsarmanesh, 2005). Social networks are thus characterized by a one-to-one connection versus virtual collective gathering in one space to work on a single project or problem, as is the case with collaborative networks (Fulkerson, 2009). Fulkerson proposes the following aspects that characterize and distinguish both types of networking:

- **Social Networks:** One-to-one, Social interaction-centred, Achieving personal objectives, Individual enrichment, Immeasurable results.
- **Collaborative Networks:** Group-to-group, Objective and content-centred, Achieving group objectives, Operational excellence, Measurable results.

From this view, on the one hand, social networking is seen as producing intangible results, such as socialization, sharing ideas and knowledge. On the other hand, collaborative networking seeks tangible results such as reports, diagrams, developments, and so on. However, there is no clear frontier between the two types of networks. For instance, social networking tends to create a relationship between individuals, but a group of people interested in some topic may interact with another group by using collaborative networks. In addition, the results of social networking are not measurable if we expect a tangible goal, but the relationship can be measured by tools, such as social network analysis (SNA). Thus, sharing and distributing knowledge can be measured. Overall, these differences are found in general as nuances and both types of networks are eventually merged to form a general view of networking, especially for e-learning (Barabasi et al., 2003).

NETWORKING IN E-LEARNING

Looking in more detail at this introduction to the field of e-learning, it is possible to apply some features of both types of networking so as to consider a new kind of learning experience focussing on virtual environments. Indeed, intelligent networking understood to be the efficient and effective use of networks can provide the support and physical structure needed for e-learning. However, some relevant questions arise in this context: How can intelligent networking improve and make virtual learning more efficient? How to construct a special virtual environment where the collaborative and social networks work together to achieve the learning goals, minimizing the problems of virtuality? How is the time factor involved in the virtual learning processes?

In order to answer these questions, certain capabilities for networking in the context of learning have to be considered. As for collaborative networking, Rosas et al. (2010) classify capabilities by focussing on the organizational competence. They show two levels of competence, soft and hard, and define the organisation's soft competency as a general aptitude for performing abstract behaviour (e.g. the ability to exchange knowledge), which is beneficial for the achievement of the outcomes and goals associated with the performance of hard competency. The organisation's hard competency is defined as the capability to run activities, tasks or processes, that enable specific outcomes or goals to be achieved.

In social networking for learning, it is not easy to classify capabilities (competences). Many authors like Boyanzis et al. (1999) cite the following as crucial competences: listening, empathy, responding, problem solving, achieving goals through relations, leadership, helping and conflict management, these being seen as the main competences needed to develop good social networking. These competences are directly related to social identity (sense of belonging to a social group). Promoting this social sense of belonging to a group can become an important motivational factor.

Finally, effective networking requires competences in time by knowing how and when to select the appropriate learning goals and how to achieve them by means of planning the learning path. This competence is directly related to the time factor in e-learning and through the students' self-assessment. Guash et al. (2010) describe this dimension by showing the results of a collaborative learning experience, which makes it clear there is a need to provide immediate just-in-time feedback to students during the on-line collaboration. Also, they point out that students must be able to improve their argumentative schema, re-work the information, and produce new ideas. The time factor is found implicitly in all kinds of re-planning or re-working the networking.

At this point, we can define intelligent networking for e-learning as an innovative and efficient way of learning together in three main areas:

- Goal definition and planning, where collaborative networking contributes and is necessary.
- Human relations and affective support, supplied by the social side of networking. (e.g., minimizing the isolation factor is crucial to getting good results).
- The time factor involved that relates the two areas just mentioned.

There is also general agreement on the limitations and deficiencies of the current technological support for networking, especially when addressing e-learning. Many researchers (Dillenbourg, 1999; Goodsell, 1992; Stahl, 2006) argue that students must be meaningfully engaged in the learning tools for effective learning to occur. This lack of engagement is especially evident in collaborative networking tools and can be attributed to the lack of (i) real interactivity (in many cases the only interaction available is to click on the "next" button to obtain the next message in a discussion forum); (ii) challenging tools, which fail to stimulate learners, making the collaborative networking experience unattractive and discouraging progress; (iii) empowerment, as learners expect to be in control of their own collaborative learning experiences. Moreover, social networking tools for e-learning do not consider the social identity of the learners, who thus become mostly isolated from their peers.

