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Scenarios for active learning in smart territories

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Abstract. This work is intended to foster a "quantum leap" in the reflection on learning in smart cities/territories. We try to move from a vision according to which *education* is considered as an "infrastructure/service" needed to improve the quality of life (due to opportunities and social capital that it may produce) toward the recovering of its role of founding process, through which the relationships between persons and the inhabited territories - in which the stratification of our cultural DNA/heritage often has become illegible to the most - are continuously reshaped. According to the above position we present: a) a strategic and methodological approach that focus on *museal field* and on *narrative* as key elements of the future "learning from smart cities"; b) a model of an advanced integrated technological environment (mobile, web, internet of things) designed to support such an approach. The need for a different approach to the monitoring of complex learning experiences is also underlined.

Keywords: smart city, smart education, cultural heritage, museal field, experience monitoring

1 Introduction to smart cities and education

During the past years it has emerged and acquired an increasingly relevance the concept of *smart city* that characterizes itself, with respect to other definitions used in the past, by the focus on sustainable use of environmental resources aimed at preserving and improving the well being of society. Another element that strongly characterize smart cities is the relevance assumed by the environmental and intellectual/social capitals, which are considered as important as hard infrastructures (physical capital). In this context, Information and Communication Technologies (ICTs) are considered essential components of an indispensable infrastructural backbone able to influence all our behaviors and support the improvement of all key factors that contribute to the development of a sustainable economy: mobility, environment, people, quality of life and governance. It is no coincidence that the policy-makers' attention and, as well, European and national programs of applied

research are increasingly focused on fostering ICT support to the development and integration of all factors that may contribute to regional competitiveness [1].

No doubt that among the consequences of this attention there is an acceleration towards the integration and embedding of ICT within physical environments to realize what has been defined the "everyware" [2].

In this context, despite its inclusion as indicator of quality of life, *education* is seen primarily as a mean to educate labor force and to renew/improve their life-long skills. Not by chance in the ranking scheme [3] developed to classify the European medium-size smart cities, education, listed among the factors contributing to the smart living, is considered only in terms of education facilities. Education is also considered, but as "side effect", a factor able to limit the digital divide, favor the e-inclusion and foster citizens to learn how to learn and innovate, also for the purpose of increasing the level of participation to the governance.

To conclude this short introduction we would like to stress that among the factors able to contribute to the smart living the ranking scheme lists also the touristic attractiveness, a factor of great interest to many territories with established historical background (like most of the European ones). However the interplay between touristic attractiveness, education and other possible related factors, such as cultural initiatives, is never considered explicitly. The aim of this contribution, thus, is to foster a reflection on how the interplay among the downing age of the ubiquitous computing combined with factors that contribute to the living quality, like our cultural heritage, could lead to learn in a smarter, more direct and active way, favoring a more intimate contact with the cultural stratifications enriching our territories and cities.

In the following we first describe our ideas and strategy, and then a technological environment designed to sustain them. To conclude, we propose few considerations on the needs to change the approach to the monitoring of complex experience.

2 The state of art

Nowadays a sort of invisible barrier separate the urban context (with its living streams of activities) and the content preserved in typical accumulation points of our Cultural Heritage (museums, interiors of historic buildings and, sometimes, churches), CH. Many pieces of our CH, unfortunately, live an isolated existence preserved in their "caskets", out of living context, and are no longer able to narrate their story to the people (apart from experts), to produce a living contact (apart from storytellings “accompanying” spatially localized guided tours). We are deeply convinced that their virtual re-contextualization, where possible, within the "fabric" of cities, villages and territories, could foster a more intimate contact with the narration of "our memory", as tourists, as citizens and, overall, as potential learners. A large number of European cities and villages, in fact, could be considered as open libraries containing a huge

number of "texts" (buildings, artworks, etc.), but, often, we are not any longer able to read such texts, basically because of the effort needed to master again all their symbolic meanings and to relocate them in their historical contexts.
The support of technologies to foster a different approach to such open libraries could be particular relevant for children who may acquire a deeper level of awareness about history and meanings hidden behind a mute appearance. Those who are accustomed to deal with teen-agers know very well, in fact, that they learn more by playing with video-games based on historical settings that by studying traditional text-books. Too often these latter miss very important ingredients like the narrative power of involvement, pathos and action and, sometime, even the ability to critically analyze the events to find parallels and better explain the present.
A new technological infrastructure that could act as a modern "volumen" is needed.
Its goal should be to foster a more intimate contact with the cultural background of cities/territories and to support living experience characterized by an high level of physical involvement. An very different involvement from being "glued" to a screen of a laptop or concentrating on a Nintendo DS. In this way, perhaps, one will succeed also in avoiding that when visiting an exhibition the greatest attractions become multitouch screens instead of the exhibited artifacts.

3 The inspiring vision

The key concepts that inspired the design of our technological infrastructure are:
a) *the "museal field"*
proposed already in 1999 by one of the authors [4] to describe the field of force that an accumulation point of our cultural heritage (museum, collection, etc..) could generate around to foster the contact between accumulated contents and individuals. When the interaction takes place exclusively inside the physical location of the Institution responsible for the conservation of our CH, one is faced with a short range interaction that requires a continuous process of "marketing" to force the contact. The territorial re-contextualization of the contents (albeit in virtual form), instead, could produce an extension of the range of interaction and, thus, an increase of the probability to involve individuals located inside the interaction area - tourists, citizens, all potential learners - even though they may have not planned to visit the museum/collection. Moreover re-contextualization of pieces of the collections - e.g. archaeological and historical artifacts, historical views provided by photographs, prints, paintings, etc. - may promote: i) the mutual amplification of sense, due to the interplay among re-contextualized "objects" and hosting contexts; ii) the design of environments more suitable to foster engaging narrative experience of the "places". In fact, the use of content in virtual form allows for its easy manipulation and, thus, to create more engaging inter-actions for specific targets (e.g. to amplify the ludic

dimension [5] of the interaction when children are involved) and stimulate the proactivity of individuals providing them the means to add "sense and meaning".

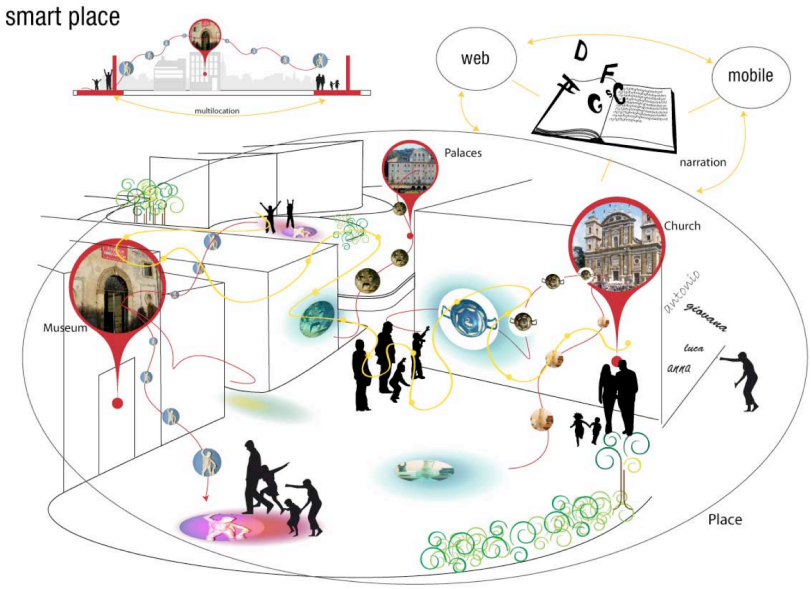

Fig. 1. Sketch of a museal field: a smart physical place always in interaction with the virtual components (web and mobile) of the technological environment.

b) *the support to narration*

from early childhood we develop our knowledge of the world also through multiple forms of storytelling, the most important of which is the tale. In adulthood, then, narrative not only still represent an interesting way to learn (just think of the successful emissions on scientific subjects, history, art based on narration, or to school and university lessons characterized by a strong narrative content and a high dose of pathos) but also a "pause" that, thanks to the temporary suspension of reality allows us to live highly engaging experiences: novels, films, theater, radio and television, in fact, although in a different way due to their typological diversity, allow to satisfy individual needs and expectations. Beside these form of narratives, that we might refer as "traditional and passive", nowadays we have to considered less traditional ones like the multiverse narrative typical of video games, that actively involve individuals in the construction of the plots. Such active participation satisfies one of humanity's basic needs: feel active protagonist of the story of which one is embedded [6,7]. The need to feel protagonist and, at the same time, to share with others their own experiences emerge also from the narrative of travel. Just think to the huge number of people that spend time in reconstructing the memory of travels through the editing of movies or by assembling slide shows; activities now available to everybody

thanks to the large diffusion of increasingly powerful laptops and network connections

4 The technological environment:

Technology enhanced learning experiences from our cultural background requires thus the integration of many technologies and infrastructures: web, mobile and smart spaces (Internet of Things, IoT, and Points of Interaction, i.e. PoInts, based on multimodal and natural interactions). No more than five-ten years ago the idea of such integration was still considered a far possibility, today, thanks to the recent technological developments, it has become a viable reality.

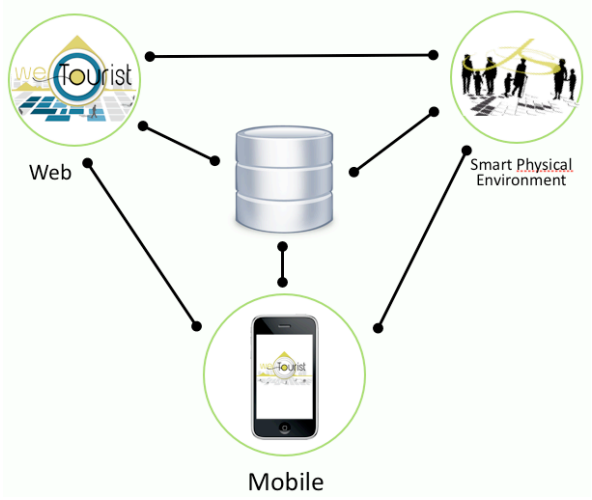

Fig. 2. All components of the technological environment sharing the same database

The modular and scalable web component of the technological environment, currently still under development, has been design to support a generic territorial experience. The portal consists of three areas dedicated to assist people during the three phases of a territorial experience: "before", "during", "after". Each area can accommodate modules/functionalities specifically designed to assist the person in a given phase of the experience. The modular organization of the portal allows to integrate, as "plug-ins", service and modules developed by third parties either free or vendors. Appropriate API, some of which are already available, will enable interoperability and data exchange with other infrastructure/platform: e.g. applications for Android and iPhone, or wearable enhanced fabrics and tools.

For example, we have realized an iPhone (see fig. 4) application offering narrative paths that may develop either in space (territorial paths) or in time (event paths). Paths are composed by Points of Interest (PoIs): the associated content can be inserted and upgraded anytime through a dedicated web editor. New PoIs and Paths can be added ad any time and, in close future, users could contribute actively to their development (stratification of tales and experiences). Learners could upload into the App the path of their interest, follow the narrations they offer and jump from one narration to another at crossing points.

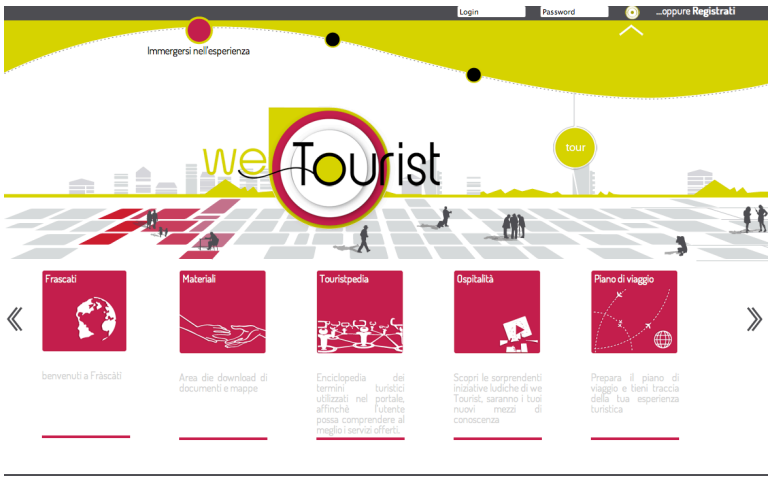

Fig. 3. Screenshot of the home page of the web portal: before the experience

Fig. 4. Flow diagram of use of the iPhone app

Figure 1 offers a sketch of the enhanced physical component of the technological environment, a Museal Field: i.e. a portion of village/city, within which are embedded installations allowing for a smart interaction among persons, museums' content and physical elements of the place. In the case of "K12", such smart places may include educative games, applications that allow to leave the signature of her/his own passage, to produce collaborative narrations, to creatively redefine the meaning of the Museums' content, etc. The augmented and sensitive physical environment is made of PoInts connected among them, and/or interact with integrated virtual environments (web and/or mobile). Thanks to such level of integration smart physical environments will allow to play and learn in multi-user modality, being people physically or virtually delocalized (i.e. active in other smart physical environments, or in other virtual environments).

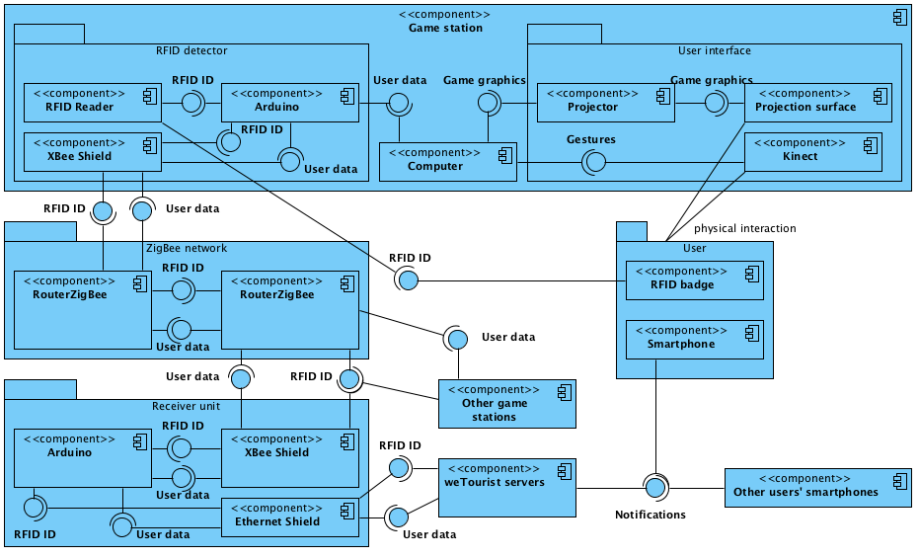

Fig. 5. UML diagram of a typical PoInt

As a first brick toward the construction of the smart physical environment envisaged above, we have designed an infrastructure that allows to identify the player and personalize the experience using RFID/NFC technologies, put in communication the various smart environments via ZigBee and to interact in a natural way, thanks to the integration of Microsoft Kinect sensors (see figure 6).

Figure 6 shows an early prototype of an interactive board to be embedded into the urban environment, featuring several different applications (widgets that can be activated at will using a text file): an art-puzzle based on the image of an archeological remain preserved in a Museum, an art-based pong, various example of interactive digital signage, a light intensity controller, etc.

Fig. 6. Prototype of PoInt, Kinect based, containing games and informative widgets. The two interaction strategies adopted are also illustrated.

As far as the interaction design is concerned we used two different approaches:
a) SimpleOpenNI library, and a series of dedicated algorithms, to recognize the position of a hand in the space and its state (open/closed); an appropriate combination of hand states, then allowed us to simulate the four states (functions) of a mouse: hover, pressed, dragged and released (see the case of the art-puzzle)
b) algorithms for the recognition of the hand centroid and an interaction based only on two mouse states: hover and pressed (this latter has been simulated by a movement of the hand towards the screen).
These simple realizations shows how realistic is a scenario based on future embedded smart learning places.

Fig. 7. Views of the augmented backback

To complete the overview on the technical environment we would like to mention also the effort we have been doing in designing possible personal add-on, like the *smart backpack* shown in figure 7. In the backpack we have embedded an integrated system of detection (photographic images, sounds, temperature, etc..) that allows, without having to hold any device, to record sets of signals describing the experience of the territory. At present data are recorded in a microSD, in the future we expect the smart backpack to interact with the tech infrastructure through mobile phones.

5 Experience monitoring and 'evaluation'

All above have hopefully convinced the readers that an active learning “experience” of the territory is a complex process that cannot be assessed any longer in a traditional manner (e.g. exclusively in terms of effectiveness and efficiency). The logical and very concrete consequence is that *deterministic previsions and evaluations should transform into the monitoring of the experience's qualities and into the analysis of the*

emergences and it should be done by recording and analyzing traces produced at many different level:

a) those produced by the gestural interaction with the apps embedded in the territory;

b) those derivable from the mobile phone that allow to keep track of the spatial movements performed by the people and of some of their qualities (location, accelerometers, etc..)

c) those produced during the exchange of data (mainly textual ones among members of the community).

To track and analyze the traces of the gestural interaction, we have adapted an application developed few years ago to analyze tracks recorded during eye-tracker measurement sessions [8]. Trials with such application are currently in progress.

In progress is also the development of an application that will allow to analyze the data collected through mobile phones.

Already active [9] are web applications able to detect social and emotional characteristics of the on-going process by means of social network analysis (SNA) [10] and automatic text analysis (ATA) [11].

All together the above techniques of analysis, and many other under development, could contribute to define the experiential profile of the learner. Of course its derivation is not an easy task and requires the definition of a model of the experience [12] acting as framework of reference.

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Understanding Trajectories of Experience in Situated Learning Field Trips

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Abstract. This paper discusses the role context plays in promoting engagement and exploration in situated learning experiences during field trips. We look at field trips where children engage with the physical and social environment in order to learn about cultural and social aspects of the city they live in. By drawing on empirical data collected by means of qualitative methods, we discuss how learning unfolds along trajectories of experience towards pre-defined and emerging learning objectives. We reflect of the role technology can play in supporting learning experiences outside the classroom.

1 Introduction

The city has always been an important arena for learning [10] and schools have taken advantage of the urban environment and all its resources to promote learning activities [3]. Recent development and diffusion of mobile and ubiquitous technologies throughout the cities increase people mobility and opportunities to engage with the environment [7, 13]. This allows for more support for learning to continue outside the classroom, providing possibilities for mobile learning experiences [9].

The work presented is part of the FABULA project whose objectives are to design and develop a platform of services to support different forms of learning in a city-wide context. The project focuses on the experience of learning a city by being in it, through an exploration of its physical places and cultural aspects. This paper contributes to the discourse on smart cities by reflecting on the role technology could play in supporting learning experiences outside the classroom. We look at real field trips where primary schools children engage with the physical environment in order to learn about cultural and social aspects of the city they live in. On the one hand, we focus on the strategies the teacher and facilitators enact in order to keep the students focused on the main topic. We relate to this aspect as convergence. The teacher always strives to engage the students, scaffolding the learning by triggering their reflection and dynamically orchestrating [4] the activities to guide them along a *hypothetical learning trajectory* [16] towards defined learning objectives. On the other hand, we focus on the *actual learning trajectory* the students follow by taking advantage of

adfa, p. 1, 2011.
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the opportunities emerging from being present in authentic settings, and able to explore the physical and social context. These opportunities can potentially trigger new interests and learning objectives, and we refer to them as divergence. Both convergence and divergence open up a space of opportunities for reflection about the experience and hence for learning. Limited work has been carried out to support both the ongoing learning activity and emerging opportunities [5]. It is hence necessary to broaden the understanding of how learning experiences unfold in authentic settings in order to exploit convergence and divergence opportunities.

2 Related Work

A body of research has focused on how to complement school activities with the ones carried outside the classroom taking advantage of the opportunities offered by the context [2, 15, 18]. Many projects have focused on promoting learning by supporting data collection in the field and reflection and elaboration of the data mostly when back in the classroom [2, 15]. The systems proposed in these projects could be employed in different contexts (not being customized for a particular venue), lucking support for reflection in situ. Other projects have focused on enhancing reflection while out in the field, like Ambient Wood [14] supporting student-initiated scientific inquiry by providing different sources of digital augmentation of the physical environment; or the M3 system [18], an example of how mobile technology can become an "object-to-think-with" supporting a treasure hunt game in informal learning settings. These projects outlined the importance of reviewing collected materials in the field. The nQuire toolkit [12] support students in inquiry-based learning (to formulate questions, collect data and test hypothesis) both in formal and informal settings with the support of facilitators. Support provided by these technologies [12, 14, 18] is customized to specific settings and facilitators play an important role throughout the experiences promoted by them. Cromar [11] is an example of an application providing support for reflection on crowd management situations that could be employed in a variety of settings without facilitation. All the above mentioned projects outline the usefulness of the possibility to keep track of, review, reflect (either in situ or later in classroom) and elaborate on contextualized collected data, e.g. by selecting specific views or 'trails' [15] through the data. However, the above mentioned research focuses on supporting a specific learning objective, without providing means to take advantage of other learning opportunities offered by the same experience, e.g. exploring alternative trajectories, aiming at emerging learning objectives.

The goal in this paper is to better understand how to provide support for situated learning experiences, both in terms of pre-defined and emerging learning objectives by suggesting a model based on trajectories of experience. Our research questions are: what is the role of context in supporting students' engagement and exploration in situated learning experiences? How is it possible to take advantage of opportunities offered by converging and diverging learning trajectories?

3 Understanding Experience and Trajectories

Kolb suggests that "Learning is best conceived as a process, not in terms of outcomes" [8]. To understand a learning experience as a process, we look at it in terms of a trajectory. Learning trajectories have traditionally been used by teachers to inform and plan their instructional interventions. Simon [16] defines a *hypothetical learning trajectory* as the teacher prediction of "the path by which learning might proceed". This is characterized by: "the learning goal that defines the direction, the learning activities, and the hypothetical learning process - a prediction of how students' thinking and understanding will evolve in the context of the learning activities" [16]. The *actual learning trajectory* cannot be known in advance and is not necessarily unique. Learning trajectories are useful tools for supporting teachers in achieving certain pedagogical objectives; however they provide limited insight for taking advantage of emerging opportunities for learning and for designing technology to support situated learning experiences. In this perspective, we adopt the concept of trajectory as defined by Strauss: "the course of any experienced phenomenon as it evolves over time and the actions and interactions contributing to its evolution" [17]. In particular, we look at the work suggested in CSCW and HCI fields by Benford and colleagues [1] that can broaden our understanding on how to design experiences that promote engagement and physical exploration while dealing with multiple and interconnected trajectories. Situated learning experiences in fact are not just about kids learning something, they are about kids exploring a place, referring to past visit experiences whilst engaging in new ones, comparing what is being experienced with everyday life and wandering along unforeseen paths. Benford et al. [1] suggest a conceptual framework of trajectories that outlines the role of *space*, *time*, *roles* people may assume and *interfaces* used to support interaction and collaboration [1]. Different kind of trajectories have also been identified: *interleaved trajectories* expressing the collaborative aspects of experiences (e.g. possibilities for encounters), *group trajectories* emerging from several individual overlapping trajectories, *multi-scale trajectories* for nested trajectories, and *evolving trajectories* [1, 6]. In the present paper, we focus on how the actual learning trajectory of the whole class was shaped by the teacher and the guides through orchestration to converge towards a hypothetical learning trajectory, but also how the students exploring different places and resources got engaged and moved towards emerging learning objectives. We also pay attention to how the field trips were tight to other experiences (e.g. previous and everyday experiences).

