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COLLABORATIVE COMPLEX LEARNING OBJECTS IN SUPPORT FOR SOCIAL AND COLLABORATIVE JUST-IN-TIME NETWORKING

Néstor Mora[1]
Santi Caballé[2]

Universitat Oberta de Catalunya (Spain)
[1] scaballe@uoc.edu
[2] nemonu@uoc.edu

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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.

KEYWORDS

Collaborative learning, Social networking, Collaborative complex learning objects, Virtualized collaborative sessions, On-line discussions

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:

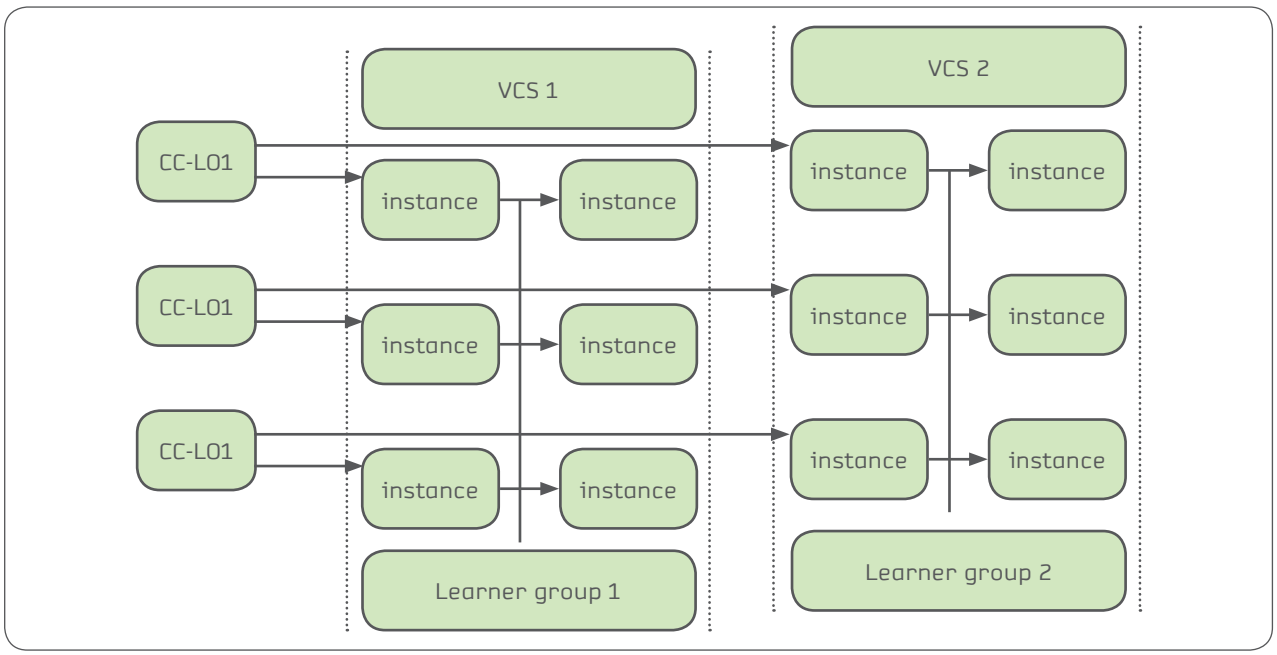
- **Educator-centred:** the educator assumes the role of author, moderator, and deployer of the CC-LO.
- **Technology-centred:** creation, management, and execution are handled by technology.
- **Learner-centred:** these methods advocate techniques such as participatory design to allow learners to be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