To overcome these aforementioned limitations of current networking tools and systems, we focus on defining a new type of Learning Object (LO) called Collaborative Complex Learning Object (CC-LO) embedded into a Virtualized Collaborative Session (VCS). A VCS is a registered collaboration session augmented by alternative flows, additional content, etc., during an authoring phase (subsequent to the registration phase). The VCS can be interactive and animated (by movies or comic strips) and learners can observe how knowledge is constructed, refined and consolidated. CC-LOs also include assessment, collaboration and communication features to enrich the learning experience provided by the VCS. The VCS containing the CC-LOs is eventually packed and stored as learning objects for further reuse so that individual learners can reap the benefits from live sessions of collaborative learning enriched with high levels of interaction, challenge and empowerment.

The following sections further explore and validate the notion and nature of the CC-LO concept embedded into a VCS system that supports networking in e-learning.

RESEARCH METHODOLOGY

In this section, a methodological approach is shown that addresses how CC-LO are created, managed, and executed in order to support networking from both collaborative and social points of view and the interrelations between the two. The time factor is incorporated by providing just-in-time conversion of live collaborative sessions into an animated CC-LO so that learners can observe and receive immediate feedback about how people collaborate and socialize and how networking occurs.

METHODOLOGIES TO CREATE, MANAGE AND EXECUTE CC-LO

Technologists have made many attempts to provide better tools for content creation, management, and execution of LOs for educators, but the transition from the role of content creator to moderator generates inherent resistance in the educator (Mosley, 2005). The LOs are usually customized and adapted to learners' needs whereas the educators' adaptation needs are not considered.

Commonly, methods for creating LOs include mining existing information to construct learning objects autonomously and participatory techniques (Singh et al., 2004), which build upon the use of the creation process itself as a means for learning, instilling learners with increased engagement as a result of deeper engagement within the educational process (Abad, 2008). However, learners are not often the best LO creators and the resulting LOs require careful validation to ensure quality.

Recently, the management of learning objects has benefited from semantic technology, which supports both bottom-up processes such as support registration, management and sharing methods. Also, it creates high-level features such as courseware and e-learning tools autonomously, with remarkable benefits in terms of ubiquity and interoperability, in line with tutors' needs.

The execution of learning objects has previously been achieved through methods such as the SCORM Run-Time Environment (Costagliola et al., 2006), allowing for user customization, adaptability, good dynamics and progress of learning objects over time across a range of formats. Overall, creating learning objects in an executable form represents a change in the context and autonomy in which they can be deployed, and reflects the transition of LOs from pedagogical material to semantic data constructions.

Considering all these approaches, widespread usage of CC-LOs implies conforming to core SCORM standards and representation formats, with CC features added as independent extensions. Incorporation into more sophisticated systems would require the CC-LO to be enabled with the information required to generate the high-level tools required for collaboration, and support for complexity. As an initial approach, existing methodologies for CC-LO can be grouped under three headings:

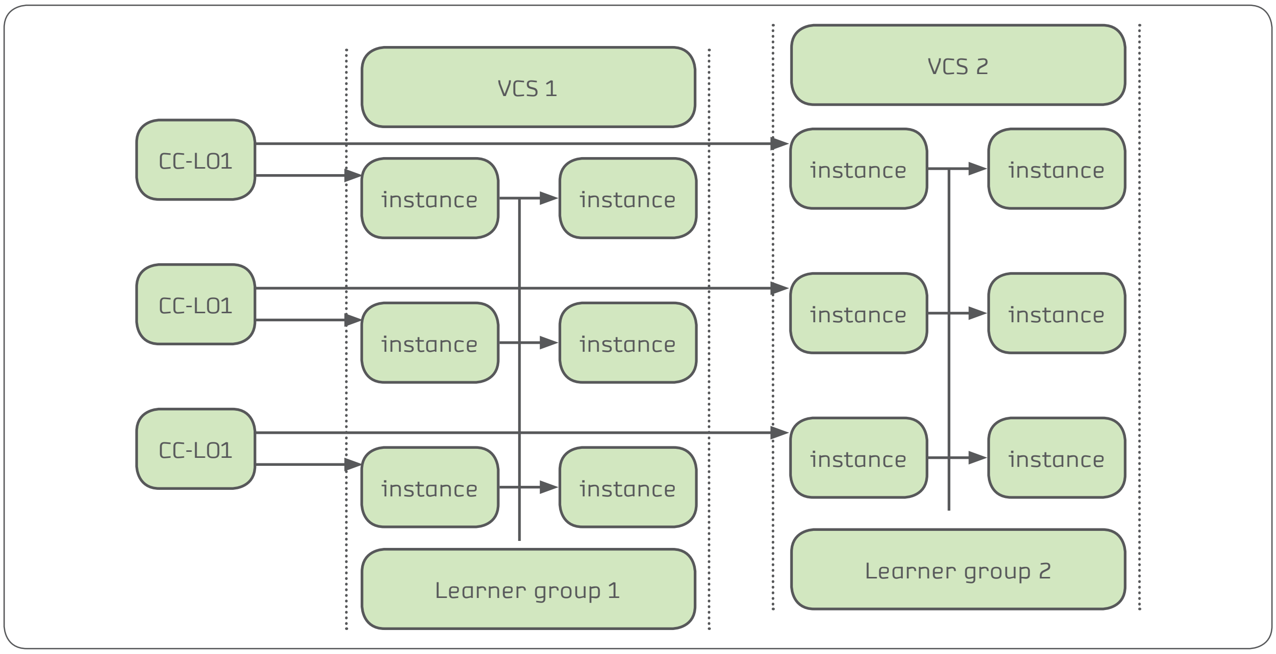
- **Educator-centred:** the educator assumes the role of author, moderator, and deployer of the CC-LO.
- **Technology-centred:** creation, management, and execution are handled by technology.
- **Learner-centred:** these methods advocate techniques such as participatory design to allow learners to be involved in the creation and management of CC-LOs.

DEFINITION AND PURPOSE OF VIRTUALIZED COLLABORATIVE SESSIONS

Perhaps a VCS can best be defined by analogy with a computer program, where CC-LOs exist as objects within the code, and the VCS is the overall execution of the program. As it runs, CC-LOs are created, evolve over time, and are subsequently disposed of. On ending, the VCS becomes ready to 'run' with new instances of CC-LOs, repeating the learning cycle for a new group of learners. This is illustrated in Fig. 1.

An early approach to a VCS system is depicted in Fig. 2 (see also Caballé et al 2011b for further details). The VCS is intended to be compatible with collaborative sessions in general, such as chats and forums, in order to create CC-LOs as general as possible. For this purpose, the input from the VCS system is a file with collaborative session data in a common format called Collaborative Session Markup Language (CSML) based on XML (see Conesa et al., 2011 for further details). For each source of collaborative session

Fig. 1 .Execution of CC-LO instances within VCS programs.



the data is converted into CSML by a specific plug-in and then processed to create a Virtual Collaborative Session Complex Learning Object (VCSCLO), containing information about scenes, characters, and other features used during the visualization of this CC-LO (VCS Viewer). A VCSCLO can also be edited with a VCS Editor allowing for changing the order of scenes, adding assessment scenes, defining workflow, etc.