4 Method and Settings

The exploratory study presented was carried out at an international school, where we followed a fourth grade class to two different field trips: one to an open-air folk museum, and the other to a cathedral and its museum. Children were between 9 and 10 years old and 20 pupils were present during both trips. During this phase of the project we decided not to intervene with any technology to focus, instead, on the social interactions and the actions with the physical context that might help explaining the

convergence and divergence of learning trajectories. The data were collected mainly through qualitative methods: observations, audio-recordings note-takings, and a follow-up interview with the teacher. Both excursions lasted about six hours from the moment we arrived at the school, to when we departed after the field trips were over. The interview with the teacher aimed at understanding the role of the field trips within the school pedagogical objectives, and gaining insights on the classroom activities organized as a preparation and as further elaborating on what was learnt.

The class followed an inquiry-based approach to learning (formulate questions, collect data and test hypothesis) focused on a central idea. When the study was carried out, the class was working on a six-week unit of inquiry about Norway. The central idea was defined as "Understanding our host country's culture, geography and history helps us develop our identity and perspective on the world". The first trip was concerned with the relationships between Norway's climate and its culture. During the first trip, the class visited the local open-air folk museum, where traditional buildings (e.g. farms, churches and houses from different periods) had been moved from all over the country. The second trip focused on the cultural influence of religion in Norwegian society. This excursion included two separate visits: one to the museum where original sculptures from the cathedral and archaeological exhibitions were displayed, and one to the cathedral itself. Each visit was led by a different guide and lasted for about one hour. The two trips offered two interesting settings to understand the situatedness of a learning experience, and to explore how learning experiences unfolds and what contextual aspects contribute to emerging learning opportunities. The trips allowed us to understand how specific mechanisms allowed the teacher and the guides to stir the students towards pre-defined learning objectives while also letting them explore emerging ones.

The concepts presented in Section 2 were used as sensitizing concepts during the analysis, which was iterative. The first two authors collected the data and carried out the analysis together. The intermediate results were then discussed and expanded through discussion among the authors.

5 Shaping Learning Experiences

In this section we discuss how the field trip learning experiences were tailored to the pre-defined learning objectives, and how new objectives emerged through exploration of authentic settings. The teacher embraced an open but focused approach during the field trips. In the interview she explained: "*The process comes alive as you do it*". There was not a strict plan (no script) to be followed during the visits: "*I have a plan that I like to have, but if children have an interest in something else, as long as it's staying in the central idea, we can move over there…that's allowed because we want to keep the children excited about, we want to keep them interested*". This approach allowed the students to contribute with their own ideas and interests pursuing both pre-defined and emerging learning objectives. The guides knew about the unit of inquiry and the central idea, but they had not agreed with the teacher what path to follow and what exhibitions to show to the students. These elements allowed for a flexible, unanticipated process to unfold during the visits.

5.1 Starting the Visit: Recalling and Contextualizing

Our observations started in the class waiting for all the kids to arrive. Preparation was done the days before the visits, no recall and no material was gathered before leaving the school the day of the visits. However, as soon as we arrived to the museums we observed how the teacher and the guide enacted different strategies to recall kids attention and engage them with the environment they were about to explore. On our arrival to the museums the teacher asked questions to the kids to recall goals and relevant events. For instance, before entering the folk museum, the teacher asked "*Does anybody remember why we are here?*" to remind the students what the goal of the visit was and how it was connected to the inquiry they were carrying out.

After meeting the guides, the kids would receive an introduction about the place they were about to visit; the guides would ask the kids to pay attention to resources around them. During the first trip the guide, standing by the entrance of the folk museum, pointed out a hill and explained "*We're on an historical ground* […] *800 years ago there was a fort to protect the city up there and a fight took place in the same spot where we are standing now*". The kids got very curious about, and wanted to know more about the place and its history. Then a kid noticed a construction on one side of the hill and asks what it was. The guide explained it was a small hut used by the Sami to store food. The kids asked to visit them. Unfortunately, even if the class was interested in knowing how food was preserved, it was not possible to visit the huts.

In the early phases of a visit it was important to create connections to what the class knew from before and build up anticipation for what it would come next, creating bridges with past and future episode of an experience. Particularly, at the beginning of the visit, the teacher would make an effort to connect the visit to things that the class had discussed or seen before (e.g. "*Do you remember the Birkebeiner?*" to recall a previous discussion and link it to the story of the folk museum) or things they were about to see (e.g. "*And when you walk around now, you will see that the construction of other buildings are completely different*"). During the rest of the visits the teacher would usually not intervene and let the guides lead the visit, unless further explanations were necessary. It seems that it was crucial to create a strong bond between past and present of an experience and to stimulate kids' engagement to explore the context early in the visits.

5.2 During the Visit: Roles of Questions, Objects and Kids' Experiences

During the visits, exploration and reflection were encouraged in different ways. Questions played an important role in keeping the students engaged. In this way students were not just passive audience, but were invited to take a more active role as inquirers. Objects were used to tell stories and make the environment comes alive by populating it with people and activities. Elements in the context were sources of both convergent and divergent opportunities, exploited by the guide or discovered by the students. Objects acted also as connectors between different experiences (e.g. across class and museum, across different museums, or across past and present of a place).

The guide encouraged exploration and reflection with probing questions often linked to specific objects or the surrounding environment. At the folk museum, while kids were sitting inside a farmhouse from the 17th century surrounded by objects to recreate the original settings, the guide said: "*This was the main building, this was where the people lived and in this room, this was the living room which they use every day. And this wasn't just a living room, was it?*" All the objects and furniture around the room suggested how the living room was used for. A bed made a boy wonder "*Sleeping room?*" A girl referring to the open fire asked "*Kitchen?*" And another kid suggested "*They spin the wool here*" pointing at a wool spinning wheel.

Objects would not only be used by the guide for engaging the kids, they would also trigger kids' attention and exploration. At the folk museum while still inside the farmhouse, a girl was interested in knowing more about a pendulum clock and asked clarification about it to the guide. This led to an emerging opportunity for learning:

Guide: "This, actually, came like a fashion from the US, where M. [the teacher] *is from. And…do you know why? Because a lot of Norwegians in the 1850s, where did they go?"*

Kids: "In the US? America?"

Guide: "To the US! They immigrated."

Teacher: "Do you know why they decided they wanted to go over to America?"

Guide: "[…] Have you heard about the industrial revolution? Going from being self-supplied like they are on this farm, and then starting to deal, to trade with money. And then they needed the mass production, factories started to produce stuff [...]"

In this example, the pendulum clock triggered an interesting discussion about the industrial revolution, its influences on Norwegian living and immigration to US that the kids had not discussed before creating a learning opportunity that had not been planned. Other times looking at and discussing about an object could raise a subject that had been encountered before offering the possibility to investigate them through new perspectives. Kids could build their understanding on several interconnected experiences, some they have shared together (during previous visits or in class) and some personal experiences (e.g. their everyday life). For instance, during the visit inside the cathedral, the guide showed the kids a baptizing font and the kids recalled what they had heard during the first visit to the folk museum. They remembered there was a habit to spit in the font if there was no water and that the Pope forbade it afterwards. This episode also offered the opportunity for kids of different believes to discuss the meaning of baptism. Other times, this chance to connect experiences was missed. During the second trip, no activities were organized by the guides in order to relate what was seen inside the museum with what was presented inside the cathedral (e.g. the statues of the Saints, the painting and story of St. Olav).

One thing seemed very important, that is to always relate to what kids were familiar with (in their everyday life and in the present situated experience). The teacher and the guides often related concepts, stories and experiences to everyday situations ("*Is it warm in your basement?*" or "*Do we do that today?*"). Taking advantage of the present experience, the guide at the folk museum connected to how cold it was that day; so when a student asked *"Was that little warmer before?"* the guide replied *"Not at all. It was like here, like we have today"*. In this way kids could better understand the

conditions people were living in the past and relate to them, crossing a traversal between past and present of a place.

5.3 Ending the Visit: Brief Recall in Situ and Connections to Be Made Later

At the end of the visits, before leaving the museums and go back to school, we observed only a brief, informal recalling of interesting events and favorite things. The teacher asked individual questions while kids sat together, resting and having some snacks. Further reflection and elaboration on the visits were carried out in classroom, however not the same day of the visits. The teacher was aware that not everything the kids listen to during the visit would be remembered, but she still valued the fact that they got to experience things in authentic settings and they would retain this later on. This is what the teacher said in the interview *"I don't think they [the children] got even half of what was being talked about, but they made… a connection, they have a …sort of file folder in their head…They might remember this field trip later. They have a connection to make. I think that's really important […] just being there and being in the city they live in, this is something that they may take for granted but then they will be making connections later.*"

6 Discussion

In this section we will point out some interesting aspects to look at when designing for situated learning experiences exploiting the opportunities offered by the context, as outlined in the previous section. In this paper, we want to look at the field trips' learning experience as a process and describe it in terms of a trajectory. Looking at different aspects of an experience, as suggested in [1, 6], i.e. role of space, time, resources and other interconnected experiences, can point out how to exploit opportunities for supporting reflection and learning offered by situated learning experiences. We refer to the actual learning trajectory followed by the whole class as the path that is made up of actions and interactions that unfolds over time [17] during the visits, while the hypothetical learning trajectory is represented by an ideal path aiming at the visits' pre-defined learning objectives.

Previous work showed the usefulness to support collection of and reflection on a stream of data, both during and after the experience. Being able to capture the actions and interactions characterizing a situated learning experience and to relate them with a hypothetical trajectory could help, not only the teacher orchestrating the process, but the students as well. Prompting the students to reflect on their experience, wondering if an action is related to the pre-defined learning objective or to an emerging one (*Does the immigration to US relate to the influence of climate on Norwegian culture? How?*), could lead to an increased awareness of how things connect with each other throughout the experience.

In Fig. 1, the class actual trajectory[1] (continuous line) diverges from and/or converges towards the hypothetical learning trajectory (dashed line). The grey area around the hypothetical learning trajectory represents the converging area characterized by possible actions and interactions connected to the central idea of the inquiry unit the students were studying[2]. The actual trajectory moves outside this area when (a) divergence occurs, i.e. topics outside the central idea are explored (e.g. immigration to US) and emerging learning objectives may arise; or (b) when kids get distracted or disengaged. During the visits, the teacher and the guide try to limit the actual trajectory of the class within the converging area through orchestration (rectangles in Fig. 1) by: (1) keeping engagement (e.g. asking questions, recalling events or presenting a new object); (2) re-establishing convergence; and (3) limiting distraction. The children had the possibility to explore the context and follow different paths than the hypothetical learning trajectory. However, it is important to notice that divergence and distraction are not necessarily negative aspects during a visit. In fact sometimes students needed them to maintain engagement throughout the visits.

Elements in the context (starts in Fig. 1) influenced the students' actual trajectory by triggering kids' attention (e.g. the Sami huts on the hill); by being exploited by the guide or the teacher to keep kids engaged (e.g. the bed and wool spin wheel inside the farmhouse); or by raising a topic, inside or outside the central idea (e.g. the pendulum clock).

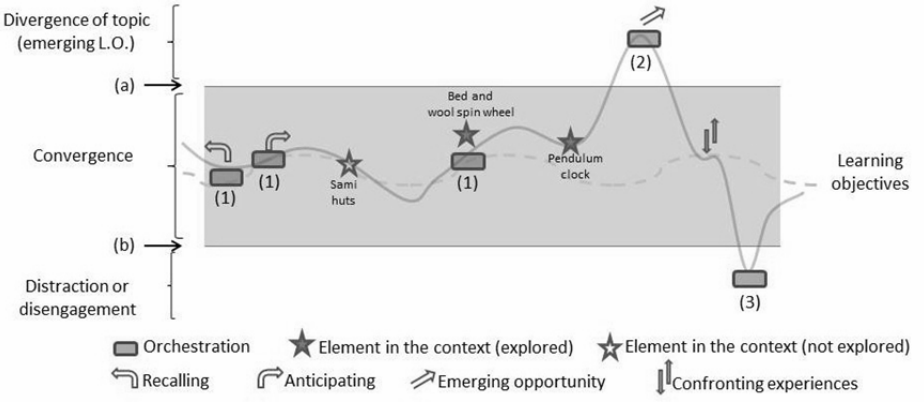

Fig. 1. The actual trajectory characterized by actions and interactions.

The authors in [1, 6] suggest to think of trajectories in terms of space, time, roles and resources. We should therefore think to support different representations and means for navigation of trajectories that outline how actions and interactions are connected through time, to places visited, roles played by the students (e.g. passive audience vs. active inquirer) and elements encountered in context.

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1 We refer to the class trajectory as we observed the dynamics of the group. Focusing on the actions and interaction of each pupil, it would be possible to define individual trajectories.

2 Where to place actions and interactions on an absolute scale is not crucial, but it is important to identify and outline if they pertain to convergence and/or divergence.

The pervasiveness and proactivity of smart city technologies could offer great potential to automatically capture the actions and interactions occurring during situated learning experiences, to trigger reflection or to suggest connections across related episodes during the present experience or across past and present experiences. Technology should support further exploration of the elements encountered and explored during the situated experience and trigger a more thorough reflection on aspects the students experienced simply as passive audience. It would be useful to provide means to explore elements that were not examined, like the Sami huts (e.g. through virtual visits, or by making available resources collected by other visitors). During the visits the students together with the guides unveiled also some interesting stories that could be of interest for the students for later elaboration, but also to other visitors as well (e.g. the discussion about immigration to US connected to the pendulum clock) creating learning opportunities for later exploration and for interleaved trajectories. In this perspective, technology could promote learning across social and physical contexts.

In [1, 6] it was also pointed out the need for paying more attention to interleaved, multi-scale and evolving trajectories. As observed in the field trips, situated learning experiences are often bridged to and enriched by past and future experiences. Experiences could be connected for different reasons: to recall previous learning events, goals or related topics; to create anticipation for future events; to confront with personal experience; or to generate emerging learning opportunities (see arrows in Fig. 1). When designing technology to enhance situated learning experiences, a challenge is then represented by supporting multi-scale experiences: triggering recalling of goals and allow reviewing past events at crucial times; promoting anticipation to foster engagement; prompting connections to be made with previous experiences and encouraging reflection on how things relate to everyday life.

7 Conclusions

In this paper we presented an account of situated learning experience in terms of trajectories to outline the role technology could play in supporting both pre-defined and emerging learning objectives, promoting engagement and exploration of the physical context. As part of our future work, we plan to validate the model of trajectories in different settings, also considering informal and work related situated learning experiences. For taking advantage of both converging and diverging learning opportunities, the solution is not to be found in the design or employment of a specific tool but more realistically in a configuration of technologies. We therefore plan to deploy a configuration of systems to provide support during situated learning experiences.

8 Acknowledgments

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Learning in the smart city: a virtual and augmented museum devoted to Chaos theory

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Abstract. This paper presents a virtual museum introducing the interactive VR and MEMS applications related to the learning of chaos and complexity theory. In this museum, the user can learn the history of the dynamical systems and how to build Chua's circuit, as well as realize artistic artifacts transforming attractors into sounds and music. This environment can be used in the city in order to create new ways of experiencing science, turning physical activities into virtual ones, an important step towards being able to have the museum in the smart city. Moreover, some applications have been developed to work on iPad and iPhone and can be used as a guide in the real exhibitions. A user-centred design strategy with 40 students has been carried out in order to implement the Virtual Museum of Chua's Attractors, aiming at widening the experience in the smart city and allowing a considerable public participation.

1 Introduction

The advantages of integrating technologies in educational environments have been widely discussed in literature [1, 2]. Nowadays, Virtual Reality allows the creation of multimodal and multi-activities environments for science education, by which the user can have an active role exploring the contents and learning by doing or playing [3, 4, 5]. Hence, the virtual space is not only a tool for representation, but also a tool for action and interaction, integrating constructivist theories as well [6]. Many authors suggest that the interaction with virtual environments and immersive 3D scenes involves learning [7], but not all the environments imply education [8, 9]. The users can learn and improve their skills because the interaction mechanisms strongly stimulate cognitive capacities such as eye-hand coordination and visual-spatial representations [10].
Virtual environments could be used to present and disseminate many scientific topics [11]. Moreover, auditory display techniques combined with immersive virtual environment could be used both to improve the comprehension of scientific phenomena by using 3D modeling and music, and to use science for artistic purposes [12, 13, 14]. Many authors suggest that digital learning application can stimulate students' interest about complex scientific topics [15]. Students' lack of interest into

scientific topics originates from the difficulty to understand specific phenomena. However, the 3D visualization of scientific objects, associated with real-time interaction, and the simplification of the complex phenomena can involve students. Moreover, by providing various interactive hands-on paths, it is possible to engage them in an immersive learning environment on topics like physics and mathematics. Furthermore, since the pioneering experiments in hands-on approach of Museums such as La Villette (Paris) or The Exploratorium (San Francisco), a Virtual Museum has become a compelling metaphor by which it is possible to create high scaffolding educational environments. Moreover, a number of large-scale projects have been primarily dedicated to the archaeological site modelling or museum collection digitization. In fact, the current situation of virtual reconstructions accessible via Web is principally focussed on the reconstruction of historical finds using 3D digitalization and scanning techniques (3D-MURALE, http://dea.brunel.ac.uk/project/murale/), the interchangeable visualization of the archaeological site and its reconstruction using Virtual and Augmented Reality technologies (ARCHEOGUIDE, http://www.archeoguide.it/), and the Web navigation of 3D scenarios (Nu.M.E. project, http://www.cineca.it/sap/teatrcultherit.htm). Moreover, the well-known European Network of Excellence EPOCH (http://www.epoch-net.org) is engaged in the challenge of standardizing processes for data capture, networking, and interoperability as primary strategies for linking information throughout the entire sector.

The aim of this paper is to present a Virtual Museum in which visual and auditory representations of three dimensional chaotic and complex objects show the simplicity of science learning. This tool has not been designed for advanced users and is an easy-to-use, easy-to learn, and stand-alone environment. In particular, this virtual environment can be used as an Edutainment laboratory in order to promote new ways of experiencing science, such as Chaos Theory, and turning physical activities into virtual ones. The aim is exploit the availability and quality of knowledge communication in the smart city, highlighting the growing importance of Information and Communication Technologies in learning contexts.

The paper has 5 sections: Section 2 introduces science dissemination and the use of new technologies. Section 3 presents the main scientific topics displayed in the Virtual Museum. Section 4 deals about the virtual environment with a detailed description of the interaction systems we have developed. Section 5 concludes the paper providing future directions of this work.

2 Science dissemination and new technologies

Since it is essential to involve young generations in scientific studies [16], a wide number of interactive exhibits are incorporated into virtual museums. Frequently museums present exhibitions developed in order to enhance the visitors' experience, as well as to facilitate new forms of participation in science. In fact, the lack of interest in key science topics and mathematics has been linked to the way they are taught from the earliest age. Therefore, greater emphasis needs to be placed on the development of more effective forms of learning method, and analytical skills as well as the improvement of techniques for stimulating intrinsic motivation for learning

science. Many researches show that learning by non traditional methods is a successful experience. Research in Psychology indicates that active learning (the physical construction of knowledge by using the hands in coordination with the eyes) could remarkably enhance students' learning efficiency [17, 18]. A rich interaction can offer participant feelings and, hence, benefit students' active learning, and promote teaching effects. An immersive environment allows a direct approach to science, influencing the formation of critical thought, the development of psychological and social relationship, scaffolding the learning process. The users are active subjects in the virtual environment and learn by performing different activities. On the side of the system development, the construction of the Virtual Museum of Chua's Attractors has been an interdisciplinary effort and many problems of attractors representation in graphics have been already solved [19], but a lot of work needs to be done. Due to the difficulty of chaos visualization, the quality of the interaction with dynamical systems that it is possible to realize and the development of compelling paths on complexity and chaos is still at the beginning. We want to exploit the cognitive advantages of learning by a virtual museum in an immersive audio-visual three-dimensional scene. The complexity of many physical phenomena can't be easily understood, this is even at the base of the chaos basilar mythological concept developed by the ancient Greeks. Contemporary science tried to understand the principles of chaos theory. In particular, Chua [20] invented the first circuit able to visualize chaos. In the following 30 years of research on this topic, many studies have experimentally, mathematically and physically demonstrated chaos. This effort changed the way we perceive science and the scientific discoveries in society, developing larger and more complex visions of the phenomena. Basically the aim of research is to open a new access to science matter for everybody and not only for scientists. In this view, the Virtual Museum we have developed try to activate a new way of learning science, linking our everyday life to scientific improvements. The museum promotes also collaborative and social skills, based on shared learning and joint activities among students.

2.1 Chaos and Complexity

Chaos and Complexity theories are some of the most remarkable achievements of science in the 20th century. A complex system is a collection of many simple nonlinear units that operate in parallel and interact locally producing an emergent behavior. A complex dynamical system evolves in the space of phases (the set of variables that define the state of the system) delineating a particular evolution. In Chaos Theory, we consider non-linear dynamical systems that evolve in an unpredictable behavior from initial conditions, even though their behavior is deterministic and well structured. Chaotic systems exhibit both complex behavior and stable dynamics in a well defined region of space known as "attractor". Chaotic attractors themselves are markedly patterned, often having elegant, fixed geometric structures, despite the fact that the trajectories moving within them appear unpredictable. The geometric shapes of the chaotic attractors are the order underlying the apparent chaos. Chua's oscillator [21, 22] is a canonical system for research in chaos, since it can be realized in a real world setting as a simple electronic circuit. It is

the simplest electronic circuit in which the presence of chaos has been proved mathematically. The circuit exhibits a rich variety of bifurcations and chaos and it has become a paradigm for chaos theory [23, 24, 25, 26]. For these reasons Chua's Oscillator and its mathematical model can be used in many different tasks such as research on non-linear dynamics and chaos, chaos theory demonstration, and also for educational purposes and science dissemination. The Lorenz attractor generates only few classes of dynamics and their associated patterns [27]. On the contrary, Chua's circuit, and all the systems based on the circuit, produces a broad variety of chaotic structures, of many different shapes and sizes [28]. Today more than one thousand attractors have been visualized. The variety and richness of the chaotic shapes produced by Chua's circuit and its generalizations inspired the idea of creating a Gallery to collect them. The Gallery shows the complexity and the beauty of the chaotic patterns and presents science through an artistic interpretation. Simulation of chaos produces not only a wide variety of three dimensional model of attractors but also rich collection of sounds and music [29].

3 Educational Virtual Museum

In order to realize a tool based on a user-centred design strategy, we have designed a pilot questionnaire aiming at gathering information for eliciting user requirements. Then, we have realized the final questionnaire, administrating it to a sample of 40 subjects. Data analysis has provided useful data for the implementation of the museum; finally, the positive usability results have shown the suitability of the adopted participatory strategy. Regarding the virtual museum software architecture, it is as simple as powerful. There are only three different layers: one for handling user interface, one for managing scenes, and one for 3D Audio and 3D Video render (simply called Render Engine). The user interface layer can receive and manage the inputs provided by different user controllers as Wii-mote, mouse and keyboard. Then the processed input signals are control by the scene manager that updates the user's avatar position and the point of view.
The scene manager also sends requests to render engine for drawing the virtual 3D world and playing sounds and music from exposed objects. The main employed technologies (Fig. 1) comes from free and open source projects: users' inputs are managed and filtered by GlovePIE (http://carl.kenner.googlepages.com/glovepie_download) and then translated in a compatible way for the user interface layer. The Scene Manager and 3D video Render

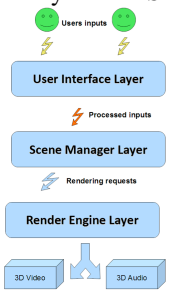

Fig. 1. Architecture.

are guied by Irrlicht (http://irrlicht.sourceforge.net/). The 3D audio rendering are controlled by OpenAL (http://connect.creativelabs.com/openal/). 3D Objects, Musics and Sounds enjoyable in the virtual museum, are generated at run-time in a systematic way, or randomly.
The Gallery of Chua attractors has become a virtual museum available both to researchers and to non specialists. Within the museum, visitors can manipulate the chaotic shapes, change their parameter values, create new attractors and listen to music and sounds generated by their dynamics. In this way, users can discover new and unexpected dimensions of chaos, beyond anything they could previously imagine.