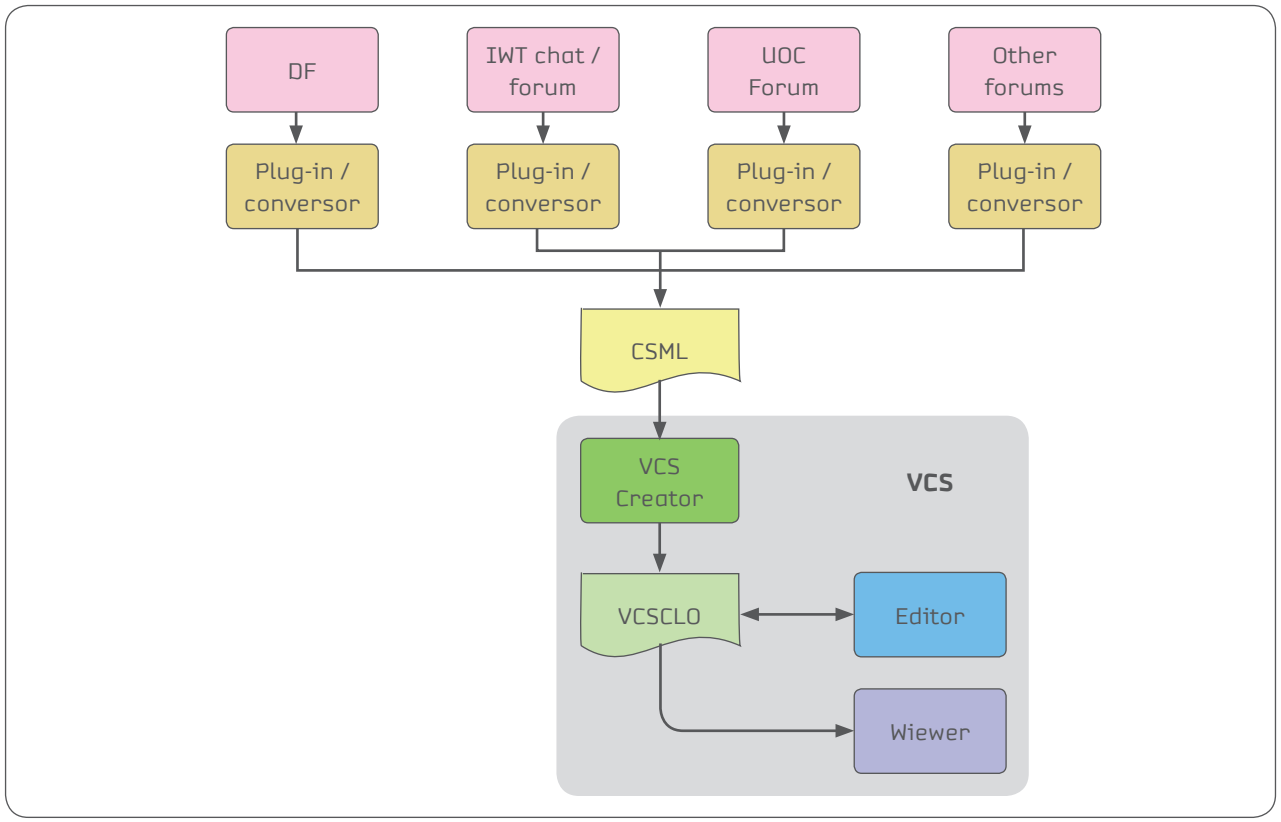
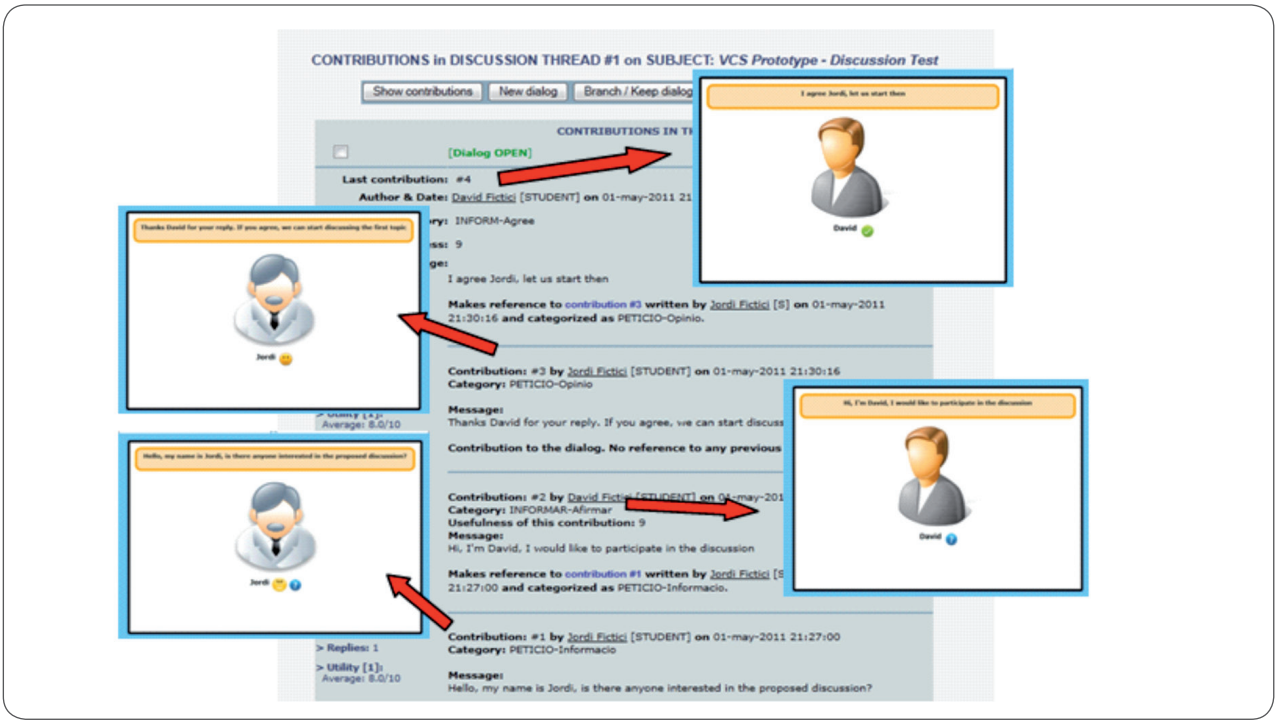


Figure 3: Sequence of snapshots of a CC-LO evolving over time after the virtualization of a live collaborative session. Four contributions from the text-based discussion are converted by the VCS prototype into an animated storyboard (SLO) supported by a text-to-voice engine.



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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