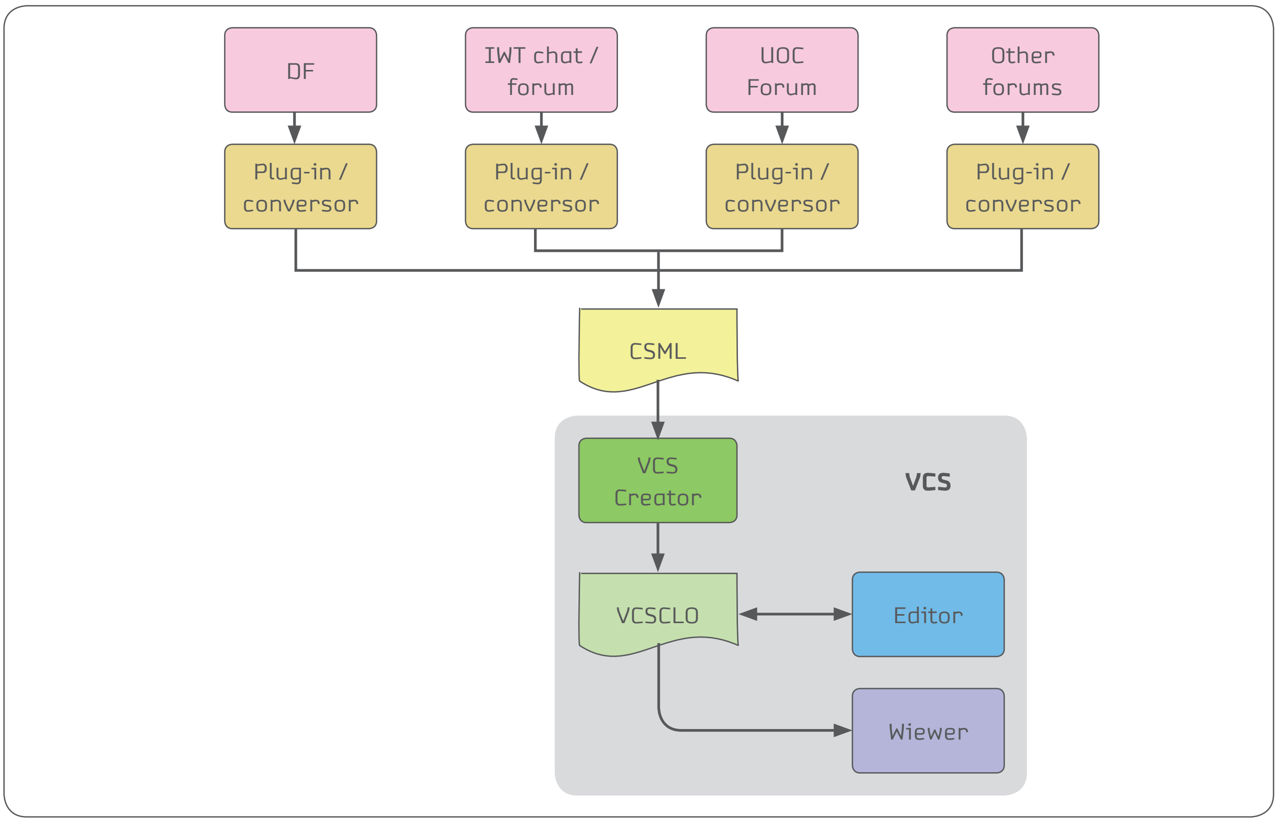
A VCS is a registered collaboration session augmented by alternative flows, additional content, etc. during an authoring phase. The VCS is animated and learners can observe how people collaborate and socialize, how discussion threads grow and how knowledge is constructed, refined and consolidated. Overall, a VCS produces an event in which CC-LOs are applied and consumed by learners, sessions evolve ("animate") over time, and the ultimate end-user interactions with CC-LOs are handled.

VCS SYSTEM IMPLEMENTATION

A VCS prototype with an embedded CC-LO was created to test the concept (Fig. 3). The VCS transforms a live discussion forum into an animated storyboard and shows how people discuss and how the collaborative session evolves ("animates") over time.