Visitors to the museum are accompanied by an avatar that acts as a guide. It describes the general characteristics of Chua systems and their generalizations (including formal aspects) together with the characteristics of the specific system the visitor is looking at. The system allows visitors not just to admire the shapes but to manipulate them in a 3D environment, using special glasses for stereoscopic vision of the shapes and data gloves for interacting with the pattern in an unconventional way. This kind of immersive interaction with an artificial world provides visitors with an insight into the full complexity of chaos. The investigation of chaotic domain still requires much work. Nonetheless, there can be little doubt that the approaches and technologies we have developed provide new ways of exploring chaos, and expanding our scientific knowledge.

3.1 Interface

The main goal of the virtual Museum of Chaos is make use of science in a creative approach and arouse curiosity and interest of a wide auditory about chaotic phenomena. The virtual Museum tries to realize a concrete idea of edutainment tool that combines the educational and entertainment purposes. The setting consists of a single navigable area divided by panels showing pictures of attractors and chaotic evolution. The visitor can control his/her position by using the general map of museum, located on the right bottom site of the screen. The museum symbolically contains five sections, like five different typologies of artistic productions coming out from chaotic system simulations. An avatar functions as guide in the space exploration (Fig. 2).

Fig. 2. The avatar that accompanies visitors in the exploration of the Virtual Museum of Chua's Attractors. In the original idea of this character, the avatar is Professor Leon Chua who shows the different patterns of chaos to the visitors.

Moreover he can interact with three dimensional chaotic objects. Models of attractors in rotation are placed in central position and utter their characteristic sound. The first section is dedicated to the attractors produced by the Chua's Oscillator. The second section is dedicated to present visual representation of patterns generated by the system with dimensionless equations. Other sections display images from the cubic functions and single point of equilibrium systems. The central parts of the Museum are dedicated to n-scroll, hyper chaotic and synchronized system. Many rotating attractors are in the middle of each room, like sculptures. The user can listen to sounds when he comes up to attractors. Special cameras, mounted on the sculptures, provide alternative views of the museum, directly under the user's control. The novelty bring into the last issue of Museum is a more user friendly interface and a new interaction system MEMS technology based.

3.2 Interaction system

Moving round the museum, the avatar (and the user) can interact with attractors, listening to music and sounds produced. The environment supports sophisticated forms of interaction. By controlling the avatar users can move from room to room interacting with the objects they find there. Moreover he can visualize, modify and hear the evolution of chaotic trajectory. But the success of such virtual "direct experience" depends heavily on the design of interface and interaction techniques. For these reasons, the interaction between users and the immersive environment has been realized by an interface more usable and receptive to the user's needs, taking in account the experimentation we have done in a real class situation [29]. An enjoying interaction between the learner and the interface is possible using the Wii Remote control by Nintendo Entertainment System (Fig. 3 and 4).

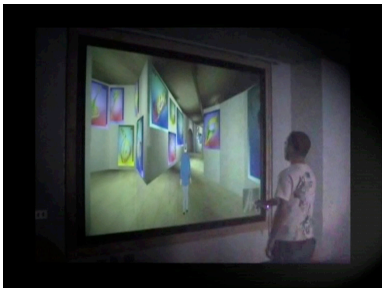

Fig. 3. An user interacting with the environment by using a Wii Remote control by Nintendo Entertainment System.

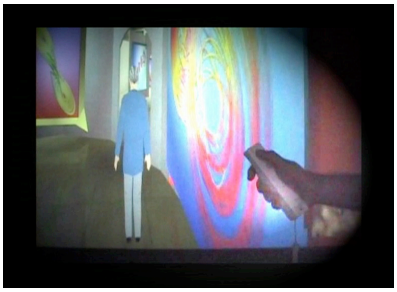

Fig. 4. By using the Wii Remote control, the user can easily direct the avatar and interact with the systems visualized in the Gallery.

We organized the museum like an immersive 3D environment in which the real-time interaction permit to explore scientific topic usually dedicated to specialists in an original fashion. The museum space contains a number of components, and each

encapsulates specific areas: sculpture of attractors, painting and agent-based interface. Understanding the relationship between educational needs and environment elements will allow us to develop the improvement of this educational museum.

4 Applications

In the Virtual Museum of Chua's Attractors we have implemented 4 main sections, which correspond to 4 different types of interaction. In the first the user acquires knowledge on the main concepts related to chaos and complexity theories, by some short video that have been realized for making simple difficult concepts.
In the second section, more action-oriented, the user reconstructs the Chua's circuit in 20 steps, by interacting in a 3D environment by using a computer screen in a room in which other people are making the same activity. The construction is visualized in a wide shared 3D screen, and it is possible to use the single user's interaction or the shared users' interaction. Third and forth sections are about the visualization of pattern generated by chaos and the realization of sound and music by using Chua's attractors.
The first section is related to stories on the Chua's circuit. On a wide 3D screen, which enables stereoscopic vision, the history of the Chua's circuit has been reconstructed in a film, which uses 3D VR and mixed VR technologies. User can view the film and observe the 3D patterns in stereoscopic vision to detect uncovered particulars of these shapes. Furthermore he/she can operate to review the main stream of the story. A singular movie of this section has been devoted to the relationship among dynamical systems, human creativity and arts, especially visual arts [38]. The educational aim of this section is to give some preliminary concepts about chaos, dynamical systems, creativity and science, how it is possible to detect the beauty in these mathematical patterns and transform them into sound and music.

The second section has an application which allows the Chua's circuit construction. Users are in a room in which they are connected to the 3D screen by a computer. First they watch at a 3D short movie which illustrate in 20 steps how it is possible to connect the circuit elements for allowing the system's working. Then they have to build the circuit by themselves. Again the activity could be done by a single user or by many users together.

This method is based on the idea that the manipulation experience can be very effective in this context. Physical construction of the electronic circuit can stimulate the creativity and curiosity of the students, covering step by step the assembly of circuit components. The image in Fig. 5 shows "The Chua's Circuit Virtual Builder". The arrows in the down corners of the screen allow real time user's interaction which consent the users to navigate through the different steps of the circuit building. The construction of the circuit, as shown in Fig. 6, has been again transposed in a virtual application to let the students to experience and learn all different steps.

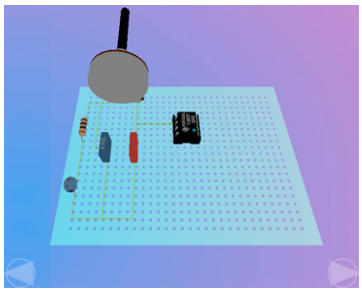

Fig. 5. Chua's circuit virtual builder

Fig. 6. Construction of the Chua's circuit

The third and fourth applications in the third section of the Virtual Museum of Chua's Attractors allows the modification of the 3D models of the attractors with a real time interaction by controlling the system parameters.
Driving the MEMS interaction tool, students can experiment the modification of chaotic attractors and hear the acoustic signal produced by themselves.
As is possible to see in Fig. 7, a specific mask, shaped like a star, appears on the screen allowing the user to have a visual feedback of the change applied on the values of the parameters. The system allows also a multiuser interaction in the virtual experience on chaotic system understanding, like shown in Fig. 8.

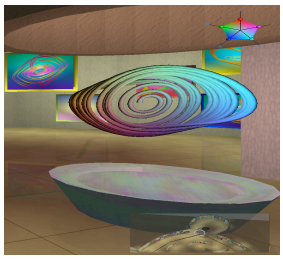

Fig. 7. Interaction interface

Fig. 8. Multiuser interaction system

The developed system allows the user creating music and sound from chaotic shapes. The mathematical models used in this environment are the dimensionless equations for Chua's Oscillator. These models, as the other generalizations of Chua's circuit, generate the sequence of numbers used to produce sound and music. Alternatively to the above mentioned interaction, a learner can use a MIDI Input Device that makes possible to change both the control parameters and the initial values, in order to obtain different kinds of sound and music. This process is very important for grasping the intrinsic nature of chaos as these variables are related to the sensibility to initial conditions of chaotic behavior. Furthermore, many translation codes have been developed, which allow a new way of understanding and studying chaos and complexity [29].
The systems allows the registration of the sound tracks produced by the students and of the patterns of the attractors visualized on the screen.

5 Conclusion and future work

In this paper we have presented new applications in the Virtual Museum of Chua's Attractor, related to the visualization, musification and sonification of Chua's attractors. An experimentation with different classes of students, from elementary to high school has been carried out, in order to evaluate students' learning and motivation. Analysis of results is in progress.

Moreover, the environment will be downloadable from the net and a wider experimentation will be possible. The collaborative way of learning in a class will also be investigated in a further experimentation.

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Contextual Mobile Learning for professionals working in the "Smart City"

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Abstract. In this study, we propose an innovative approach using the "Contextual Mobile Learning System" based on the "Electronic Performance Support System" (EPSS) to support efficient just-in-time learning for professionals working in the "Smart city". In this paper, we present the principle and the structure of our contextual mobile learning system, which uses a search engine to find appropriate learning units in relation with working activities and conditions and the user's / worker's profile. We further discuss the proposed system structure, supportive process and context-driven engine. Finally, we describe a scenario using our contextual mobile learning system.

Keywords: smart city, contextual learning, EPSS, collaboration community, learning engine

1 Introduction

Cities throughout the world face the challenge of combining competitiveness and sustainable urban development simultaneously [1]. This challenge has an evident impact on issues of urban quality, such as economy, culture, industry and social aspects. The term "Smart city" focuses on a city's forward-looking development approach, which includes issues such as awareness, flexibility, transformability, synergy, individuality and self-decisive and strategic behavior [1]. For professionals working in the "Smart city", their work efficiency is crucial for maintaining availability of proposed services.

The study of working – learning conditions of professionals in the "smart city" seeks out solutions for the problem: how to create or to maintain professionals' working environment and professionals' working conditions, in order to improve working efficiency and enhance their companies' performance. In our study, we focus on providing professionals with efficient learning methods in the "smart city". We propose inspiring professional learning methods to contribute to "smart city" equipment mastery and maintenance by providing professionals with the right approach to acquire knowledge and skills wherever and whenever they so require.

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To provide a valid solution, it is important to analyze what kind of learning contents, including knowledge and skills, are needed to learn and understand in each professional field. The learning process to acquire professional skills can be summarized in three categories [2]:

1. Before work studies: this category provides learning contents before starting professional work, mainly during school studies. It offers theories and generic methodological approaches. However, due to time limitations and lack of a precise technical environment, learning contents in this phase are still generic and mainly theoretical.
2. Professional training: this category provides more practical learning contents at the beginning and during professional work at a fixed period of time and in a precise environment, during training periods. It offers more specific and precise information about the company and products, and explains the solutions to typical problems which emerge frequently during work. However, professional training cannot involve all tricky problems, and cannot offer the learning contents appropriate for all professionals according to their various profiles.
3. Workplace Learning: this category provides learning contents during professional work wherever and whenever the problems occur. In this phase, learners can acquire appropriate professional knowledge and skills for specific issues according to the context and learners' profiles. Learners could master specific equipment and appliances as well as special tasks, methods, tools and gestures in relation with and by practicing in the real environment.

We focus our research on workplace learning, which is a practical approach to solve specific problems. We tackle the process of problem-solving in relation with a task. Three learning periods in relation with a precise task can be identified, namely [3]:

1. Before the task: to learn about future actions.
2. During the task: to master the problem just-in-time by "learning by doing".
3. After the task: to learn about past actions to understand better what happened and accumulate experience.

Contextual Mobile Learning is an appropriate method used in workplace learning [4]. Based on its conception, a system could provide "just-in-time" learning contents, and implement a "learning by doing" process. In order to provide learning contents in response to context change, a workplace learning system should be aware of learning contexts. Learning contexts include any information which can be used to characterize the learning entities' situation and which are considered relevant to interactions between a learner and an application [5]. Mobile devices, which are equipped with many sensors and are characterized by mobility, can seek contexts more freely from both physical and virtual domains, and allow the mobile learning system to construct learning contents based on contexts [6]. Application of contextual mobile learning in the professional field has major advantages: increase learning flexibility, promote

problems solving efficiency, shorten learning time, and enhance company performance.

In this paper, we describe the principle and the structure of our contextual mobile learning system, and its context-driven engine. We then present a scenario ALF (French abbreviation for "in city goods delivery system") using this learning system. ALF could use the contextual mobile learning system to increase the use of delivery areas by prior reservation and dynamic adjustment if necessary.

2 Related work

A number of contextual mobile learning systems have been identified or created. Bristow [9] has demonstrated an approach which shows that simple sensor input indicating user status could provide effective context-dependent content provision. The result of this research indicates that context awareness can improve user performance on information retrieval tasks and leads to considerable improvements in user tasks.

The MOBIlearn project explored the ways of using the mobile environment to meet learners' needs. It provided an m-learning architecture to support learning contents' creation, storage and delivery. Peter Lonsdale presents an object-oriented, feature-based architecture for a context-awareness subsystem to be implemented within the MOBIlearn project, and considers the implications involved in the use of such a system for mobile learning [4].

While all the works mentioned above focus on how to classify and collect contexts, they ignore the approach used to provide abundant and appropriate learning contents according to those contexts.

3 SAMCCO system characteristics

By comparing with other contextual mobile learning systems for providing comprehensive professional learning contents in the PhD thesis carried out in our laboratory and defended in 2010, Chuantao YIN proposed the design for a contextual mobile learning system known as SAMCCO (French abbreviation for "contextual and collaborative mobile learning system for professional fields") [7]. This system is based on EPSS (Electronic Performance Support System), the goal of which is to store technical, working and learning data together in order to provide just-in-time, just enough training, information, tools and help for mastering or repairing equipment, appliances or products disseminated in the smart city environment. This system is able to provide appropriate information designed to maintain or ensure appropriate performance of smart city users when and where needed, thereby also enhancing the performance of the company as a whole and industry [8]. EPSS is used to store and deliver plant reference materials including: training documents, operating procedures and historical maintenance information. SAMCCO edits and organizes learning contents stored in the EPSS information database, which is an essential professional learning resource offering abundant and well-structured learning contents.

SAMCCO is based on AM-LOM metadata, an ontology, which are used in the learning unit model to describe and identify contextual mobile learning contents in a particular professional field. The goal of this model is to characterize learning units which will be explored by the search engine in order to provide appropriate "just-in-time" learning contents. SAMCCO's main component is the search context-based engine.

3.1 Metadata

Proposed learning units are expressed complying with a learning unit context model, which can be searched by a context-driven engine. SAMCCO defines a learning unit model, AM-LOM (Appliance Mastering Learning Object Metadata) to describe learning contents. AM-LOM is an extension of LOM (Learning Object Metadata), a standard metadata to describe a learning resource with 9 categories. AM-LOM inherits, redefines and adds elements to LOM for describing contextual mobile learning contents in a professional field. AM-LOM is expressed and can be edited as XML (eXtensible Markup Language), which provides the opportunity to exchange information between different databases and platforms and reorganizes the learning contents into learning units. The structure of SAMCCO's learning unit is shown in Fig. 1.

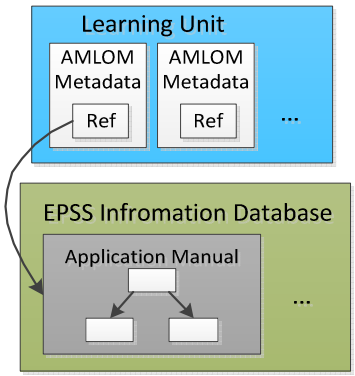

Fig. 1. Learning units identified by AM-LOM metadata and stored in EPSS

3.2 Context model

SAMCCO proposes a learning activity context model able to describe the main aspects of the contextual mobile learning activity in a professional field. By analyzing several learning scenarios in a professional field, involving just-in-time learning and collaborative learning, we defined a general context model for the contextual mobile learning activity. This general context model is based on six metamodels: actor, equipment, environment, activity, learning method and collaboration. Each metamodel has its own context elements. The general context model of the contextual mobile learning activity is shown in Fig. 2. Each specific learning activity is able to provide its learning contexts according to this general model.

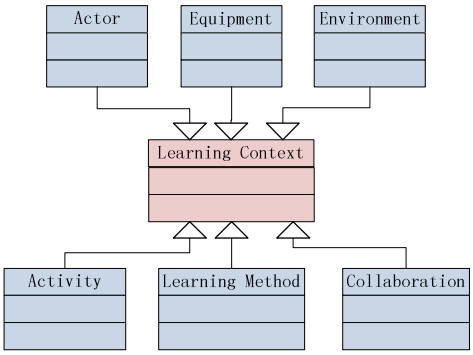

Fig. 2. General context model used for characterization of learning units

3.3 Context-driven engine

The main goal of the SAMCCO context-driven search engine is to find appropriate learning unit(s) in relation with contexts (complying with the general context model). This engine works systematically in four steps: grasp the learning context, select appropriate learning units, process the most appropriate contextualized learning unit, consolidate or finish the learning activity. The engine work process is shown in Fig. 3.

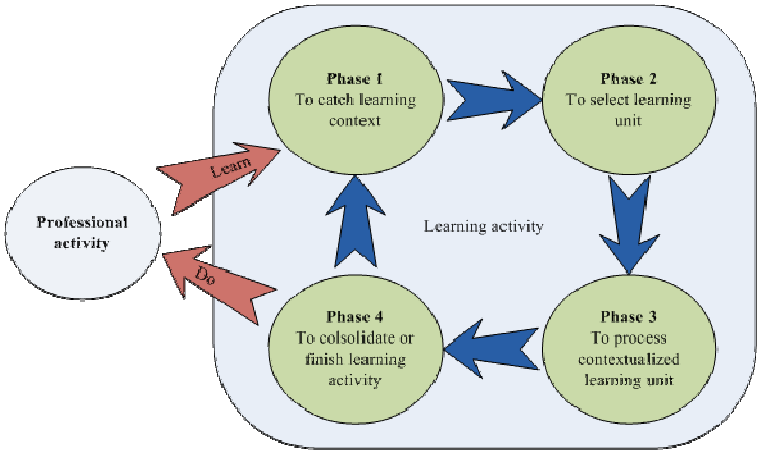

Fig. 3. Working process of the context-driven search engine

3.4 Principle and structure of our Contextual Mobile Learning System

The overall structure of our system is shown in Fig. 4. Professionals work on an application that allows them to perform a specific task. When they encounter a problem, the application sends the contexts (e.g. professionals' profile, operating records), which are collected during work and sent to the contextual mobile learning system.

Based on a series of strategies, the context-driven engine provides just-in-time learning contents stored in the learning engine database or indicates how to establish contact with partners to create a collaboration community. If the collected contexts are not sufficient to locate learning contents, the context-driven engine can ask the context-aware devices or the system for additional information to specify the context, and repeat the engine process.

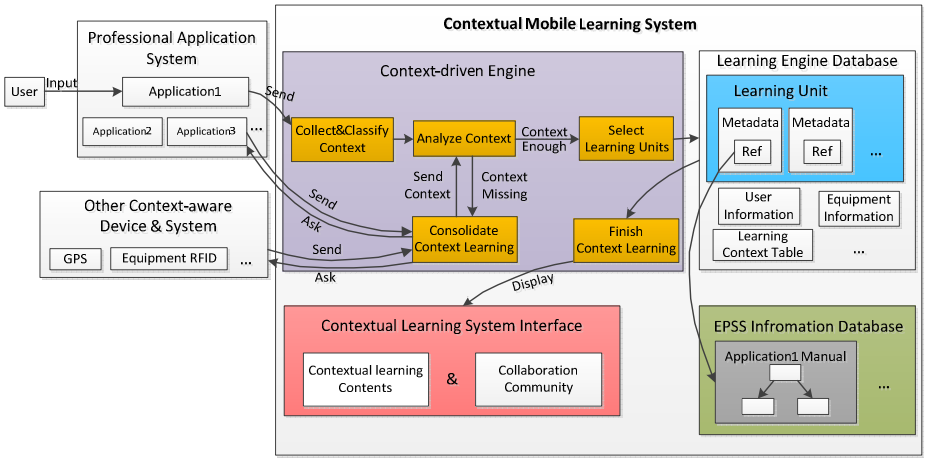

Fig. 4. Overall structure of the contextual mobile learning system used in a professional situation (application)

Globally, our contextual mobile learning system is divided into four parts: the EPSS information database, the learning database, the context-driven engine and the contextual learning system interface. The EPSS information database is the main source of professional learning contents. The learning database contains learning unit characterization by contextual metadata expressed in AM-LOM. These data are used to locate the learning contents by contextual searching, such as learning units, professionals' information, equipment information, learning context table and so on. The context-driven engine is the main part of our learning system. It provides a number of services to implement engine functions, such as collecting and classifying learning contexts, analyzing learning contexts, selecting learning units, and consolidating or finishing contextual learning.

3.5 Working process of the context-driven engine

To analyze whether or not collected contexts are sufficient to search for learning units, we have designed a learning context table stored in the learning engine database. Before applying the contextual mobile learning system, an application needs to register this learning context table. This table concludes the application ID and all the contexts mentioned in SAMCCO's general context model. Three states are defined to mark contexts. They are either compulsory (C), optional (O) or unnecessary (U). Applications register the learning context table on the basis of their own context needs.

For example, application1's ID is 1, and its compulsory contexts are context1, context2 and contextN, the optional context is context4, the other contexts in the model are unnecessary. Application1 needs to register the learning context table as in Fig. 5.

Application ID	Context1	Context2	Context3	Context4	...	ContextN
1	C	C	U	O		C

Fig. 5. Example of a learning context table

We construct the framework of the context-driven engine and give an accurate definition of its process. The process is shown in Fig. 6 and can be described as follow:

- **Collect and Classify Contexts**: In this step, contexts are input by professionals (e.g. professionals' profile Id and level) or recorded by applications (e.g. operation process). The context-driven engine collects these contexts and classifies them to form a current collected context table.
- **Analyze Contexts**: In this step, the context-driven engine selects the specific application's context item from the learning context table and compares the selected item with the current collected context table. If compulsory or optional contexts are missing, go to "Consolidate Contexts"; else go to "Select Learning Units".

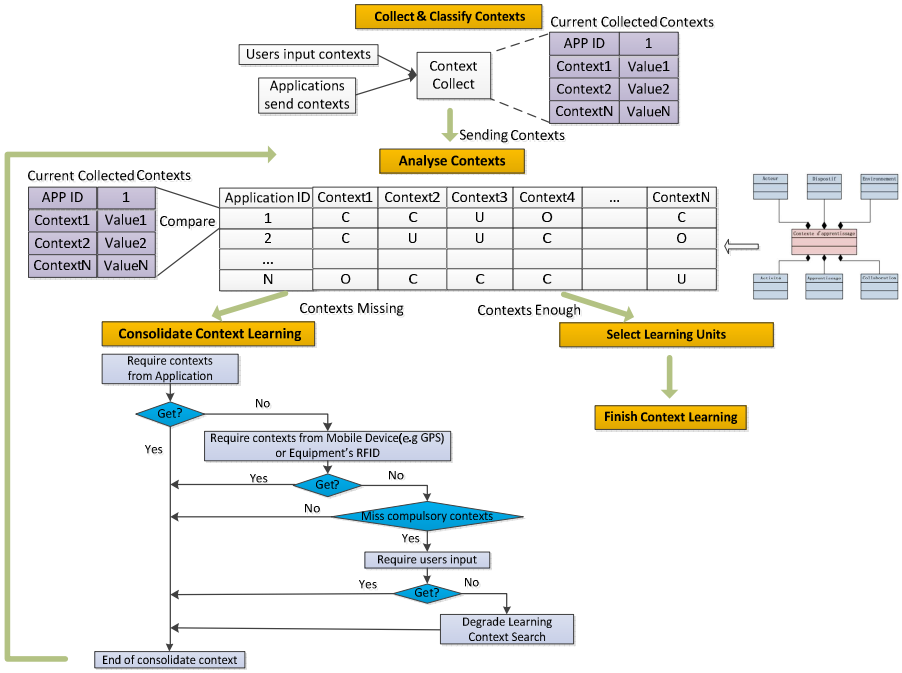

Fig. 6. Context-driven engine process

- **Consolidate Contexts:** In this step, first the context-driven engine acquires the missing contexts from the application. If this is not possible, the context-driven

engine acquires the missing contexts from the mobile device (e.g. GPS embedded in mobile device) or workplace equipment (e.g. equipment RFID). If contexts could not be acquired, the context-driven engine estimates whether the missing contexts are compulsory. If they are not, the engine stops consolidating contexts. Otherwise the engine continues to consolidate by sending messages which will be displayed in the application to ask for users' inputs. If users could not input, searching context learning unit is degraded.