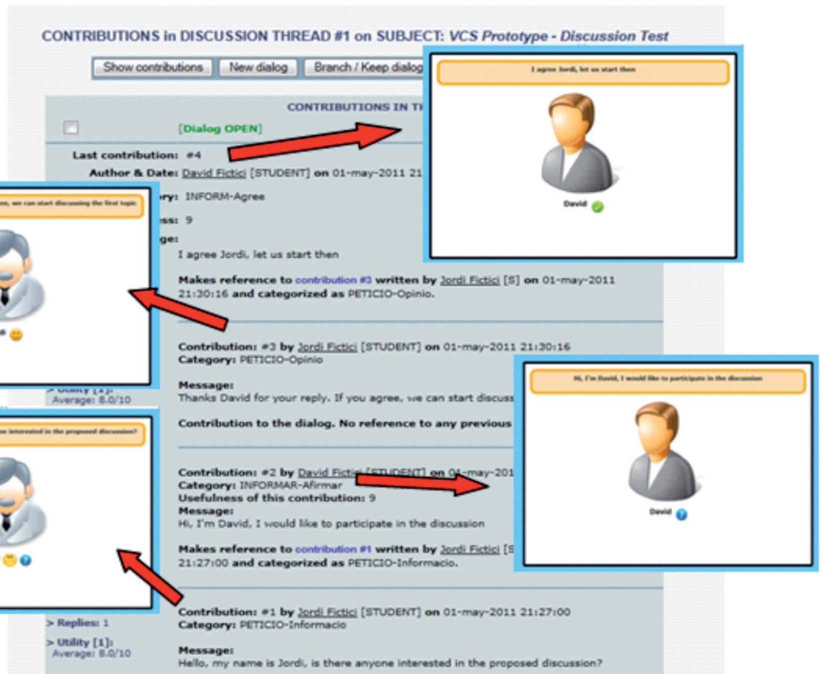
The resulting CC-LO is ready to be played back and seen by learners. The time factor is involved in the CC-LO by providing just-in-time networking opportunities even in situations and time periods when networking is difficult. Moreover, by adding self-assessment scenes it is possible to provide students with immediate feedback from their progress during the networking. To this end, the VCS containing the CC-LO is packed and stored for further reuse like any LO so that individual learners can at will benefit from

Fig. 2. Layout of the VCS system.



Mora, N. and Caballé, S. (2011). Collaborative Complex Learning Objects in Support for Social and Collaborative Just-in-Time Networking.*eLC Research Paper Series, 3, 60-70.*

Figure 3: Sequence of snapshots of a CC-LO evolving over time after the virtualization of a live collaborative session. Four contributions from the text-based discussion are converted by the VCS prototype into an animated storyboard (SLO) supported by a text-to-voice engine.



others' live networking sessions and in turn make the most of the knowledge constructed collaboratively. Eventually, the CC-LO becomes an attractive learning resource so that learners can become more motivated and engaged in the learning activities.

PROTOTYPING A CC-LO EMBEDDED INTO THE VCS SYSTEM

For validation purposes, the concept of our VCS prototype with an embedded CC-LO/SLO was tested (see Fig. 3). To this end, first the data source from a live collaborative learning session was considered from a web-based forum called Discussion Forum (DF) (Caballé, 2011c), used to support in-class networking-based activities in the real context of learning at the Open University of Catalonia. Then, following the process of modelling and representing forum data mentioned (see Section 2.2), a specific converter was made to turn the data model of the DF into CSML representation (see Fig. 2). From the CSML representation, the VCS prototype generated an animated SLO showing how people collaborated and socialized, how discussion threads grew and how knowledge was constructed, refined and consolidated.

An assessment of the prototype was carried out to evaluate the test of the concept at the Open University of Catalonia (UOC). On the UOC site, a group of three testers formed by an expert (i.e., researcher in e-learning), a skilled technician and a novice user carried out a battery of tests on the VCS prototype by using different data input and running the prototype several times. The aim was to check the prototype by focusing on the following four indicators of interest presented to the testers in this questionnaire:

1. Automatically building an effective draft storyboard (CC-LO/SLO) from a discussion

thread from a forum. Scored on a scale of 0-5 with open comments.

2. The VCS prototype allows non-expert users to build a CC-LO/SLO (i.e., in a user-friendly way and efficiently). Score on a 0-5 scale.
3. Create, edit, manage, store and play back the storyboard generated. Score on a scale of 0-5 with open comments.
4. The VCS prototype allows users to observe how knowledge is constructed. Score on a scale of 0-5 with open comments.

RESULTS AND DISCUSSION

This section presents a brief discussion about the data collected from the aforementioned technical test performed at the UOC on the VCS prototype.

QUANTITATIVE AND QUALITATIVE RESULTS

Table 1 shows on the one hand some basic statistics of the quantitative results on the 0-5 scale scored by all testers for each of the four indicators of interest considered in the last section. Each tester performed 5 executions in a row before providing the scores. On the other hand, Table 2 shows an extract of the qualitative results from the indicators with open comments provided by the testers after the test.