- **Select Learning Units**: According to the collected contexts, compulsory or optional, the context-driven engine selects learning units in the learning engine database. The context-driven engine then sorts the selected learning units by priority: top priority are those learning units conforming both to compulsory and optional contexts. Besides, if so required by the learning activity, the context-driven engine selects experienced professionals and places them in a community to encourage collaboration.

4 A scenario using the Contextual Mobile Learning System

To illustrate our explanations, we present an actual example of use. In our work on Smart City problems [11] we work on a project called ALF (French acronym for "in city goods delivery system": "Aires de Livraison du Futur"), the goal of which is to increase the use of delivery areas by prior reservation and dynamic adjustment if necessary. Information Technologies (IT) with mobile communicating devices and in-roadway sensors are used to support the process management system. The ALF system is developed by a consortium in which we are the leading partner [12].

Transport and delivery of goods requires mastery of logistics in order to obtain coordinated transport of goods, transport chains, freight handling, respect of time windows, and planning arrangement [10]. A number of transport management software was designed to produce a well-organized workflow and ensure maximum efficiency. However, in reality, traffic jams are very common and all the odds are against application of off-line elaborated journeys. In the ALF project we examine the possibility of reserving delivery areas in the same way as conference rooms. A logistician can thus prepare a journey, organizing not only the trip, but also reserving delivery areas complying with delivery constraints such as client time availability. At the beginning of the journey, the driver – delivery person receives on his/ her handheld computer (tabletPC or Smartphone) a precise description of the journey. However, during his/ her trip he/she may encounter unpredictable situations such as an accident, roadwork, etc., and he/she must study how to obtain a more appropriate journey. These situations need to learn "just-in-time" about the right behavior to adopt. Appropriate learning units are proposed to take into account the delivery person's profile (beginner or expert) and the different situations to be studied. We identified several scenarios, to arrange delivery journeys, reserve or free delivery areas and promote communication among users. A picture of a tablet using the ALF system is shown in Fig. 7.

ALF applies our contextual mobile learning system to improve the learning capacity of transport companies by offering "just-in-time" learning contents (e.g. operating

steps, solutions for exceptions, current traffic situation) as well as a collaboration community among relevant delivery persons and logisticians. Two tasks should be performed beforehand:

1. Produce ALF system learning units: because ALF is a new application system, its manual should be added to the transport companies' EPSS information database. We then fragment all the documents and multimedia materials stored in EPSS into learning fragments. By editing the fragments with AM-LOM metadata, we obtain the ALF learning units.

Register ALF learning context: in the ALF system learning activity, we are mainly concerned with professionals' contexts (such as ID and level), environment contexts (such as traffic jams) and users' operating contexts. We then register the learning context table by filling in the ALF ID and marking each context.

Fig. 7. A tablet using the ALF system

The ALF system process can be described as follows: a logistician defines a delivery plan and reserves delivery zones on the ALF system. Then he/ she sends the delivery journey to a delivery person. This person then takes a mobile device running the ALF system. He/ she logs into the ALF system by inputting his/ her ID and executes the delivery journey by following the instructions displayed on the mobile device. The ALF system records the delivery person's operating steps. The mobile device detects the entire external environment. If the delivery person does not know how to operate the ALF system, ALF sends the delivery person's operating steps as operating contexts to the contextual mobile learning system, and the system returns the accurate operating instructions. If the truck is blocked in a traffic jam which can be detected by the speed sensor embedded in the mobile device, ALF sends the environment contexts to the contextual mobile learning system, and the system builds a collaboration community between the delivery person and the logistician to reorganize the delivery journey.

5 Conclusion

In this paper, based on our contextual mobile learning vision, we described our learning system which combines abundant learning contents in an EPSS information database and encouragement for collaboration. We elaborated the principle and structure of our contextual mobile learning system, and the process of its context-driven en-

gine. Finally, we discussed a scenario using our learning system. The features of the proposed system can be summarized as follows: (1) reorganizing learning contents, so that information in different systems could be shared between professionals (2) providing professionals with “just-in-time” learning contents anywhere and anytime; and (3) increasing the probability for collaborating in workplace learning. Our future works include (1) implement the prototype of the contextual mobile learning system using the context-driven engine; (2) design other professional scenarios to evaluate the learning system; (3) adapt our contextual mobile learning system to other fields in the “Smart city” on which we are working [11]: a few examples are dynamic lane management, bus shelter use for traffic, neighborhood social life.

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A Web Content Accessibility Evaluation process for Learning Objects in the context of a Virtual Learning Environment

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Abstract. A wide variety of web content editors that are included on virtual learning environments, help teachers to create learning objects as web pages to support their teaching processes, those editors add some accessibility features to the generated web content . However in most of the cases, the generated web content is not always according to all Web Content Accessibility Guidelines (WCAG 2.0). As a result, teachers and students with disabilities could not properly use the web content in their learning or teaching process. In this paper, we introduce a plug-in for the TinyMCE web content editor to support the web content accessibility manual evaluation process by applying the Case Based Reasoning technique. It is useful, when teachers use the TinyMCE editor upon the ATutor virtual learning environment, because teachers can identify web accessibility failures that can be improved by using recommendations provided by human evaluators.

Keywords: virtual learning environment, learning objects, web content accessibility, accessibility evaluation, case based reasoning.

1 Introduction

Web content accessibility evaluation is a process whereby experts, developers or teachers should ensure that their web contents have at least the minimum level of web accessibility required by any user (with or without disabilities) in special when there is an interaction in a Virtual Learning Environment (VLE). One of the most important features in a VLE is the web accessibility. This feature allows teachers and students to use contents without any accessibility barrier. According to Dunn [1], when web technologies are used in an appropriate way and there is an understanding of user requirements, the learning objects presented on a VLE, can, at least, be made accessible to students with some type of disability.

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The widespread use of VLEs through the web requires accessible web contents to improve the access and use of learning objects by teachers and students with disabilities. Each time, teachers use more tools, like web content editors, to generate those contents. However, teachers are not always familiarized with web accessibility. To tackle this situation, the experience from experts can be used in the web content accessibility evaluation process.

In this work, we have considered some elements to introduce a new approach in the web content accessibility evaluation process especially when learning objects are created in the context of a VLE. Those elements are:

- Web content accessibility guidelines: In some countries the governments and educational institutions have a concern to improve the accessibility in web environments. But as an international recommendation we can use the guidelines of World Wide Web Consortium (W3C) known as Web Content Accessibility Guidelines (WCAG 2.0).
- VLE: virtual space where teachers create their learning objects and students interact as a complement to their traditional learning process. In this work we use ATutor as the VLE.
- Web content editor: in ATutor the default web content editor is TinyMCE.
- Learning Objects: in this work we consider as learning objects the web pages created by means of the TinyMCE web content editor upon the ATutor VLE.
- Users: there are two users, teachers and experts. Teachers create de learning objects and may be tagged as beginners in their knowledge about web accessibility; and experts evaluate the web accessibility in the learning objects.
- CBR: the recommendations from experts in the web content accessibility evaluation process help teachers to improve the accessibility of web pages. To support the generation of those recommendations we use the Case Based Reasoning (CBR) technique.

One of the most important questions we need to answer in order to provide an additional support in web accessibility evaluation (considering as scenario the interaction between users and a VLE) is: How can CBR technique support the web content accessibility evaluation process for learning objects in a VLE? To answer the research question, in this paper a new approach in the web content accessibility evaluation process is introduced.

This document is structured as follows: section 2, we introduce a background of web accessibility and the CBR technique; in section 3, we describe the main components of the introduced approach in a plug-in called Web Content Accessibility Plug-in (WCAP) and its implication on the ALTER-NATIVA project; finally in section 4 conclusions and future work are stated.

2 Background

2.1 Web Accessibility Guidelines

To understand the web content accessibility evaluation process it is important to have a reference about the guidelines proposed by the World Wide Web Consortium (W3C) [2] for this purpose. The Web Content Accessibility Guidelines (WCAG) is a recommendation of W3C and its latest version is the WCAG 2.0 [3] which was published at 2008. WCAG 2.0 is organized in four principles: perceivable, operable, understandable and robust. Principles are, in turn, divided in 12 guidelines and for each guideline was defined some success criterions [4]. In Fig. 1, it is given representative organization diagram for principles in WCAG 2.0. In addition to above organization of WCAG 2.0, each success criterion has one of the three levels of conformance proposed by W3C too. These levels are: A, AA and AAA, being A the lowest level [5].

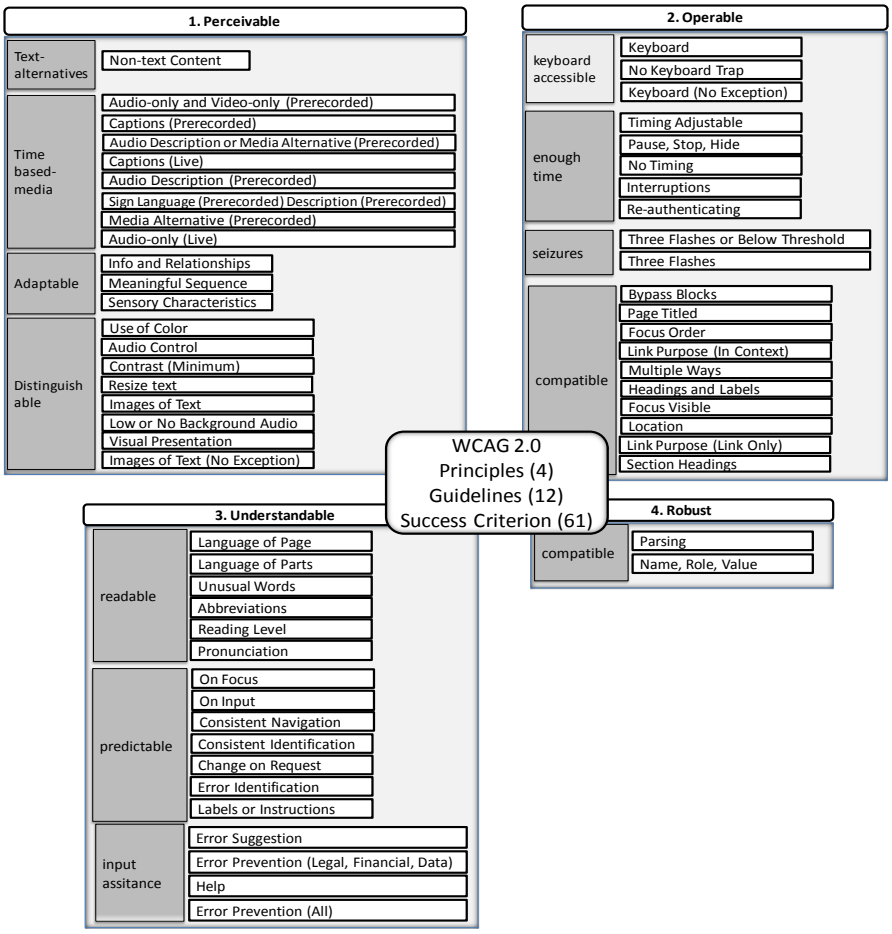

Fig. 1. Principles organization in WCAG 2.0

2.2 Web accessibility evaluation process

According to the WAI (Web Accessibility Initiative) [6], a web content accessibility evaluation process can be defined as the process in which experts (with different expertise level) verify and determine if a web site meets standards and guidelines. As examples of this process, there are some case studies that show how is applied this web accessibility evaluation process. For instance, according to the study made by Alonso, Fuertes, González and Martínez [7], a set of web page are analyzed by people whose are learning about WCAG 2.0 (beginners) and Branjnik, Yesilada and Harper [8] present an study where the web accessibility of a set of web pages is evaluated by "expert" people in WCAG 2.0. In both examples, there is an agreement, a web content accessibility evaluation process has to ways of evaluation, a manual evaluation and automatic evaluation.

In the manual evaluation, experts use different strategies to evaluate the web content accessibility. Whereas that, the automatic evaluation is supported by software that analyzes the internal markup on the web pages and gets reports according to some characteristic selected by user. Following this description, on one side we can conclude that both of them process can be used in parallel way, because in a manual evaluation experts can use automatic evaluation tools in order to identify and get a solution to new failures on success criterion, on the other side an important stamen is mentioned in [7], the support material and different evaluation tools need to provide some kind of help to human evaluators in order to obtain consistent results in the future. In [8] is analyzed the expertise effect assuming that there is different expertise levels of different evaluators. Then in the evaluation process, [8] define that is required that experts know and understand about:

- How people with some kind of disability use the web environments?
- What kind of assistive technologies need to use the user to navigate through the web contents?
- Which are the limitations of those technologies?
- How they interact with other technologies?

As mentioned above, manual evaluation process requires the support of some automatic evaluation tools. These kinds of tools get us different possibilities when we like to generate a report evaluation of a specific web page. For example, in some of them we can select which version of WCAG we like to work, which type of structure (CSS, HTML, and so on) we like to evaluate.

2.3 Automatic Evaluation tools for WCAG 2.0

There are a set of automatic validators for web content accessibility evaluation that works under WCAG 2.0 recommendation. In the Table I, are listed and analyzed some of them. The comparative attributes are referred to: is the validator an online service?; is it an standalone application?; is it open source?, does allow it a demonstration?; and does allow it file upload to test local web pages?.

Table 1. Comparative of Automatic validation tools for WCAG 2.0

Validator	Comparative attributes					
	Online	***Standalone***	***Free***	***Open Source***	***Demo***	***File Upload***
AChecker	X		X	X		X
TAW	X		X		X	X
eXaminator	X		X			
TotalValidator tool		X	X			X
SortSite	X	X			X	X

By means of above analysis we identified that is possible to work with the AChecker validator [9] because this service is available online, is free and open source, besides it can be integrated within some VLE.

Once we have introduced the web accessibility concepts, in the next section a background of case based reasoning (CBR) is presented.

2.4 Case Based Reasoning (CBR)

As is known in the CBR technique new problems represent new cases to be solved by means of case retrieval from previously correctly solved similar problems [10] [11] [12]. Moreover, this technique uses the past experience (solving cases) to feed a set of cases. In this work, we choose CBR technique because it allows us to match the experience from experts who know about accessibility in web contents (using the success criteria of WCAG 2.0) with the design of educational web content. For instance, when a teacher uses the TinyMCE web content editor, he/she would need a help to know how to do web pages more accessible. In this sense, the CBR technique is useful to provide a set of recommendations based on the identified web accessibility failures in the evaluation process.

CBR technique is developed by means of a cycle which is known as four R or R4 [13] because the process (that is involved on it) can be represented as a cycle of four stages and each first letter in the name of the stage is R: Retrieve, Reuse, Review and Retain.

3 WCAP – Web Content Accessibility Plug-in

This section explains the plug-in developed and integrated in the TinyMCE editor in order to support the web content accessibility evaluation process when teacher are creating and editing learning object as web pages. Besides, this section explains, each step of the CBR cycle involved in the web accessibility evaluation process.

3.1 CBR Cycle on Web Content Accessibility Evaluation

In Fig 2 is presented the R4 cycle applied to the web content accessibility evaluation process described for this work. It is given a new problem (failure with some success criterion according to WCAG 2.0) at first stage or retrieve stage; a similar case or a set of similar cases are retrieved from the library case which store all case solved (second stage: Reuse); Then when a similar solution is retrieved some adaptation could be needed in order to solve the new case (third stage: Review). Once the solution is given, a new case and its solution are stored in the library case as a learned case in the retain stage. Finally the system store the case completely solved (fourth stage: Retain).

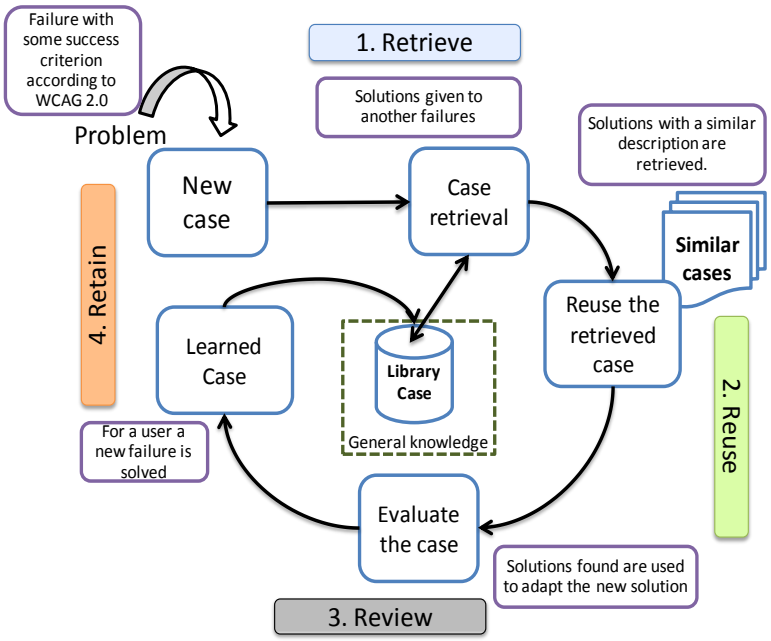

Fig. 2. R4 Cycle in web content accessibility evaluation.

3.2 WCAP and ALTER-NATIVA Project

WCAP is presented as a plug-in which will support the task of teachers in the web content accessibility evaluation process when they using TinyMCE editor. This plug-in is developed under work context of ALTER-NATIVA [14] project. ALTER-NATIVA is a European project and its main goal is to define curricular references with technological support for higher education in the areas of language, mathematics and science, for attending people in context of disability (such as blind people, deaf people and indigenous people). Taking into account the disabilities covered by the project, there is a need to create accessible learning objects, so that all people, with

different needs and preferences, can use the generated content for their learning process. WCAP will be tested in the validation stage of ALTER-NATIVA project.

As a schematic representation of the process depicted in Fig. 3 shows how the workflow diagram is performed when the teacher and the expert interact with WCAP. Notice that some steps have an indication of which stage of CBR cycle is corresponding with.

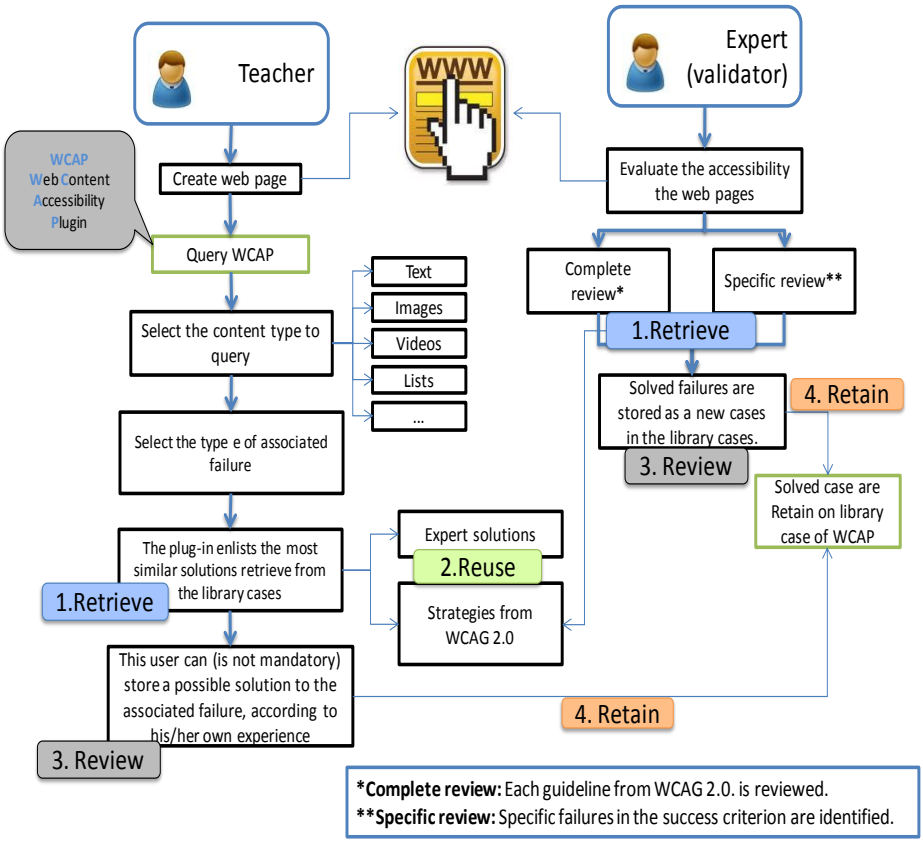

Fig. 3. WCAP Workflow.

The main steps in the process are:

- Teacher creates new learning objects as web pages by using a web content editor integrated in a VLE.
- The expert reviews the list of web pages in the system and then selects some page to be evaluated. Next the expert chooses between a complete review of the web page or a specific review.
- After that, expert or teacher can select an element with some failure according WCAG 2.0 and at this point is presented the form of a new case.

- Once the expert or teacher sends the query that allows evaluating the new case, by means of WCAP (Fig. 4) the most similar cases are retrieved. This similarity is calculated by mean of the attributes presented in each case.
- A set of the most similarity solutions according to the current case are suggested to the expert or teacher who decides if use some of these suggestions to elaborate the new solution to that case
- When the solution to the current case is stored as a learned case in the library cases, it will be available to solve other new problems.
- The teacher uses advertise of the web content accessibility manual evaluation process as a recommendation to improve the accessibility on their learning objects (in this case web page).

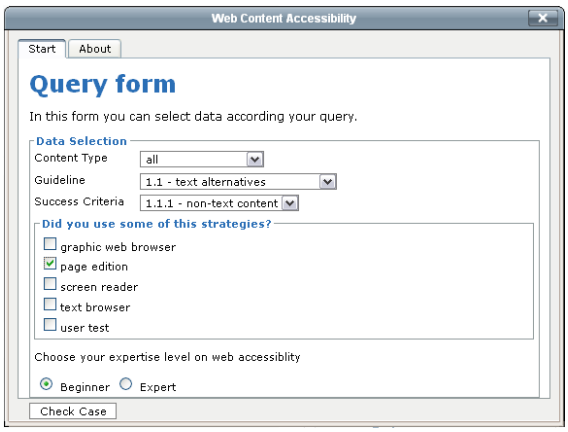

Fig. 4. WCAP query form screenshot

3.3 Implementation notes

To develop the WCAP plug-in integrating the CBR technique we use the jCOLIBRI [15] framework. This framework was developed by the GAIA [16] group from the Universidad Complutense de Madrid. A class in the framework is implemented by using three main methods: PreCycle, Cycle and PostCycle. In the PreCycle method, the component and its connection to the library case is configured, in the Cycle method, each stage of the CBR cycle is performed and in the PostCycle method connections are closed.

Taking into account the CBR cycle, to retrieve the most similar cases in the retrieval stage, jCOLIBRI uses different methods and the most important retrieval methods is the Nearest Neighbour or NNretrieval. In this method a similarity between new cases and stored cases is computed to retrieve the best recommendation in web accessibility for teachers.

To integrate the WCAP plug-in in the TinyMCE editor, we developed two modules:

- The first module was modeled as a dynamic web application, which uses the jCOLIBRI framework. This application is connected with a library case (in a Postresql [17] database) where the expert`s experience about the failures in web content accessibility is stored. This module also supports the core services of the CBR-based component.
- The second module is the plug-in developed in Javascript language, in which teachers can search for solutions about their web accessibility doubts, mainly when they need to know how to solve an accessibility problem in the web content they are editing.

Both of these modules were connected using the DWR (Direct Web Remoting) [18], a bridge to communicate the Javascript interface of the plug-in with the CBR-based component.

4 Conclusions and Future Work

The plug-in WCAP is not introduced as a new web accessibility evaluation method; it is an additional support to the manual approach of web accessibility evaluation. In addition, the architecture could be implemented in a wide variety of areas such as software development industry (in order to improve the process of accessibility evaluation in software products), educative context (in order to manage the evaluation process of learning objects during the implementation process by teachers), organizations (which support companies in the process of making their web pages accessible). This wokr is an effort towards the inclusive and accessible web for all so that people with any disability such as visual impairment, deafness or cognitive disabilities can access to all web content.

CBR technique provides an important support that allows us to integrate the people's expertise about accessibility in web content evaluation with the success criterion of WCAG 2.0. By means of CBR the architecture combines solutions regarded web accessibility issues providing a better support in the evaluation process including recommendations from other experts.

As future work, we are planning to use and improve the plug-in according to the results obtained after the test stage of ALTER-NATIVA European project.

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Virtual Laboratory for the Study of Kinematics in Engineering Faculties

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Abstract. In engineering faculties, kinematics is studied during the first year, providing the basic knowledge for understanding, modeling and designing mechanical systems. The traditional method of teaching kinematics uses drawings and mathematical equations to explain the motion of rigid bodies forming various mechanisms. From the experience of the authors, due to this approach students often tend to regard kinematics as excessively abstract, having difficulties in understanding the correspondence between analytical expressions and the actual behavior of mechanisms. The Virtual Laboratory of Kinematics (VLK) is an attempt to overcome these difficulties, by allowing students to visualize and interactively modify the motion and configuration of basic mechanisms. VLK consists of a package of software applications, which has been tested in theoretical mechanics classes during the past few years. The favorable feedback received from students encouraged the authors to improve it gradually and, recently, to completely re-write it, also implementing additional features and capabilities.

Keywords: virtual laboratory, mechanics, simulation, mechanism

1 Introduction

Generally taught in the first year in engineering faculties, kinematics is part of the fundamental course of theoretical mechanics. The knowledge acquired in this course provides the basics for the study, in the following years, of technical disciplines addressing the design of mechanisms and, in general, of various mechanical devices.

The traditional way of teaching kinematics consists in using schematic drawings and mathematical formulas to explain the motion of points or of rigid bodies. The application sessions consist, in the same approach, in demonstrations made by instructors in the laboratory, based on the use of mechanical models. This teaching method has inherent shortcomings because of its relatively limited capacity of illustrating the correspondence between the analytical expressions taught at the course and the actual phenomena. At the same time, the mechanical models used for demonstration are unable to exemplify some of the key notions taught at the course, for instance the

trajectories, velocities or accelerations of certain points. Moreover, their configurations and characteristics are generally difficult to adjust, so that the possibility of varying the problem input and parameters is limited.

The use of e-learning technologies and software can provide a modern, more efficient way, of teaching kinematics, by the virtualization of mechanical models and laboratory demonstrations. During the past two decades, with the increasing use of personal computers, the development of virtual laboratories as e-learning instruments has gained momentum in various fields, from technology to natural sciences or mathematics and for different levels of instruction [9], [10], [13]. Applications designed for teaching engineering sciences in universities represent a distinct category. Today, many universities use in-house software dedicated to such purposes [2], [4], [6-8]. This software provides low-cost, highly customized solutions for the teaching process, having the advantage, in contrast with commercial products, of being easily adaptable and extendable according to local curricular requirements.

During the past few years, the authors of the present paper have experimented different methods of improving the teaching of kinematics, and of theoretical mechanics, in general. The Virtual Laboratory of Kinematics (VLK) is one of the most recent results of these efforts, consisting of a package of software applications dedicated to the modern and efficient teaching of the discipline. Created by using modern software development platforms, namely Visual C++ [5] and OpenGL [12], these applications display real mechanisms and allow the user to interactively customize the sizes of the parts, the parameters of the motion and the graphical representations. VLK incorporates the experience acquired by the authors in the use of earlier applications developed by them for the study of different chapters of theoretical mechanics [3].

2 Description of the Virtual Laboratory of Kinematics

2.1 General

The Virtual Laboratory of Kinematics (VLK) includes, at present, four software applications, designed to illustrate animatedly various kinematical characteristics of mechanisms containing rigid bodies, in translation, rotation and plane motion, respectively [1], [11].

Each application starts with a default set of values, but the user can define, optionally, his own input data. By checking or unchecking various checkboxes, the user can also choose the characteristics that are represented.

The applications display the motions of the mechanisms, with the instantaneous values of the coordinates, as well as the velocity and acceleration components, for the relevant points of the considered mechanical systems.

The graphic style and layout of the applications was optimized, taking into account the following requirements:

- maximum clarity and simplicity of representation, for easy understanding and focusing on the important features;

– minimal use of hardware resources, so that students working on lower performance computers should not be disadvantaged;
– maximum contrast and visibility, for visually impaired students;
– large display, adapted for use with a projector.

All applications provide the possibility of zooming in and out the display, in order to obtained detailed and overall views of the mechanisms. This feature is particularly useful for displaying entirely the generated trajectories and centrodes.

2.2 "Cardan" Application

The application studies Cardan's problem, i.e. the motion of a bar with one end constrained to move on a horizontal straight line and the other end constrained to move on a vertical one. An application of this type of mechanism can be found in steam engines.

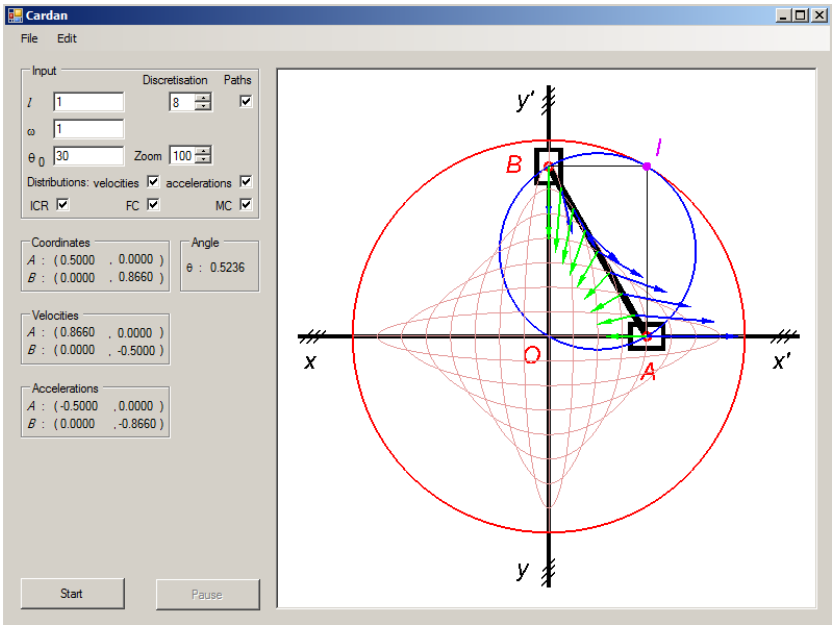

Fig. 1. "Cardan" application: trajectories, velocities, accelerations, instantaneous center of rotation, fixed centrode, movable centrode

The application illustrates the main characteristics of the plane motion of a rigid body (Fig. 1): trajectories, velocity and acceleration distribution, instantaneous center of rotation (ICR), fixed centrode (FC) and movable centrode (MC).

The student can define the following data: length of the bar, l, angular velocity, ω, initial angle between the bar and the vertical direction, θ_0, and a bar discretiza-

tion parameter (used to represent the trajectories, as well as the velocity and acceleration fields).

The program is based on the formulas that define the coordinates of the end of the bar, expressed with respect to the Cartesian reference system in Figure 1 (with the horizontal axis xx' and the vertical axis yy'),

$$\begin{cases} x_A = l\sin\theta \\ y_A = 0, \end{cases} \qquad \begin{cases} x_B = 0 \\ y_B = l\cos\theta, \end{cases} \tag{1}$$

where

$$\theta = \omega t + \theta_0 . \tag{2}$$

The instantaneous center of rotation, I, is a point of zero velocity, situated on the rigid body that is in plane motion (bar AB) or on an extension of this body. With respect to the fixed reference frame, the point I describes a curve called fixed centrode (the large circle in Fig. 1), while with respect to the reference frame linked to the body it describes another curve, called movable centrode (the small circle in the same figure).

2.3 "Parallelogram" Application

The program studies the motion of a parallelogram mechanism, which consists of three bars. Two of the bars (having the same length), are connected by hinges to the fixed element, while the third one (with the length equal to the distance between the fixed hinges) is connected by hinges to the first two. The first two bars have rotation motions, while the third one has a translation motion. An application of this type of mechanism can be found in front end loaders.

The program illustrates the main characteristics of the rotation motion and translation motion, respectively, of a rigid body (Fig. 2): trajectories, as well as velocity and acceleration distributions.

The student can define the following data: length of the rotating bars, $a = OA$, length of the translating bar, $b = AB$, angular velocity, ω, initial angle between the rotating bars and the horizontal direction, θ_0, and two bar discretization parameters.

The program is based on the formulas defining the coordinates of the movable hinges, expressed with respect to a Cartesian reference system chosen with the origin in the fixed hinge, O,

$$\begin{cases} x_A = a\cos\theta \\ y_A = a\sin\theta, \end{cases} \qquad \begin{cases} x_B = a\cos\theta + b \\ y_B = a\sin\theta, \end{cases} \tag{3}$$

where the angle θ, made by the rotating bars with the horizontal direction, is expressed by relation (2).

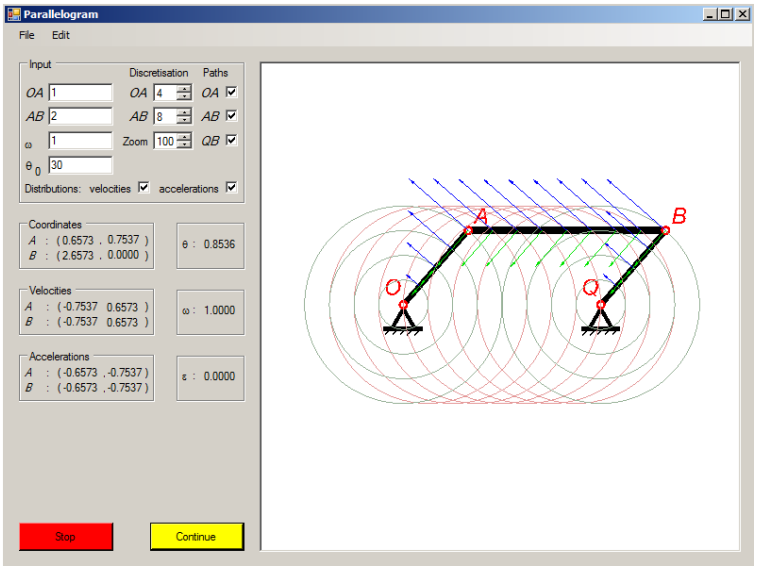

Fig. 2. "Parallelogram" application: trajectories, velocity and acceleration distributions

2.4 "FourBar" Application

The program studies the motion of a plane four-bar mechanism. The system consists of two bars connected by hinges to the fixed element, a third bar connected by hinges to the first two and a fourth bar (not represented by the program), connecting the fixed hinges. Unlike the parallelogram mechanism, the lengths of the bars are arbitrary. The first two bars have rotation motions, while the third one has a plane motion. Applications of this type of mechanism can be found in various industrial machineries, such as robots.

The program illustrates the main characteristics of the rotation motion and plane motion, respectively, of a rigid body, i.e. trajectories (Fig. 3), velocity and acceleration distributions (Fig. 4), instantaneous center of rotation (ICR), fixed centrode (FC) and movable centrode (MC) (Fig. 5). The method of velocity plane and the method of acceleration plane, used for the kinematical analysis of the system, are also represented in Figure 4.

The student can define the following data: lengths of the bars, $a = OA$, $b = AB$, $c = QB$, $d = OQ$, angular velocity of the bar OA, ω, initial angle of the same bar with the horizontal direction, θ_0, and three bar discretization parameters.

Using a Cartesian reference frame with the origin in the fixed hinge, O, the coordinates of point A are the same as for the parallelogram mechanism (3), while the coordinates of B can be determined from the equations

$$\begin{cases} (x_B - x_A)^2 + (y_B - y_A)^2 = b^2 \\ (x_B - d)^2 + y_B{}^2 = c^2. \end{cases} \tag{4}$$

The two centrodes of the bar AB are complex curves, each with two branches, determined numerically, unlike the case of "Cardan" application, where they are circles.

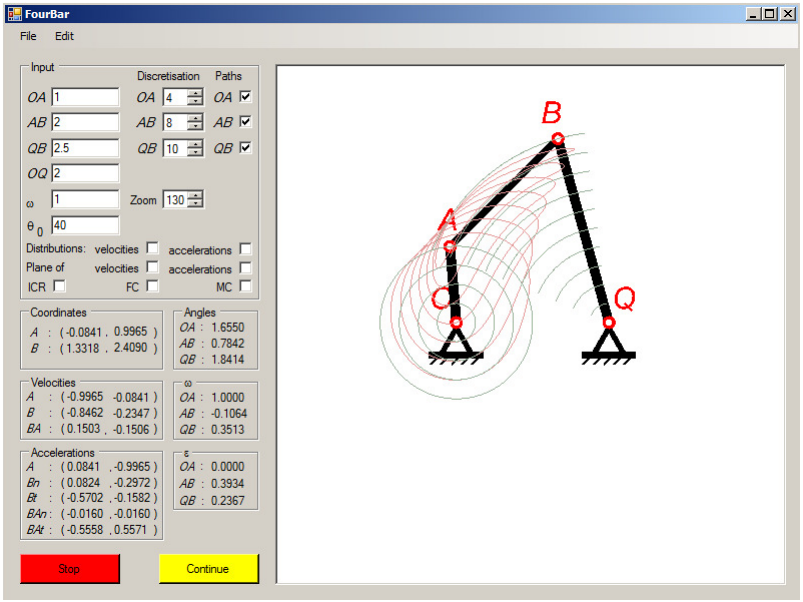

Fig. 3. "FourBar" application: trajectories

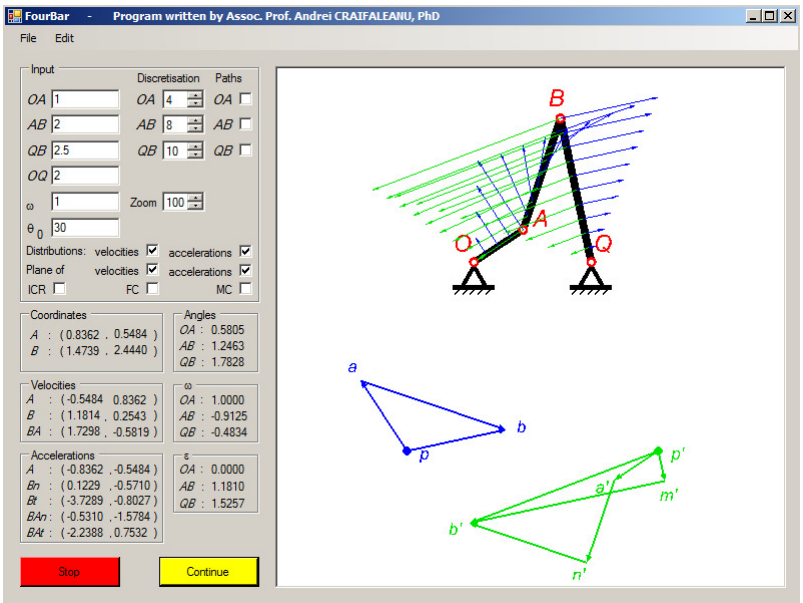

Fig. 4. "FourBar" application: velocity and acceleration distributions, plane of velocity, plane of acceleration

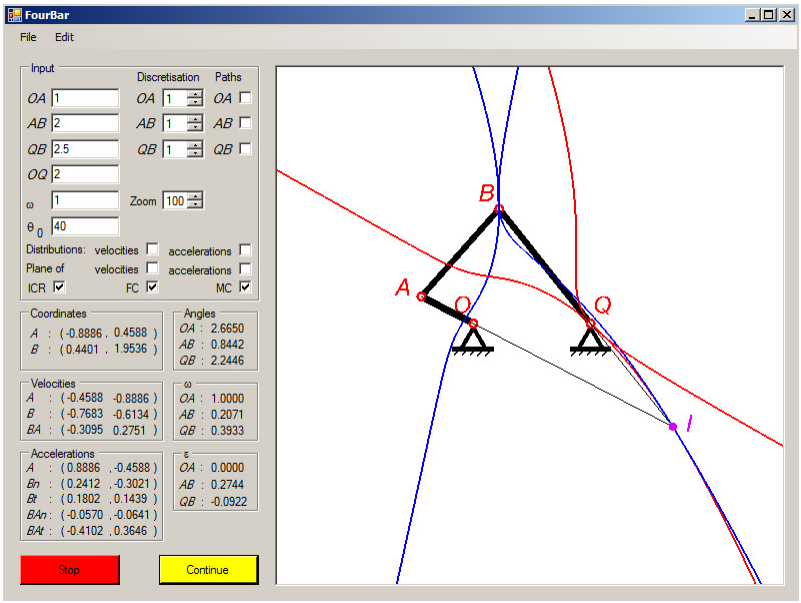

Fig. 5. "FourBar" application: instantaneous center of rotation, fixed centrode, movable centrode

2.5 "SliderCrank" Application

The program studies the motion of a slider crank mechanism (without or with offset), which consists of two bars, one of them connected by a hinge to the fixed element and the other connected by hinges to the first bar and to a slider. The first bar has a rotation motion, while the second bar has a plane motion. This type of mechanism, which converts the translation motion into rotation, is currently used in piston heat engines.

The program illustrates the main characteristics of the rotation motion and of the plane motion of a rigid body, i.e. trajectories, velocity and acceleration distributions, the method of velocity plane, the method of acceleration plane (Fig. 6), instantaneous center of rotation (ICR), fixed centrode (FC) and movable centrode (MC).

The student can define the following data: bar lengths, $a = OA$, $b = AB$, offset (distance between hinge O and fixed direction xx'), e, angular velocity of the bar OA, ω, initial angle of the same bar with the horizontal direction, θ_0, and two bar discretization parameters.

Using a Cartesian reference frame with the origin in the fixed hinge O, the coordinates of point A have, again, the expressions written for the parallelogram mechanism (3), while the coordinates of B are determined from the equations

$$\begin{cases} x_B = a\cos\theta + \sqrt{b^2 - (a\sin\theta - e)^2} \\ y_B = e. \end{cases} \tag{5}$$

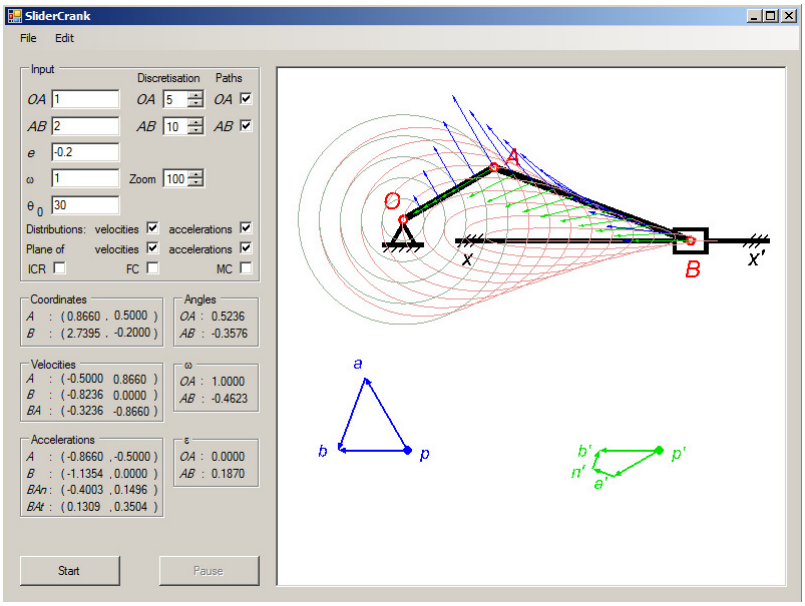

Fig. 6. "SliderCrank" application: trajectories, velocity and acceleration distributions, plane of velocity, plane of acceleration

3 Use of VLK in application sessions

3.1 Steps of the application session

VLK was used in kinematics application sessions at the University "Politehnica" of Bucharest. The steps of the application session are described below. The corresponding course chapters are used as prerequisites.

1. Brief reminding of applicable notions and equations, performed by the instructor.
2. The instructor presents problem-specific aspects, in preparation of the practical demonstration.
3. The instructor explains the use of the software application (component of VLK).
4. The students fill in the input data, launch the animation and observe the motion of the mechanism, as well as the real-time evolution of parameters, trajectories and graphic representations.
5. By changing successively each input parameter, the students observe the modification of the mechanism behavior and of the graphical output (trajectories, centrodes etc.).

The instructors assist the students in performing the last two steps and explain the changes observed on the screen. They also highlight the practical applications of the concerned mechanism, e.g. in various types of industrial machinery, and answer the questions asked by the students.

3.2 Observed outcomes

The response of the students to the use of VLK in application sessions was extremely positive, with an evident progress in their active participation in the class. Due to the interactive features of the software, the sessions became more dynamic and attracted increased attendance. Students expressed favorable opinions about the new teaching method, some of them also suggesting GUI improvements or the development of VLK by including new applications.

From the point of view of the impact on the teaching activity, the use of VLK facilitates substantially the explanation of the mechanism motion and of the influence of various parameters on its behavior. Since most of the engineering students have a particular interest in mechanisms, as a field of their future profession, the illustration and the highlighting of the practical applications respond to their expectations.

One of the main factors that contribute to the success of kinematics teaching based on VLK is the fact that it puts together both the theoretical aspects of the problem (i.e. the equations that define the motion of the mechanism) and the practical aspects (i.e. its visualization and interactive control), creating, thus, a suggestive correspondence between the analytical expressions and the actual behavior of the mechanism.

4 Conclusions

The Virtual Laboratory for the study of Kinematics (VLK) consists of a package of graphical interactive software applications, developed to facilitate the understanding of the key notions of kinematics by students in engineering faculties. The applications provide a set of simple mechanisms, for which the user can customize appearance, size, motion parameters and displayed diagrams.

The applications structure is developed such as to illustrate the key aspects taught at the course, by providing an intuitive demonstration of the motion of the studied mechanisms, combined with various animated representations, such as velocity and acceleration diagrams, fixed and movable centrodes etc.

The graphical representations, as well as the layout of the applications screens, are optimized for maximum clarity, accessibility and visibility, in order to provide the best quality of information dissemination to all students.

The authors benefited, in the development of VLK, by the experience acquired with some earlier applications developed by them for the study of different chapters of theoretical mechanics. The favorable feedback received from students encouraged the authors to gradually improve these applications, by adding new features and, recently, by completely re-writing them, adding new mechanisms and upgrading their graphical capabilities and overall performance.

Based on the scalable concept of VLK, future development is planned, consisting in gradually adding new applications for various kinematic mechanisms.