DISCUSSION OF THE RESULTS

From the quantitative results, we can see that although the total score is promising it is not high because the VCS prototype currently

Table 1: Mean (M) and Standard Deviation (SD) score on a scale of 0-5.

	Indicators of interest				
Testers	#1	#2	#3	#4	Total (M)
# Expert	4	4	2	2	3.0
# Technician	5	4	4	3	4.0
# Novice	5	4	4	2	3.8
Total M(SD)	4.6(0.6)	4.0(0)	3.3(1.1)	2.3(0.6)	3.6(0.5)

Table 2: Excerpt of the questionnaires' results.

Indicators of interest with open comments	*Excerpt of testers' comments (type of tester: E: Expert; T: Technician; N: Novice)*
Automatically build an effective draft storyboard from a discussion thread from a forum.	"I could watch the storyboard very easily; it was exciting!" (N) "The automatically-created SLO follows the same structure as the threaded discussion." (T) The draft SLO should be larger to be tested appropriately." (E)
Create, edit, manage, store and play back the storyboard generated.	"I could fully control the storyboard with the play, pause, stop, back and forward controls and play back the discussion many times." (N) "The player only gives a sequential view of the knowledge " (T)
VCS prototype allows users to observe how knowledge is constructed.	"Yes, it was possible to observe some knowledge building but it still lacks the editor tool to remove some scenes that create noise." (E) "It is very interesting to be involved in the collaboration this way!" (N)

provides the player tool only. In particular, indicators #3 and #4 were scored low by the expert tester since the prototype could still not meet all of its potential as regards editing the storyboard, which in turn limited the improvement of the storyboard-based discussion. In contrast, from the data collected from the normal user tester it is evident there is potential for the VCS player tool as it provides a great leap forward by providing an attractive resource that motivated and engaged the tester in the test discussions.

To sum up, the results of the tests reported here are not conclusive due to the exploratory nature. However, they showed the main processes and concepts of the new paradigm of CC-LO as well as guidelines for their use by educators on a wider scale.

CONCLUSIONS AND FURTHER WORK

On-line networking for learning is today one of the most promising opportunities for educational institutions, though this promise is not exempt from problems and challenges, such as the learners' feeling of isolation. Learners use networking as a means to reach the proposed objectives, on both collaborative and social levels.

Social and collaborative networking for e-learning can share the same tools and benefit from the synergies presented in a unique and coherent environment. Social networks can help to minimize the isolation factor implicitly found in virtual environments. Once the isolation is minimized, collaborative networking can take advantage of all its potential and be truly effective. However, a virtual learning environment must be designed carefully to make both networking levels possible.

In this paper, the concept of CC-LO has been defined from a multi-fold approach and as an extension of LO with the aim of supporting both collaborative and social networking for e-learning and thus playing an important role in current on-line learning. An example of a CC-LO, in the form of SLO, has been developed and a research methodology has been proposed to validate the notion and nature of the CC-LO. As a result, a VCS containing the CC-LO allows individual learners to benefit from others' live networking sessions and in turn make the most of the knowledge constructed collaboratively. Underlying all the aspects of CC-LO, the time factor forms an implicit aspect by allowing just-in-time networking to occur at will even in situations and time periods when networking is difficult. Eventually, the CC-LO becomes an attractive learning resource so that learners become more motivated and engaged in the learning activities.

Ongoing work includes the evaluation of the VCS prototype in the real context of learning at the Open University of Catalonia. Intensive experimentation and validation activities will be conducted in on-line courses in order to provide attractive and challenging CC-LOs to support networking-based learning activities during in-class discussions. Moreover, current work includes the development of an editor tool to augment the VCS system with author-generated information. For instance, e-assessment scenes will be added to the VCS, such as tests (with optional jumps to storyboard scenes) as well as supporting videos to be connected with scene parts according to the dialogue timeline. As a result, tutors will be provided with edition capabilities of the SLOs, such as cutting scenes, modifying characters involved, selecting emotional states, dialogues and connected concepts, among others.

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