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Effect of Multiplayer Interactive Violent Video Games on Players' Explicit and Implicit Aggression*

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Abstract: While violent video games are of great concern to the public for their potential impact of inducing aggression, recent changes in the dynamics of gaming has rendered study of such phenomena quite challenging. The impact of interpersonal factors on players' aggression has not yet to be fully understood. The present experiment was designed to test explicit and implicit aggression caused by multiplayer interactive violent games. 56 male participants were randomly assigned to three groups (four-player group, double-player group and solo-play group). Extrinsic Affective Simon Task (EAST) and words evaluation task (WET) were used to test implicit and explicit aggressive cognition respectively. Competitive Reaction Time Task (CRT) was for measuring explicit aggressive behavior. Results showed: (1) Participants with low-trait aggression were more aggressive in implicit aggressive cognition when playing in four-player group than in other two groups. (2) Explicit aggressive cognition was affected by both interactive modes and trait aggression without interaction. The solo-play group was more explicitly aggressive than the four-player group. High-trait aggression group was more aggressive than low-trait group. (3) Participants' aggressive behavior decreased as the number of players increased. Factors that affect violent video games' impact on players' aggression were discussed.

Keywords: Violent Video Games, Multiplayer Interaction, Explicit Aggression, Implicit Aggression, Trait Aggression

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Introduction

1.1 Violent Video Games in People's Daily life

Video games are widespread with the popularization of the Internet. According to the report of user's consumption in game market (2010), sales of online games in mainland China reached RMB 25.62 billion, an increase of 39.4% compared with the year 2008. Another accounting report (2012) showed that by the end of 2011, users of online games in China had surpassed 324 million.

Applications of rapidly developed computer-based technology make video games quite different from those PC designed games. Seeking commercial benefits, game developers design more interesting and more realistic video games to attract players through Virtual Reality Technology (VRT). More role-play modes are employed in video games to increase players' engagement and identity in game roles. Besides, open ended stories in online games increase the likelihood of players' addiction. At present, Massively Multiplayer Online Role Playing Games (MMORPG) becomes a trend of online games. Bringing high level enjoyment and immersion, multiplayer interaction has become essential in game design (Mandryk, Inkpen, & Calvert, 2006).

Of more concern, violent content is also designed in video games to attract players. In mainland China, supervision systems of video games are not sound, resulting in a flood of violent games without classification sold in markets. The authors in this study conducted a survey on video game habits in mainland China from 2009 to 2011, which showed among the most often-played three video games for college students, 84.4% of the games consisted of violence and 30.2% were extremely violent. For middle school students, 92.5% of their favorite games were violent.

1.2 Impact of Violent Games on Aggression

Early in the 1960s, psychologists found children learned aggressive behavior through imitating violent behavior on television (Bandura, 1961). Compared with other media, violent video games tend to have a greater impact on players' aggression. With players' highly participation and interaction (Calvert, & Tan, 1994), video games reinforce players' aggressive behavior more directly and immediately (Dill, & Dill, 1998). Besides, lifelike violent content is more likely to form players' identification with violent characters in games (Leyens, & Picus, 1973). Early surveys showed adolescents' aggressive behavior in schools was positively related to their frequency of playing violent video games (Dominick, 1984). Recently, many experiments have tested the causal relationship, indicating that playing violent games for a short time increased aggressive cognition, affect and behavior, physiological arousal, and decreased pro-social behavior (Anderson, & Dill, 2000; Anderson, & Bushman, 2001; Anderson et al., 2004). Latest meta-analysis has reached conclusion that violent video games undoubtedly serve as risky causal factor of aggression (Anderson, et al., 2010).

1.3 Affecting Factors of Aggression: Focus on Multiplayer Interaction

Online games have popularized throughout the world. Rather than human-computer interaction in console games, online games are characterized by immediate

multiplayer interaction. Online game players usually form groups or virtual communities, fight together as combat teams or fight against each other. Worries arouse that once multiplayer interaction is brought into violent games, aggressive behavior in the game world is connected to real life.

According to General Aggression Model (GAM) (Anderson & Bushman, 2002), when an individual is exposed to violent environment, personal and situational factors as input variables arouse a present internal state (i.e. aggressive cognition, aggressive affect and physiological arousal), consequently leading to thoughtful or impulsive aggressive behavior after appraisal and decision process. Most studies focus on the effect of physical situations (i.e. bloody graphic, game realism, game characters, playing perspective etc) (Ballard, & Weist, 1996; Barlett, Harrisb, & Bruey, 2008; Zhang et al, 2009; Barlett, & Rodeheffer, 2009). However, as a potential situational factor inducing players' aggression, multiplayer interaction was rarely studied.

Theoretically, multiplayer interaction in online violent games may affect players' aggression in following aspects: first, unlike console games, aggressive behavior in games is reinforced by social reinforcer as well as material reward. Second, as an easier transfer of learning aggressive behavior in games, multiplayer interaction relates the virtual world to real life more closely. Third, through playing roles and interacting with others in games, players tend to identify with the violent roles or gangs (Fischer, Kastenmüller, & Greitemeyer, 2010), thus increase aggression.

Empirical studies also demonstrated the difference between playing multiplayer interactive games and human-computer interactive games. It was found players experienced higher presence, immersion and enjoyment when playing with a real person than a computer (Weibel, Wissmath, Habegger, Steiner, & Groner, 2008). Participant would show different physiological arousal when he was informed that he is playing with a human rather than a computer (Lim & Reeves, 2010). William and Clippinger (2002) found, relative to computer opponent, participants reported less hostility after playing with human opponent in non-violent games, implying that human opponent might arouse participants' awareness of social evaluations. However, another study indicated that participants had more aggressive thoughts after playing a violent game with human opponent than computer opponent (Eastin, 2006).

When multiplayer interaction especially cooperation taken into account, the effect of violent games on aggression becomes confusing. On the one hand, realistic violent games increased higher aggressive affect and physiological arousal than non-realistic violent games (Barlett & Rodeheffer, 2009). Thus, players tend to increase higher aggression than solo-play violent games (Weibel et al, 2008; Lim et al., 2010). On the other hand, other studies indicated playing shooting games cooperatively with others resulted in less aggressive cognition (Schmierbach, 2010). Cooperation in games led to players' higher perspective taking and empathy (Salem, 2010).

Based on the above analysis, for one thing, multiplayer interactive violent games may lead to less explicit aggression under the influence of awareness of others with social evaluations. For another thing, it may lead to higher implicit aggression due to a more realistic violent content as well as higher involvement and physiological arousal. Therefore, the study aimed to test the effect of multiplayer interactive violent games on players' explicit and implicit aggression in comparison with solo-play

games. As participants with high trait aggression are more likely to be affected by violent games (Anderson & Dill, 2000), trait aggression was examined as well.

We hypothesized that, as the number of player increases, (1) implicit aggressive cognition increases; (2) explicit aggressive cognition decreases; (3) explicit aggressive behavior decreases; (4) participants' aggression after game-playing is also affected by trait aggression. In general, multiplayer interactive violent games induce lower explicit aggression but higher implicit aggression.

2 Method

2.1 Participants

Participants were 56 male undergraduates at a large university in China, aged from 18 to 25 (*Mean*=21.07, *SD*=1.693). To avoid frustration (possibly aroused due to lack of game skills) which may result in aggression, all participants were required to have an experience of playing "Counter Strikes" (CS) (the game used in the experiment) for more than half a year. All participants provided their written informed consent for participating. Procedures were approved by the local institutional review board.

Participants completed a Game Addiction Scale (Cui et al, 2006) and the Aggression Questionnaire (AQ) (Buss & Perry, 1992; Anderson & Dill, 2000). Their game habits were also investigated. The average self-report time of playing video games during the past 6 months was 0.86 hour/day (*SD*=0.679). The whole group was divided into high and low trait aggression groups by the median of AQ scores and randomly assigned to three between-subject groups (i.e. four-player/double-player/solo-play group). No differences were found on the total and subscales scores of AQ (Table 1) in the three assigned groups, all $F_{(2, 53)}<1.5$, all $p>0.10$.

Table 1 Group Assignment and AQ Scores *M (SD)*

		N	Total AQ	PA	VA	Anger	Hostility
Single	High T	10	89.6 (8.02)	29.3(4.35)	15.9(2.38)	23.3(6.41)	21.1(3.70)
	Low T	10	65.0 (7.18)	22.1(4.10)	14.2(4.05)	14.9(3.14)	13.9(3.60)
	Total	20	77.3(14.63)	25.7(5.56)	15.1(3.35)	19.1(6.55)	17.5(5.12)
Double	High T	8	88.0(7.97)	28.2(6.47)	19.4(3.11)	22.3(3.15)	18.3(5.37)
	Low T	8	70.3(5.92)	24.8(4.33)	12.3(2.38)	16.9(3.66)	16.4(1.51)
	Total	16	79.2(11.38)	26.5(5.60)	15.8(4.55)	19.6(4.30)	17.3(3.93)
Four	High T	10	88.2(8.39)	27.9(4.52)	17.3(3.16)	21.3(4.32)	22.0(3.77)
	Low T	10	68.9(7.51)	20.9(5.30)	13.4(2.22)	17.9(2.13)	16.6(5.62)
	Total	20	78.5(12.59)	24.4(6.00)	15.4(3.33)	19.6(3.76)	19.3(5.41)

Note: PA=Physical Aggression, VA= Verbal Aggression，High T= High Trait, Low T=Low Trait

2.2 Experiment Design

A 3 (interactive modes: four-player cooperation, double-player cooperation, solo-play) ×2 (trait aggression: high, low) between-subject design was adopted to test participants' implicit aggressive cognition, explicit aggressive cognition and aggressive behavior after playing different interactive modes of violent games.

2.3 Materials

Game Selection

The first personal shooting game "Counter-Strike" (CS) was selected for its popularity and easy operation. It can be played either as a console game or an Internet game. The number of players and opponents can be set to accomplish three interactive modes with nearly the same graphics and process. In the experiment, all participants played as cops to fight against terrorists controlled by computer. The numbers of cops and terrorists were set the same. The game was set at a low degree of difficulty so that all the participants could win over the "terrorists" to avoid frustration. According to the Video Game Rating Sheet (Anderson & Dill, 1986), games played in the three interactive modes were evaluated equally in aspects of enjoyment, difficulty, frustration, action speed, violent content and violent graphics, all $F_{(2, 53)}<1.5$, all $p>0.10$.

Extrinsic Affective Simon Task

Extrinsic Affective Simon Task (EAST) was used to measure implicit aggressive cognition (Houwer, 2003). In the EAST, 10 attribute stimuli and 10 target stimuli (Chinese words) were selected with their use frequencies controlled (Table 2).

Table 2 Words Used In EAST

Target stimuli	A	Violate	Revenge	Smash	Lash	Batter
	NA	Smile	Gentle	Considerate	Affection	Embrace
Attribute stimuli	P	Delightful	Pretty	Joyful	Blissful	Lucky
	N	Painful	Disgusting	Corrupt	Foolish	Miserable

Note: A=Aggressive Words, NA=Non-aggressive Words, P=Positive Words, N=Negative Words

Three blocks were included in the EAST. First, participants classified attribute stimuli (i.e., positive and negative words), which were colored white, by pressing either a good key or a bad key according to valence of the words for 20 trials. Then, they classified the target stimuli (i.e., aggression and non-aggression words), which were colored blue or green, by pressing keys according their color for 20 trials. In the third block, with a mix of white and colored words presented for 120 trials, participants were instructed to press keys according to not only valence when words were white but also color when words were blue or green. Participants' reaction time and accuracy of the first response were recorded by E-prime.

Words Evaluation Task

Words Evaluation Task (WET) was used to measure explicit aggressive cognition. The WET was a rating sheet scale (7-point Likert: 1= extremely negative, 7= extremely positive) to evaluate positivity and negativity of words (the same words used in the EAST). The words were displayed in a random order. More positive evaluations for aggressive words imply higher explicit aggression cognition.

Competitive Reaction Time Task

Competitive Reaction Time Task (CRT) is a valid measure of aggressive behavior (Anderson & Bushman, 1997). Participants were told they were competing against another participant of faster responses. "Winner" could choose intensities of noise from level 1 (80 dB) to level 4 (110 dB) to punish "loser". In fact the opponent didn't

exist, and the noise was set by the computer randomly in 48 trials. The intensity selections of each participant were recorded to measure his aggressive behavior.

2.4 Procedure

Participants were randomly divided into three different interactive-mode groups. Participants in the interactive modes didn't know each other and played in separate rooms contacting through the Internet.

Participants practiced playing games for several minutes before experimental task and then were instructed to play in one of the three modes for 20 minutes. The four-player and double-player groups were instructed to play cooperatively. They were told their game scores would be summed up and compared with other groups. The winning group would receive an extra reward, while the losing group would be penalized. The solo-play group was told that their scores would be compared with other individuals for reward or penalty. After the 20 minutes of game play, participants fulfilled the EAST. Next, participants played games for another 10 minutes in order to enhance the treatment, followed by the WET. Then participants fulfilled the CRT following the instruction that they would play another game with another participant in the laboratory. Afterwards participants filled in the "Video Game Rating Sheet" and were briefly interviewed about the motivation of punishment selection during the CRT. Explanation of the experiment was debriefed to participants at the end.

3 Results

3.1 Preliminary Analysis

Four participants were excluded for game addiction according to "Game Addiction Scale" (GAS) to exclude a potential disturbing factor for the results. 52 participants' data entered further analysis. Differences on AQ among the three different interactive-mode groups were not significant, all $F_{(2, 48)}<1$, all $p>0.10$.

3.2 Implicit Aggressive Cognition

In EAST, trials of colored target words were analyzed. Reaction times less than 300 ms or more than 3000 ms were re-coded as 300 ms and 3000 ms respectively (Houwer, 2003). One participant's EAST data was excluded due to his low accuracy (3 S.D. away from mean). 51 participants' data entered further analysis. The average accuracy of the remaining participants was 94%. We calculated the EAST scores *d* for aggressive and non-aggressive words respectively by deducting the mean log-transformed reaction time of trials with positive responses from that of trials with negative responses. Differences between *ds* and zero were examined. If d is significantly larger than zero, the evaluation is positive (Table 3).

Initially, the effect of interactive modes on players' implicit aggressive cognition was examined. For aggressive words, *ds* of participants from the three groups was not significantly different from zero, indicating the participants in three interactive modes evaluated aggressive words as not negative. For non-aggressive words, *ds* of solo-play

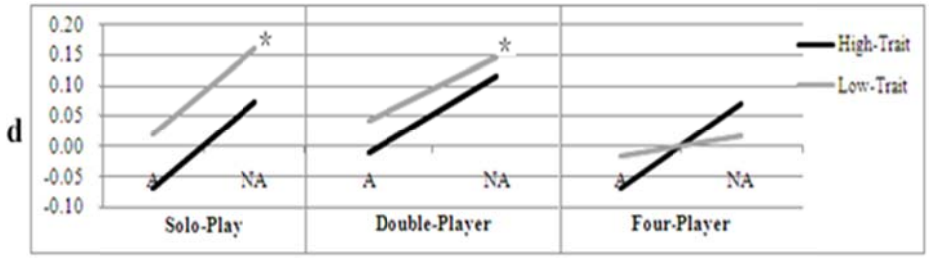
and double-player groups were significantly larger than zero, p=0.004, and 0.014 respectively, indicating the two groups evaluated non-aggressive words as positive. However, d of four-player group was not significantly different from zero, indicating evaluating non-aggressive words as not positive, implying higher aggression in implicit cognition than the other two groups.

Further analysis was conducted to test high/low-trait aggression groups in the three interactive modes respectively. As shown in figure 1, high-trait group from three interactive modes evaluated aggressive words as not negative and evaluated non-aggressive words as not positive, implying aggression in implicit cognition. Low-trait groups in the three interactive modes evaluated aggressive words as not negative. However, for the non-aggressive words, low-trait participants in solo-play and double-player modes evaluated non-aggressive words as positive; while in four-player mode, participants evaluated non-aggressive words as not positive, implying that low-trait participants had higher implicit aggressive cognition in the multiplayer mode.

Table 3 Log-transformed RT for Aggressive and Non-aggressive Words of Six Groups

		N	Words	PR	NR	*d*	*t*
Solo-play	High-trait	9	A	6.67 (0.22)	6.60 (0.21)	-0.07	1.04
			NA	6.59 (0.20)	6.67 (0.11)	0.07	-1.63
	Low-trait	10	A	6.77(0.26)	6.79(0.24)	0.02	-0.44
			NA	6.70 (0.19)	6.86(0.25)	0.16	-2.90*
Double-player	High-trait	8	A	6.76(0.20)	6.75(0.21)	-0.01	0.16
			NA	6.72(0.18)	6.83(0.22)	0.11	-1.53
	Low-trait	8	A	6.65(0.23)	6.69(0.23)	0.04	-1.19
			NA	6.60(0.21)	6.75(0.24)	0.15	-2.37*
Four-player	High-trait	6	A	6.67 (0.22)	6.60(0.21)	-0.07	1.06
			NA	6.59(0.20)	6.67(0.11)	0.07	-1.35
	Low-trait	10	A	6.79(0.28)	6.78(0.28)	-0.02	0.28
			NA	6.71(0.32)	6.72(0.31)	0.02	-0.24

Note: A=Aggressive Words, NA=Non-aggressive Words, PR=Positive Response, NR=Negative Response



Note: * =0.05 sig. compared with 0

Figure 1 *d* for Aggressive and Non-aggressive Words of Different Groups

3.3 Explicit Aggressive Cognition

The words evaluation of four groups from six groups is shown in Table 4. A 3 (interactive modes) × 2 (words) mixed ANOVA was conducted. The main effect of

words was significant, $F_{(1, 49)} = 142.28$, $p<0.001$. The main effect of interactive modes bordered on significance, $F_{(2, 49)} =2.65$, $p=0.081$. The interaction of words and interactive modes was significant, $F_{(2, 49)} =3.43$, $p=0.04$.Further simple effect analysis was carried out. For non-aggressive words, the effect of interactive modes was not significant, $F_{(2, 49)} =1.188$, $p=0.313$. However, for aggressive words, the effect of the interactive modes was significant, $F_{(2, 49)} = 3.556$, $p=0.036$, indicating the three groups evaluated aggressive words differently (i.e., they showed different explicit aggressive cognition). According to the post hoc test of Bonferroni, four-player group evaluated aggressive words more negatively than the solo-play group.

It got more interesting when considering trait aggression as covariant. Besides the significant effect of interactive modes ($F_{(2, 48)} =3.989$, $p=0.025$), the effect of trait aggression was also significant, $F_{(1, 48)} = 6.293$, $p=0.016$. High-trait groups were more aggressive than low-trait groups in explicit cognition. There was no interaction between the two factors. The results indicated that explicit aggressive cognition was affected by both interactive modes in games and trait aggression without interaction.

Table 4 Words Evaluation From Six Groups *M(SD)*

		n	Target words		Control words	
			A	NA	N	P
Solo-play	High-trait	9	2.56(0.654)	5.71(0.470)	1.98(0.430)	6.31(0.470)
	Low-trait	10	2.02(0.656)	5.98(0.569)	2.16(0.735)	6.20(0.833)
	Total	19	2.27(0.694)	5.85(0.569)	2.07(0.601)	6.25(0.670)
Double-player	High-trait	8	2.05(0.487)	6.18(0.483)	2.05(0.334)	6.55(0.298)
	Low-trait	8	1.93(0.413)	5.75(0.805)	1.88(0.320)	6.30(0.586)
	Total	16	1.99(0.441)	5.96(0.678)	1.96(0.328)	6.43(0.467)
Four-player	High-trait	7	1.94(0.472)	6.16(0.580)	1.86(0.574)	6.69 (0.414)
	Low-trait	10	1.66(0.499)	6.16(0.580)	2.00(0.490)	6.44(0.337)
	Total	17	1.78(0.494)	6.17(0.593)	1.94(0.514)	6.54(0.379)

Note: A=Aggressive Words, NA=Non-aggressive Words, P=Positive Words, N=Negative Words

3.4 Explicit Aggressive Behavior

The mean punishment intensity in CRT was calculated. Participants' aggressive behavior decreased as the number of players increased, *M* (*SD*) = 2.24 (0.94), 1.95 (0.87), and 1.82 (0.76) for solo-play, double-player, and four-player groups respectively. No main effect of interactive modes was found in the 3×2 ANOVA, $F_{(2, 46)} =1.225$, $p=0.449$, indicating participants in different interactive modes shared an equal level of aggressive behavior. The main effect of trait aggression was not significant, $F_{(1,46)}=0.657$, $p=0.502$. No interaction existed, $F_{(2, 46)} =0.931$, $p=0.401$.

4 Discussion

4.1 Effect of Interactive Modes on Implicit Aggressive Cognition

Results indicated the three groups displayed different affect to aggressive and non-aggressive words. Solo-play and double-player groups sensed aggressive words as

more negative than non-aggressive words, while four-player group sensed both aggressive and non-aggressive words as equally not positive, indicating higher implicit aggressive cognition. The hypothesis was partly confirmed.

Group size might function as a situational factor leading higher levels of aggressive cognition. Expecting to interact with an unfriendly group increases hostile expectations (aggressive cognition) and the presence of others increases arousal (DeWall & Anderson, 2011). Additionally, senses of belonging to an online game group also affect game behavior. A survey showed individuals with high allegiance to online allies behaved more immorally than those belonging to no groups (Axelsson & Regan, 2004). Fighting for benefits of in-group, individuals tend to make moral justification and dehumanize victim and consequently reconstruct cognitive structure to accept aggression (Anderson et al., 2002). Generally, fighting in groups, even cooperatively, would temporally change the structure of players' aggressive cognition, with higher implicit aggressive cognition.

4.2 Effect of Interactive Modes on Explicit Aggressive Cognition

Explicit aggressive cognition differed among groups. Four-player group showed less aggressive cognition than the solo-play group, partly confirming the hypothesis.

In multiplayer interactive games, players experienced higher presence and immersion through interaction with other players (Weibel et al., 2008). In other words, they perceived the game as real-life society with social interactions. According to Social Facilitation theories, presence of others arouses individual's self-awareness to adjust his behavior to social customs (Robinson & Cooper, 1990; Li & Feng, 1999). Multiplayer interaction made participants evaluate aggressive words more negatively to meet social norm through arousing players' awareness of social situations. In addition, players in online games pay attention to other players rather than physical stimulus (Brave & Nass, 2003). Compared with interactive groups who cared more about cooperation with others, the solo-play group concentrated more on their own aggressive actions with reinforcement, thus tended to evaluate aggressive words more positively.

4.3 Effect of Interactive Modes on Explicit Aggressive Behavior

No significant difference of aggressive behavior was found among the three groups, indicating different interaction modes in the violent game might not be sufficient to stimulate different aggressive behavior. According to reinforcement theory of social learning, whether to conduct the learned aggressive behavior depends on environment factors, such as reinforcement and social competition (Bandura, 1978). GAM also emphasizes aggressive behavior will be conducted after appraisal (Anderson & Bushman, 2002). Results of explicit aggressive cognition implied games with multiplayer situation might arouse participants' higher awareness of social appraisal, which might inhibit participants' aggressive behavior. However, facing competitive situations in the CRT, participants had limited access to cognitive resource, which might lead to impulsive aggressive behavior. In addition, a brief interview after experiment indicated some Chinese participants and tended to give low punishment in seeking for

win-win result. Therefore, to some participants, competitive situations in the CRT and that in real life differed greatly, which confused the result as well as undermined the external validity of this experiment.

4.4 Effect of Trait Aggression

High-trait group was more aggressive than low-trait group. The result was consistent with Anderson's study (2000) and the prediction of GAM that players' aggressive personality and the situational factors co-determine aggressive behavior. According to GAM, it's easier and faster for players with high-trait aggression to startup aggression-related clues and aggressive behavior scripts.

It was interesting that implicit aggressive cognition was affected by trait aggression and interactive modes in games with interaction. On the whole, participants with high-trait aggression were more aggressive in implicit aggressive cognition than those with low-trait aggression. However, the conclusion was not applicable for four-player group. As the number of interactive players increased to four, participants with low-trait aggression displayed an equal level of implicit aggressive cognition compared to those with high-trait aggression. These results indicated players with low-trait aggression were more sensitive to multiplayer interactive violent games.

5 Conclusion and Suggestions

In conclusion, as the number of player increases, multiplayer interactive violent games induce lower explicit aggression but higher implicit aggression. Base on previous results, we suggest the following:

(1) Implicit aggressive cognition was affected by interactive modes and trait aggression with interaction. Participants with low-trait aggression had more implicit aggressive cognition when playing in four-player group than in other two groups.

(2) Explicit aggressive cognition was affected by interactive modes and trait aggression without interaction. Compared with four-player group, solo-play group evaluated aggressive words as more positive, implying higher explicit aggression. High-trait aggression group was more aggressive than low-trait group.

(3) Participants' aggressive behavior decreased as the number of players increased without statistically significant difference.

With the popularization of online games, future studies should take into account multiplayer interaction in games from a social and interpersonal perspective, providing an in-depth understanding of this phenomenon and elaborating on suggestions for future prevention and intervention.

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Quality Criteria for Open Courseware and Open Educational Resources

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Abstract. Seeing the world's knowledge as a public asset that can be accessed, shared, used and reused, etc. mediated by technology, especially ICT, is a potent idea and may have an influential impact on educational processes within our society. A decade of development of initiatives that offer open courseware and open educational resources has passed, and all the related projects have contributed to the provision of open university-level digital educational materials. For the time being, there is no articulated set of quality criteria to be used for development, use, modification, evaluation, and comparison of such resources, though, there is concern about this subject. We introduce here a set of criteria for Quality Assurance of open courseware and open educational resources, from a social and constructivist perspective. They have been grouped in four categories related with content, instructional design, technology and courseware evaluation.

Keywords. open courseware, open educational resources, quality assurance, quality criteria

1 Introduction

Within the last decade, the world's knowledge has been, and it is still seen, more and more, as a public asset that can be accessed, shared, used and reused, mediated by technology, especially ICT, and this powerful idea may have an influential impact on teaching and learning within our society. During this decade, a pleiad of initiatives that offer open courseware and open educational resources has emerged, resulting in worldwide related projects that have been providing open university-level digital educational materials. All these projects meet a huge demand for high quality educational resources that anyone may access from anywhere at any time via the Internet.

The most remarkable such initiative is, of course, MIT OpenCourseWare Initiative with the available instructional resources related to 2000 courses, and with the associated 250 universities and organizations that provide their course materials freely and openly for more than 13,000 courses in 20 languages [1-3]. MIT OCW has also triggered the development of The OCW Consortium, which supports the construction of OCW projects around the world, and which offers access to more than 6000 courses

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from 64 sources in 12 languages [4]. Another comprehensive repository is OER Commons with more than 31,000 instructional materials, which are very diverse from textbooks, audio or video lectures, and readings, to lesson plans, assessments, syllabi, etc. or even games [5]. The Connexions project is also relevant both by its size (more than 20000 reusable modules combined into more than 1200 collections), and even more important by its approach to support high reusability and easy remixing of the content [6]. Other open educational resources initiatives like Carnegie Mellon University's Open Learning Initiative are interesting because they intend, beside providing open courseware, to serve as platforms that increase our understanding about human learning, aspiring to contribute to the development of better learning environments by using that understanding [7]. Other promising OER/OCW initiatives are Webcast.Berkeley, Universia, Open University, Open.Michigan, and so on [8-11].

Another approach is taken by The Free Education Initiative of The Saylor Foundation, which is driven by the idea of "building" a free online university without walls or any other boundaries of conventional higher education systems [12]. Currently, there are available course materials for over 200 courses from the slated 241 courses, which are necessary for majoring in 13 areas of study. The available educational materials may be used in various ways, though The Saylor Foundation invites its learners to use them aiming to simulate the traditional four-year higher education experience, i. e., to select a major, to fulfill its requirements, and to complete the General Education Program. Recently, The Foundation has started another challenging initiative The Open Textbook Challenge, which aims to offer learners a cost-free alternative to traditional textbooks. Thus, The OTC stimulates authors to write or re-license textbooks as CC-BY by offering a $20,000 award for each textbook released this way. Another approach, somehow in between the two presented previously here, is Coursera, a Web portal that distributes interactive courses in the humanities, social sciences, physical sciences and engineering that benefit from the constant support of the instructors and peers from a global learning community [13].

In this paper we propose a set of quality criteria that could serve as general guidelines for development, use, modification, evaluation, and comparison of open educational resources and open courseware, from a social and constructivist perspective. The structure of the paper is as follows: the second section offers o short motivation for research, the third one includes the criteria for Quality Assurance (QA) of open courseware and open educational resources, the forth includes related work and the last consists of some conclusions and future work ideas.

2 Motivation for Research

Despite that more than 10 years have passed since the launch of the MIT OCW program, a thorough search of the literature has revealed there is no articulated set of quality criteria to be used for construction, evaluation and comparison of OCW initiatives. Though, there is concern about this subject, and there are some projects aiming to develop such set [14, 15, 16]. However, no concrete results are available yet, so the users, being them learners, teachers, faculty etc., have no guidance in their quest for choosing the most suitable educational resources that match closely their educational needs at some point in time.

On the contrary, establishing quality criteria, benchmarks or metrics for evaluation of traditional online courses has been a constant preoccupation both for developers and users, on the one hand, and the educational institutions that provide such programs, on the other hand. Several programs or institutions have approached this subject and their efforts have resulted in standards for quality of online courses and learning, along with scoring systems to be used for their straightforward evaluation. These efforts have benefited from the work of teams of experts with various backgrounds (course development, instructional design, professional development, research, education, and administration) in education, both classical and online, who have been representing educational organizations that share an interest in online education and that are keen to offer to their students high quality online courses. Their work has been based on systematic literature review corroborated with specific surveys taken by significant actors in the online educational process [17-20].

Of course, we have to consider that while taking an online course in a blended learning environment or in a pure online learning program is a requirement for obtaining some formal recognition, like a degree, The OCW movement has started with the premise that OCW will not stand for a formal education, and will not be granting university degrees or certificates. However, taking into consideration the magnitude of the progress of open courseware initiatives and their impact on users worldwide, it becomes crucial to provide the users, persons or institutions, with a valuable set of quality criteria, which can be used to assess the quality of open courseware and open educational resources. These criteria may be further used to develop a scoring system, aiming at helping users to establish the appropriateness of a particular open educational resource for their specific educational needs.

3 Criteria for Quality Assurance of OER and OCW

In this section, we introduce a set of criteria for evaluation the quality of open educational resources and open courseware. This works builds on the results of previous author's works on the matter of open resources for education, which have analyzed thoroughly the main open courseware initiatives around the world, and that have identified both the strengths and the weaknesses of their offer [1, 2, 21-25]. The QA criteria correspond to the quality characteristics of *quality in use*, *internal and external product quality* according to ISO/IEC 25000 SQuaRE standard, and cover the next user needs: effectiveness, efficiency, satisfaction, reliability, security, context coverage, learnability, and accessibility. They quality criteria may be used for quality assessment of either small learning units or an entire courseware. They have been grouped in four categories related with *content*, *instructional design*, *technology* and *courseware evaluation*. A detailed presentation follows further on.

Content related. In this category we have criteria that reflect whether the resource provides the online learners with multiple ways of engaging with their learning experiences, promoting their mastery of the content. They evaluate the usefulness of each educational resource, being it a small learning unit or an entire courseware. First, we

think at easiness of using the resource, reflected by *readability* and *uniformity of language, terminology, and notations.*

When evaluating open courseware, users are first interested the *availability of the course syllabus*, so they become aware since the very beginning of the content scope and sequence. At the same time, users might be equally concerned with the *comprehensiveness of the lecture notes*, i.e. whether the course content and assignments demonstrate sufficient wideness, deepness and rigor to reach the standards being addressed. *Modularity of the course content* is another issue to be approached in the first steps of the initiation of the learning process, as modular course components are units of content that may be distributed and accessed independently, giving each user both the *possibility to select the most suitable learning unit* at a particular time, and the *opportunity to choose the most appropriate learning path* that matches user's needs and abilities, and which can be approached *top-down, bottom-up or as a combined approach*. *Availability of assignments* (with or without solutions), being them exercises, projects, and activities, is important as well, as they are content items that enhance the primary content presentation. These assignments may ask students to work independently or as a group, the latter especially when using open courseware for blended instruction.

When looking at a particular learning resource, other than an entire courseware, which can be a small learning unit, a course module, a lesson etc., users are particularly interested in various characteristics of the resource: *accuracy, reasonableness, self-containedness, context, relevance, availability of multimedia inserts*, and *correlation of the resource with the course in its entirety.*

Instructional design related. First, from the instructional design point of view, we have to consider the educational resource *goal and learning objectives*, which are expected to be clearly stated and measurable, as the learner's level of knowledge mastery and practical abilities is ought to be measured against both the main goal and each and every learning objective. The educational materials provide for multiple opportunities for learners to be actively engaged in the learning process, having meaningful and authentic learning experiences during undertaking various *appropriate instructional activities*: problem- or project-based learning, e-simulations, learning games, webcasts, scavenger hunts, guided analysis, guided research, discovery learning, collaborative learning groups, case studies etc. *Learning outcomes* state the learner's achievements after performing a learning activity, i. e. what learners will know and/or will be able to do as a result of such an activity, in terms of knowledge, skills, and attitudes. Related with them is the availability of the evaluation and auto-evaluation means (with or without solutions). The teacher users may be also interested in the *learning theory* (behaviorist, cognitivist, constructivist, humanist and motivational etc.) and the *instructional design model* (ADDIE, ARCS, ASSURE etc.) that have been used to develop that particular educational resource.

Moreover, experiences that seed the stimuli for *reflective learning* will always add to the overall quality of the open educational resource or courseware. Under the reflection perspective, the desired outcome of education becomes the construction of coherent functional knowledge structures adaptable to further lifelong learning. Reflection here has two meanings. One would be the process by which an experience, in

the form of thought, feeling or action is brought into consideration (while is happening or subsequently) and the other the creation of meaning and conceptualization from experience and the potentiality to look at things from another perspective (critical reflection) [26-29].

Technology related. Both open educational resources and open courseware are expected to benefit fully from ICT technologies, to have user-friendly interfaces, to comply with standards for *interoperability*, and to provide for appropriate access for learners with special needs (*accessibility*). *Extensibility* of each educational resource, from a technological point of view, refers to easiness of adding content, activities and assessment, aiming to expand learning opportunities. A high quality *user interface* is expected to provide for consistent and straightforward navigation throughout the resource, along with making available rich multimedia inserts, in various formats, to match various learners' needs. A clear specification of the *requirements* with respect to the supporting technology at user's end (both hardware and software), along with the *prerequisite skills* to use that technology are useful to help learners understand how they are supposed to use that resource to benefit fully from its content. A high quality open educational resource is expected to work smoothly on a variety of platform in use around the world (*multi-platform*). Having a true engaged learning relies on learner's opportunity to interact with the content and with other learners, which is not possible without the right *supporting tools*. *Security* of the confidential information regarding the learners is also an important issue to consider when evaluating quality of open educational resources and open courseware, despite the apparent anonymity in the online world.

Courseware evaluation. Despite the initial claim of just offering high quality educational materials to learners worldwide, with no other intention the support the learners during their learning journey, all major open courseware initiatives have started to be more involved with their learners. In this new context, there is a stringent need to evaluate the courseware regularly for effectiveness, using various assessment strategies, and to use the findings as a base for future improvement.

Each prospective learner would most probably first be interested in the *courseware overview*, which includes information about the *content scope and sequence*, *the intended audience, the grade level, the periodicity of updating the content, the author's credentials and the source credibility, its availability in multiple-languages, instructor facilitation or some kind of semi-automated support, suitableness for self-study and/or classroom-based study, the time requirements, the grading policy*, along with *instructions about using* that courseware and its components, in order to establish the most suitable learning paths. *Prerequisite knowledge* and *required competencies* are also useful for learners at the beginning of the learning process related to a particular educational resource. *Matching the course schedule*, if any, with learner's own pace is also desirable.

Another issue to be approached since the very beginning regards the *repository or institutional policies* with which the learner is expected to comply with respect to the use of the resource, with licensing and copyright issues, with multi-cultural education, with privacy etc. To have open educational resources and open courseware that are

free of bias and advertising is also desirable for these resources. Another quality criterion is concerned with the option to provide, or aiming to provide, a formal degree or a certificate of completion (*degree or certificate*). *Participatory culture and Web 2.0* aspects are also important being them related to possibility to contribute to the resources or to collaborate with fellow teachers/learners/developers. Other key aspects to be evaluated and improved constantly concerns *user interface*, *appropriate design and presentation* of the educational content to the users.

4 Related Work

Related work is rather scarce with just a few works approaching, in very broad lines, the subject of quality of open courseware and open educational resources in the context of evaluating the impact of these paradigms in education nowadays. All these works emphasize on the importance of the quality of OERs/OCW and on the need for continuous quality evaluation and assurance, but none of them include some guidelines or criteria for quality evaluation of OERs and open courseware [22-25, 30]. The policies to be used for Quality Assurance (QA) fall in three classes [21-22, 25]:

- QA activities are undertaken, prior to publication on the site, by the institution that offers open courseware or OERs, both as formal peer review process and as informal reviewing. Though, these processes are not open to the users;
- QA activities are performed by external peer reviewers on the institution's request, as external peer reviewing is one of the most powerful mechanisms to ensure quality in academia;
- individual users have the opportunity to review free educational resources, and to decide, on whatever arguments they want, whether the resource is useful, high-quality, or good in any way. This can be achieved by using star ratings, by adding evaluative comments, by describing in which way the resource has been used, or by displaying the number of the downloads for each particular resource. This approach is based on the argument that quality is not an intrinsic part of an instructional resource, but contextual, as a particular resource may be excellent for one user in a certain context, and, poor for another user in a different context [14];

Some authors consider that quality of open courseware and OERs is guaranteed by the reputation of their institution of origin, which is always interested to attract prospective students with the quality of its instructional offer, and to keep up with their prestige [21, 24-25]. Moreover, teachers and institutions seem to pay more attention to the QA process knowing that their instructional materials will be published as open content, and the whole world will be their audience [22, 24]. Thus, the QA awareness of each author is high and, consequently, quality of open educational resources is also high, especially for those derived from regular closed courses [22].

Quality assurance is seen as a built-in part of the development process, first by having pre-publication quality checks. However, there is concern about futile evaluation in the case of resources that have already been checked from a pedagogical point of view, because they have been developed by teachers, or by multi-disciplinary

teams that have been funded by public grants. The huge burden of pre-publication quality checks is pointed out as well in the literature [25].

A particular issue approached in the literature is relevance, as part of the concept of quality, as usually a user search for open instructional resources results in too many results, so it is difficult and time-consuming to select the most relevant resources that have the highest quality. Techniques and technologies that give users the opportunity to narrow their searches are expected to alleviate this particular problem [21].

5 Conclusions and Future Work

This paper introduces a set of quality criteria that may be used to evaluate and pursue quality of open courseware and open educational resources, and that may constitute the foundation of a quality model for such resources. This initial set of QA criteria needs to be significantly improved. First, compliance with the existing quality standards (such as ISO/IEC 25000 SQuaRE standard) is most wanted. Besides compliance, a scoring or rubric system that will help evaluate in a quantifiable manner both open courseware and open educational resources is foreseen. Furthermore, the assessment procedure needs to be established on more non-subjective grounds, in order to facilitate quality assessment performed by other users and evaluators. Other future work ideas envisage using these quality criteria to assess some particular open courseware, and learning, based on this experience, how to develop further the initial set of quality criteria.

The higher goal of the foreseen future work is construction of a quality evaluation framework for open courseware and OERs, which may help users to use, modify, evaluate, and compare such educational resources, while pursuing their educational goals. Moreover, developers may also use that framework to tailor their work.

Quality models and QA frameworks are very necessary for the time being, and, in our opinion, they may contribute significantly to the sustainability of the paradigm of open sharing of educational resources, as a key step to the development and evolution of open educational models. These models may finally lead to development of a *global reflective educational infrastructure*, which will provide for achievement of people's learning needs, both individually and collaboratively, supporting them and their communities on their lifelong and life-wide journeys for social construction of knowledge throughout their life.

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Developing Online Collaborative Games for e-Learning Environments

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Abstract. Based on our experience, we believe that games, competition and teamwork offer a pleasant and active way of learning. This is much more efficient when the learner has a smile on his face, when he is astonished and curious about next levels and finds the game sufficiently challenging and fun to try again. Our application proposal has the purpose of implementing an e-Learning platform for improving the teaching and learning process in somewhat abstract domains, such as computer architecture or object oriented programming, with the help of games. These games are time-dependent and are able to support collaboration between groups. To this date there are two learning games implemented: a crossword puzzle and a collaborative jigsaw puzzle, the last one supporting multiplayer mode for up to 16 simultaneous players, being simple, fast, fun and reliable. Our application allows geographically distributed students to concurrently and collaboratively play the same game.

Keywords: e-Learning system, collaborative tool, online games.

1 Introduction

The explosion of communication devices and pervasive computing systems in everyday life due to technological development in ICT, led for the young generation to the acquisition of skills in using computers, laptops, tablets, cell phones, Internet or social networks without too much effort and generally outside the classroom. In this context, the tendency of so called “digital” or “online generation” is not having the patience to follow a course, read a book (even electronic) but rather "play or practice instead of learning theory". A very important challenge in the teaching process is to keep students motivated throughout the course, and to help prepare outside the class hours. Learning through play, the desire to win, forcing him to pay attention to rules, to retain them, motivates him to stay focused on the studied topic. Competition and teamwork are also motivational for students.

There is one thing that teachers and learners have to agree upon: learning is boring, because of age and mentality differences [14]. Adults show commitment and disposition to learn, being aware of the need to be prepared throughout life (long life learning concept). Youngsters, however, want to acquire knowledge and technical skills with-

out too much effort. In education, as well as corporate facilities, trainings are not always seen as fun. All of this can be changed if games are implemented in the learning process. The learner's attention is kept awake by allowing him to interact with a virtual environment where he can test his skills, is allowed to restart the game at any time and, most important of all, is allowed to make mistakes (unlike real-life situations where mistakes are not desirable). Games are usually highly intuitive, user-centered; they have entered our social lives and support massive amounts of concurrent players (such as World of Warcraft, or, more recently, Minecraft).

Our application proposal has the purpose of implementing an e-Learning platform – Education Management Tool (EDM) – for improving the teaching and learning process in somewhat abstract domains, such as computer architecture, object oriented programming, operating systems, algorithms and data structures, with the help of games. These games are time-dependent and are able to support collaboration between groups. To this date there are two learning games implemented: a crossword puzzle and a collaborative jigsaw puzzle, the last one supporting multiplayer mode for up to 16 simultaneous players, being simple, fast, fun and reliable. The implemented application allows geographically distributed students to concurrently and collaboratively play the same game. Additionally, our work accomplishes many learning preferences of digital / online generation: parallel processing and multitasking, pictures processing, interacting/networking simultaneously with many others, acquiring quickly multimedia information, making the learning process funny [16]. The proposed puzzles are not used alone in teaching and evaluating the mentioned computer science subjects, they are periodically used in a mixture with classical teaching, practising with hand-on exercises and also evaluation.

Our approach mainly insists on how the professor could create his own game related to a computer science topic in the context of our previously introduced e-Learning platform (EDM tool [5]). The jigsaw puzzle is very appropriate for algorithms, computer architecture, microprocessor's organization and design because we use and refer to many pictures with (logical) schemes, instruction / data flow diagrams, memory hierarchy in the teaching process. Whatever is the engineering topic, in learning process the visual memory (visual learning style) is very important because, as an old Chinese proverb said, "a picture is worth a thousand words meaning". Also, we thought that a crossword puzzle is properly used to test student's knowledge in a funnier and more competitive manner. We have chosen examples from algorithms and other computer science fields because we teach these topics but our application allows that the didactic materials to be further extended, so that they cover other scientific fields too.

The organization of the rest of this paper is as follows. In section 2 we shortly review the Related Work in the field of educational software and mainly of game-based learning. Section 3 describes some of the latest developments of our application insisting on the games software design, concept and objectives and the user interface. In section 4 we present the system requirements. Based on a short interactive animated example, we explain the game's functionality. Finally, section 5 suggests directions for future work and concludes the paper.

2 Related work

Transforming by gamification the learning process into "flow" [12] – as enjoyable and valuable for students as possible – can produce high benefits in some educational areas. This approach is successfully used worldwide in teaching music through the Kodály method [13] which reviews and reinforces concepts by games, pictures, movements, songs and exercises. A game that revolutionized the gaming and learning communities is Minecraft. It is a simple game with simple rules, but can be extended so that it gets very complex. It is very similar to a role-playing (RPG) game, where the user can actually change the environment by adding/removing building blocks. Besides the fact that it is fun to use, this game has great educational potential. For example, students can be asked to research a historic event and then recreate it in the game, or build a roller coaster and do experiments on velocity and acceleration [1].

In [2] the authors stated out that in-class games have a positive impact on students, they are more engaged in the learning process and thus they also perform better in exams. In [3] the authors present their experience on how can puzzles and games used to teach and reinforce Computer Science concepts, since many topics of this field are well suited for coverage in such games. They show that instructional crossword puzzles and the Jeopardy!-style games are good methods to create in-class experiences that support learning terminology and basic concepts. In [4] the authors examined the use of puzzles and puzzle-like problems in teaching design and analysis of algorithms like brute-force search, divide-and-conquer, greedy, dynamic programming, backtracking, etc. As a difference, our puzzles are integrated into our own e-learning system, the EDM tool [5]. New puzzles can be easily generated through EDM.

In our previous paper [5], we presented an interactive flash application of the well-known Towers of Hanoi puzzle (with three rods), proposed by Edouard Lucas in 1883, which can be solved through the Divide and Conquer programming technique. We also implemented the generalized version of the Hanoi problem, also called Reve's puzzle, with four or more rods [6]. We used the Frame-Stewart algorithm to solve the generalized Hanoi problem, with four rods. Our proposed interactive Towers of Hanoi puzzle can be run in user mode or in simulation mode. In [7] we integrated into EDM Tool some interactive third party lessons focused on graph algorithms (Breadth-First Search, Depth-First Search, Dijkstra, etc.), on binary tree operations (insertion, deletion, traversal, search, etc.) and also on digital logic circuits.

Using simulators for teaching Computer Science is another widely used method. Besides their importance proved in the computer architecture research field, simulators have lately been extensively employed as a valuable pedagogical tool as they enable students to understand the theoretical concepts better and to visualize how microarchitectural components work and interact [8]. In [9] and [10] we proposed some interactive graphical simulators to teach Branch Prediction and Simultaneous Multithreading Architectures. Such simulators play a key role in translating all complex processing mechanisms in relevant and easy to understand information.

International e-Learning platforms such as Moodle are already very popular, available free of charge as open-source projects. Moodle stands for Modular Object-Oriented Dynamic Learning Environment and is currently the most popular of the free

e-Learning systems. It is provided without fee under the General Public License (GNU) available for any university to implement. It can be implemented on any broadly available operating system (Linux, Windows, Mac OS, etc.) and runs mainly under MySQL, though it can use any ODBC connection to other providers such as Oracle, IBM DB2, Sybase, Access, etc. [11]. It is a very complex system, managing anything from courses and lessons to exams and grades. It is a highly flexible system, but sometimes it may be hard to understand and/or use. In contrast, Education Management Tool is a targeted package that is easy to use and to understand (there is no training needed for understanding any concept in EDM), but still is powerful enough to suit the basic needs of the learner and teacher.

Other learning systems are Blackboard and WebCT, but both of them are expensive, sometimes too expensive for some universities to implement. Education Management Tool has the clear advantage of being free of charge.

3 Games software design: concept and objectives

3.1 Education Management Tool

Education Management Tool (EDM) is an e-Learning platform designed to help students in universities to access learning materials posted by the teachers, to complete online tests and obtaining immediate feedback, as well as retrieve information about results for their exams. It has the advantage of being free, accessible from anywhere and from any type of computing system device, not being restricted to the laboratory. It can manage an entire university: specializations, subjects, administrators, professors and students (see Figure 1). It is a complex tool which is easy to use, with three possible user types: Administrator, Professor and Student.

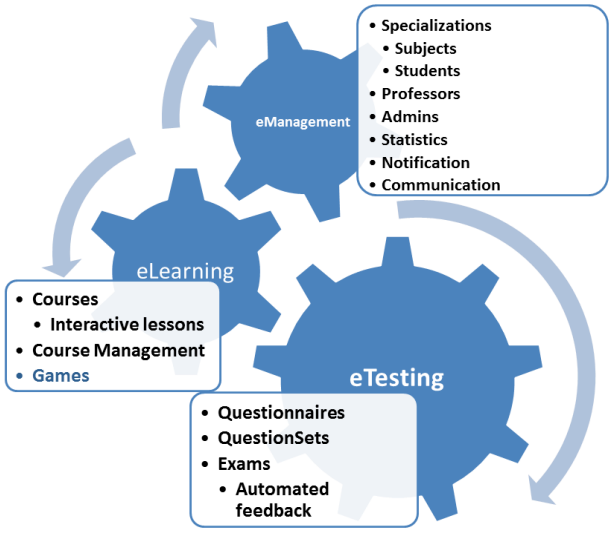

Fig. 1. EDM Tool Structure

Consisting of three modules, EDM is designed to meet the basic requirements of an e-Learning environment: learning, testing and management. The learning component consists of courses, developed by teachers in a manner similar to Google Docs, which are easily accessible by students. The courses may contain images and flash movies. The testing module consists of exams, customized and posted by the teacher. EDM provides a simple and intuitive exam management system that fits any workflow, supporting exam schedule, timed exams and highly editable quizzes. The management part offers the teacher the ability to manage grades and presence at courses together with a communication system for delivering messages to persons / groups.

Both of the games presented in this paper are implemented in Silverlight (a product from Microsoft similar to Adobe Flash) and are tightly integrated into the main application. From the Professor account, they are created and set up, and accessed afterwards from the Student account. A demo account has been set up within the system for anyone who is willing to try the new features of the system. It can be accessed at the web page http://edmtool.gotdns.com/, using the log in credentials (username/password) ism/ism. The games can be accessed by clicking on the left menu on the item "Games", then choosing from one of the two games available and finally joining a room. Because our application is in continuous development, we have not uploaded it yet on a professional server and keep it on the author's laptop, which may cause to not be accessible at any time.

3.2 Crossword Puzzle

During the lessons, the learners are taught to be able to understand and explain certain terms, but in real-life situations, they will have to recognize certain patterns and apply the required methods to solve them. Nowadays, in the age of information, when we don't have to carry around enormous amounts of knowledge, but to know how to find it using search engines (Google, Bing, Yahoo, etc.) or computational engines (Wolfram Alpha), our mind starts to behave differently. As a result, the learner can benefit more if faced with a game that allows him to guess / anticipate a certain term when he is presented with a definition or a situation where it is being used.

The rules for this game are simple: guess all words on the horizontal axis and you will get a combined word on the vertical one. When you correctly guess all terms, the game ends and your time is registered. The total time you have spent solving the crossword puzzle will be shown and compared to what other users have achieved, showing you a score leaderboard with the best times.

On the technical part, this game was easy to implement. After the game has been loaded and the terms and definitions are retrieved from the remote server, everything works on the client (the browser). When the game ends, another communication to the server is initiated, for storing the time achievement and showing the leaderboard.

Each professor is allowed to create a virtually unlimited number of crossword puzzles for the students. The creation of one is simple and intuitive, consisting of two basic steps: main term and associated terms. The main term must be a word which will be formed automatically upon completion of the puzzle. Then, the professor must enter for each character another term, along with its description, which will be

guessed by the student. When entering this information, the professor must respect some limitations. Each term (main or associated) must have a character number in the range of 2-13. It must consist only of lowercase characters, from the Latin alphabet (without spaces or other special characters). In the order of the occurrence of characters in the main term, each associated term (in the order of creation) must contain at least one corresponding character.

The user enters the game, performs a request on the server to retrieve the terms, along with their descriptions, and then displays them to the user. Next, the user repeatedly guesses the term for the provided description; if the term is incorrect, the system responds with an invalid answer message, and the procedure of entering a term is started from the beginning. If the word is true, the answer is marked as correct, and the term input procedure starts from the beginning, unless all terms have been already guessed. If this situation occurs, the game ends, the elapsed time is recorded, sent back to the server and some statistics are shown, including the current player's position, competing with the times of other players.

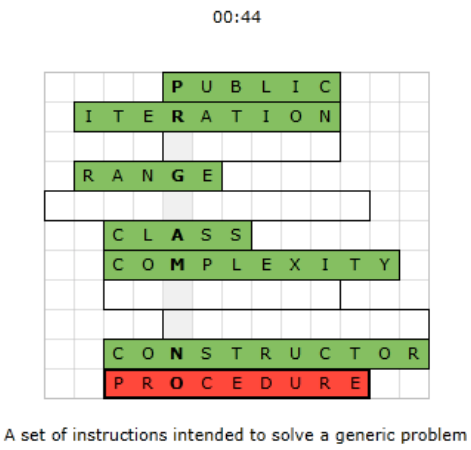

Fig. 2. Playing *Crossword Puzzle*

3.3 Picture Puzzle

The inspiration for this game came from the fact that certain subjects must be learned in text mode, while others must be mapped mentally into an image, requiring proper usage of the visual memory. The application trains the student to reconstruct an image or a schema requiring his knowledge, similarly to a jigsaw puzzle. Unlike a jigsaw puzzle, this application does not give any feedback if two tiles have been joined correctly, until the whole image has been reconstructed, making him think twice when trying to put together the pieces of the puzzle.

Picture Puzzle can be played in multiplayer mode; up to 16 players can join the game simultaneously and collaborate to form the completed image. A remote server takes care of the synchronization and the communication between the simultaneously

connected clients. Each action that a player performs on the puzzle is reflected almost instantaneously on the other clients that are connected to the same room. This is done via http by using a long polling method technique of initiating callbacks to the other clients. In addition, recovery methods are implemented to be able to reconnect if the internet connection fails or the server crashes.

The implementation was a bit more complicated, but provided a better usage of the communication skills from the learner side. The paradigm of this game is the fact that the server must notify all connected clients that the game's state has changed (one of the users has moved a tile from one position to another). The server, as its name says, serves data to the client, and in the normal case, the client performs a request, and the server responds to that request. Therefore, the communication must be done via two sockets, one from the client to the server (as in the normal case) and one from the server to the client. Desktop applications are allowed to do that, but browsers, because of security reasons, allow only client-server connections. For callbacks to be still possible, a long-polling method is implemented that simulates server-client communication. The client initiates a request and listens for the response from the server, but the server does not respond until it decides it should do that. Although it is not one of the best methods, Facebook and Google Docs have demonstrated that it can be achieved, so that we started doing it as well. This approach has led to a completely different style of server-side and client-side programming, which was in itself a challenge. For example, two different clients should not use the same tile at the same time, so that we were forced to implement an exclusive check-out system for tile selection. This has been implemented on the client side as well as the server side in the following manner: when another client selected a tile, the server was notified, and checked if no other user has already selected the tile. Afterwards, all other clients were notified of that particular tile selection in order to keep a list of selected tiles from themselves, therefore disallowing selection of tiles that have been selected by other users. This approach also covers the case when two users select the same tile at the same time. Both of them are allowed from the client application to select the tile, but the server makes sure these types of requests are handled sequentially, and only one is allowed to select, while the other client action is dismissed.

From the technology point of view, we used WCF (Windows Communication Foundation – http://msdn.microsoft.com/en-us/netframework/aa663324) at the beginning, but it proved to be unstable, crashed a lot, was hard to implement and to debug. It carried around too much overhead; sometimes it was sending twice the actual data for no obvious reason. SignalR, an open-source library (http://signalr.net/), proved to be much more stable, easier to configure, and did not carry around too much overhead by using lightweight JSON (http://www.json.org/) encoded entities.

In EDM Tool, the games are created from the Professor account, and can be accessed by any student using the system. Upon creation, the following parameters must be set: a title, a description, one of the three levels of difficulty (Easy, Medium, Hard) and the image that should be completed by the students. Once this information arrives on the server, any client can connect and play the game collaboratively. When the game is over, a leaderboard is presented to each user, and the game is reinitialized, so that other users can join a new game.

Unlike Crossword Puzzle, where the user does not communicate with the server during game time, Picture Puzzle exchanges information with the server, sometimes even several times per second. Each action from the current user must be transported to the other connected players in a fast and reliable manner. For example, when the user joins the game, the server notifies everyone and sends the player information to all clients. The same procedure is applied when the user selects a tile (it must be blocked for all other players), when the tile is dropped or when a player leaves the game. An interesting challenge was having a common, synchronized timer for all players. In Crossword Puzzle, that was simple, because only one user had to see the timer. In this case, the timer must be initialized when the first user enters the game room and, for each client that connects afterwards, the elapsed time is sent to him. From the moment the timer info is received, the client increases the time counter on its own, because no further synchronization is needed. Another alternative was possible: instead of sending the elapsed time, a more accurate measure could have been to send a timestamp containing the date and time when the game started. But because people can possibly access the game from different time zones or have their clock set up incorrectly, this approach could have led to incorrect display of the elapsed time. Although much better, the current approach is still not the best option, because delays of a few seconds can also lead to inaccurate elapsed time measure, but these differences are acceptable. The best option would have been to measure the average time it takes for the server to respond, and then add that value to the received elapsed time.

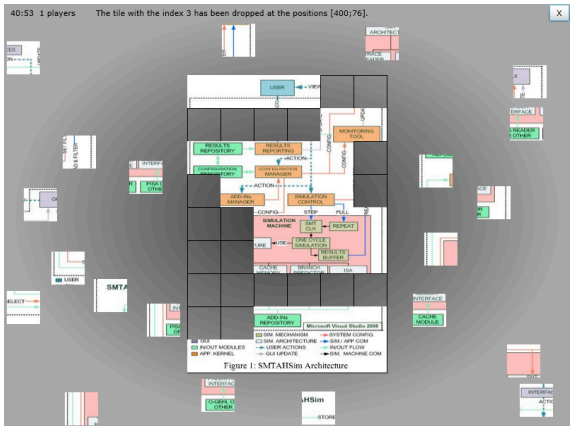

Fig. 3. Playing Picture Puzzle

4 The System Requirements

Because it is a client-server application, the system requirements have to be split up in two parts: server and client.

The server requires the operating system Windows Server 2008 to be installed, together with Microsoft Sql Server 2008 R2 as the database provider. Internet Information Services 7.5 at least has to be installed for the server-side assemblies to be

deployed and for the proper execution of the code in those assemblies, .NET Framework 4.0 or a later version is necessary. From the hardware point of view, we recommend a Dual Core processor with a frequency of at least 2 GHz, 4 GB of RAM and an Internet connection of at least 10 Mbps, for a fluid game experience for up to a few tens of players. Hardware requirements are pretty high, because on each client request, the server has to send data to all the connected players, unlike normal servers, which respond only to the connected client.

The client requirements are not as high as the server ones. From the software point of view, any browser that supports Silverlight and has version 5.0 installed will work (Internet Explorer, Google Chrome, Mozilla Firefox). The hardware requirements are also low, although there is some graphical processing done during the game, it will not require too much processing power from the machine.

5 Conclusions and Further Work

Nevertheless, the game ideas could be implemented in other basic tools and topics. From a pedagogical point of view, the proposed tool benefits the learning process, since it permits students to observe rather than learn through classical methods, discovering the fact that studying can be fun as well. Sometimes the information within lectures is not transferred completely to the students also because of the age and mentality differences. EDM Tool provides the much-needed bridge, to alleviate this misunderstanding and to encourage students to work with the concepts and ideas presented during courses. Students will use the experience with these games in later courses when more notions (about advanced processors, operating systems, etc.) are introduced. As far as concern the educational added value, in the crossword puzzle game we followed a common educational methodology in which students first tackle easy and small chapters based on few definitions, and then progressively continue to more complex ones with many and more difficult definitions and tasks.

No success story comes without problems. The system is far complete, as well as the games. Although the games run smooth and without major problems, we have experienced some issues connecting new players to the Picture Puzzle application. If the connect succeeds, the communication works without any problems, but in some cases, the messages sent from the client never reach the server for some reason.

As future work, we intend to determine the success of this game-based learning approach, through performing assessments using questionnaires (from EDM Tool). Thus, we want to quantify the learning degree of each student and the satisfaction degree if they are using games in the learning process. For now, we observed that the games have good acceptance among the students. In fact, they are using these proposed games to do their homework, obtaining encouraging results in class. In this sense, the instructors could see how student grades will improve with respect to the previous academic years. Besides the tests, we will consider a different approach inspired from machine learning. Thus, we think to improve our games using reward learning algorithms such as reinforcement learning (Q-learning or SARSA) [15]. Also, we want to add new features such as the option to save some “good but not fin-

ished configurations", resuming games from that point, etc. Another issue is security. Although our system does not manage bank accounts or sensitive information, it can be the target of malicious attacks. In the future, we will increase the security of our application by implementing data encryption and hashing where needed. For example, the students could easily figure out the answers for the Crossword Puzzle if they are curious enough to seek through the page source code.

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Supporting Knowledge Transfer and Mentoring in Companies by e-Learning and Cloud Computing

Abstract. Small and medium sized companies (SMEs) assure economic growth in Europe but havedifficulties in facing technological, economic and financial changes and skillshortage. Mentoring together with e-learning and use of cloud computing services can help SMEs to solve some difficulties like knowledge gaps and resources short-age. This article focuses on aspects of knowledge transfer, mentoring and cloudcomputing. One example is the project Net Knowing 2.0 (http://www.netknowing.com/) aiming to help SMEs to turn their daily work into a source of corporate learning forall their employees and to support KT by efficient use of online communities,learning and information and communication technology (ICT) and introducing a mentoring approach.

Keywords: SME, mentoring, e-learning, communities, cloud computing

1 Introduction

Small and medium sized companies contribute to more than half of European value-added by business and assure economic growth (http://ec.europa.eu/enterprise/ policies/sme/facts-figures-analysis/performance-review /index_en.htm). Many of them are small ones and have difficulties in facing technological, economic and financial changes and skill shortage; more knowledge, flexibility referring to a fast familiarization with new working environments and technologies as well as approaches to help and retain staff. The knowledge and human resources of SMEs are very limited and they need help to develop approaches that promoteknowledge transfer (KT) for filling knowledge gaps and learning approaches easy to use particularly based on new ICT.

Mentoring is a human research development approach and together with suitable learning methods (Hall, 2009; Hamburg 2012c) can be organized to address aspects like knowledge gaps and shortage skills (Richert, 2006). Mentorships for staff can be applied for a number of reasons (Hamburg 2012) i.e. when new ones are hired or as a part of leadership development. An existing member of staff guides newcomers or less-experienced people in a task to develop professional skills, attitudes and competencies.

On the job (or workplace) mentoring (Kram, 1985; Ragins, 2007; Hamburg, 2012) means a learning partnership between employees for sharing information, transfer of individual and institutional knowledge and insight to a particular occupation, profession, and organization. It includes the accompanying career advancement and natural support for a selected employee (mentee) i.e. through an experienced colleague (mentor), in order to achieve some present goals of mutual benefit for the mentors, mentees and organization. One problem is that this kind of mentoring is often only accessible to a few numbers of employees and its benefits are limited only to those few who fulfill the conditions to participate. We will present also formal or structured mentor-

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ing which takes mentoring to a next level and expands its advantages and corporate value beyond the mentor-mentee relation.

KT is considered as an aspect of knowledge management depending on actors, tools and tasks. Some SMEs have focused on KT and used it as an enabler for innovation capability, but many of the practiced approaches failed. SMEs priority is survival, leading to just-in-time activities; the benefits of KT to the business have to be very clear and measurableand have to be directly related to competencies and activities of the staff on the job.

Online communities oriented to learning within mentoring process and to KT have the potential to support/assist mentors/trainers in managing the assessment and feedback activities and facilitate active and passive participation of learners/mentees/protégées. Cloud computing is an on-demand service model for ICT based services based on virtualization and distributed technologies. It can be used for small and medium-size business and also for learning purposes. With cloud computing in education, powerful software and computing resources are offered where and when they are needed. It offers also possibilities for people with special learning needs: older students, people with disabilities, people seeking new job skills, migrants. For very specific needs of SMEs it offers help.

This article focuses on aspects of KT, mentoring and cloud computing.One of the examples is the project Net Knowing 2.0 (http://www.netknowing.com/) aiming to help SMEs to turn their daily work into a source of corporate learning for all their employees and to support KT by efficient use of online communities, learning and ICT and introducing a mentoring approach.

2 Knowledge transfer, e-learning and communities

SMEs are very different, have specific organizational needs and characteristics and very often are bounded by the pressure of day-to-day management and tight resources. Referring to suitable learning methods for their staff, conventional training combined with e-learning methods has objectively many advantages for SMEs. Properly developed i.e. e-learning creates a repository of knowledge that will continuously deliver to employees what they need to know at a determined time and in a way that can be individualized to be more efficient.Companies can use informal learning combined with e-learning to:

- increase sales by making product knowledge instantly searchable;
- improve knowledge worker productivity;
- transform an organization from near-bankruptcy to record profits;
- generate fresh ideas and increase innovation;
- reduce stress, absenteeism, and health care costs;
- invest development resources where they will have the most impact;
- increase professionalism and professional growth;
- cut costs and improve responsiveness with self-service learning.

One approach which seems useful in the context of improving learning and cooperation within SMEs and with other experts is that of learning and KT oriented Communities of Practice (CoPs) (Wenger, 2002). CoPs are made up of voluntary members who share knowledge, ideas and interests and who act as mentors to each other. They offer new opportunities for KT and learning processes by using new forms of interaction between team work and loose contact between the actors (Johnson, 2008) particularly when they are supported by web-based environments.

Social media i.e. media for social interaction offer the premises for a fast knowledge acquisition and support transforming learning in a continuous "lifelong process" also within the communities. Social media can be used for supporting CoPs (Hamburg, 2010) and can take many different forms, including Internet forums, weblogs, social blogs, micro blogging, wikis, podcasts, photographs or pictures, video, rating and social bookmarking (Stocker, 2008).

In CoPs, knowledge is created when people participate in solving a common problem and exchange the needed knowledge for the problem. KT is easier in the context of a CoP because its members have common interests in learning and exchanging experience in their specific area of activity and this favors reciprocal trust, being a key facilitator necessary for the effective transfer of knowledge and creation of a common pool of knowledge.

The work in progress about the community developed within the project NetKnowing 2.0, supporting also mentoring, by using social media tool TikiWiki (http://cop.netknowing.eu) will be shortly described. TikiWiki CMS Groupware is a free and open source wiki-based, content management system written primarily in PHP and distributed under the GNU Lesser General Public License (LGPL) license. The decision to use TikiWiki was taken after an analysis of some open source tools.

3 Mentoring

Mentoring has been used in Europe for a long time. Mentoring involves not just guidance and suggestion, but also the development of autonomous skills, judgments, personal and professional master ship, expertise, trust and the development of self-confidence over the time.

Mentoring on the job where the mentorsare companies' employees has advantages because the companies' employees know the work processes, what knowledge is needed for their efficiency and which the companies' knowledge resources are. They are used to the working environment and can estimate the hazards and situations which could be challenges to mentees or their fellows at the workplace. A further advantage is the development of a situation of mutual trust between the colleagues, which later is the basis in the daily work. The following figure shows an example of an efficient mentoring partnership including also KT which we use in our projects.

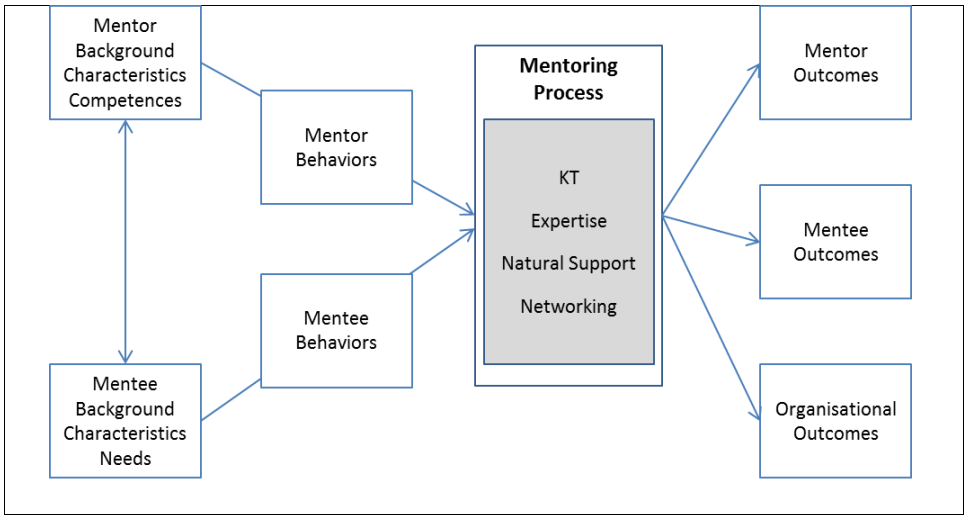

Fig.1. An efficient mentoring process (source: Giancola, IAT)

To be a mentor especially requires having:

- social competences (particularly interest, motivation, awareness, verbal and non-verbal communication, aptitude, empathy and engagement skills),
- professional competences (responsibility standards in knowledge and skill), and
- operating competences according to ethical and professional standards and to know the boundaries when engaging with mentees.

Experience and expertise is necessary in the mentoring as well as being moderately extraverted. In the relation with the mentee, motivation and responsively is required. The mentee needs to be ready for professional development, open to learn and accept feedback. Time and initiative are necessary too.

The company can have benefits from mentoring by a quick introduction of the mentee into formal and informal company structures and demands, facilitating a deliberate, systematic and smooth transfer of technical or internal knowledge, opportunities to shape the workforce of the future in an international, deliberate way to meet company strategic goals and objectives, training of social competence of the mentee and the mentor.

Mentees have the opportunityto meet with a trusted person to enter into a work place quickly and to cope with initial problems to discuss and resolve emerging job problems of genuine nature and in relation to the individual needs, to learn setting realistic goals and achieving them, to acquire new skills and enhance their skills and thus their future career opportunities and prospects in the future through the KT from the mentor. Mentee could build relationships or interactions allowing them to secure, maintain and advance in the job choosing a way that corresponds to the work routines and social actions of other employees. Mentees with special needs can receive (and

contribute to) natural support, meaning: being linked to existing social supports in the work environment.

Apart from knowledge transfer, communication with the team where mentees belongs must include building solidarity, empathy and preparedness to actively take over responsibilities.

In the following, we present the two types of mentoring, informal and formal ones.

Informal mentoring aspects.

These aspects include:

- Goals of the relationship are not completely specified
- Outcomes cannot be measured in total
- The process of KT cannot be explicitly described and it is based on the ability and willing for this process
- Access is limited and can be exclusive
- Mentors and mentees are often selected on the basis of personal chemistry, which means an initial connection or attraction between them
- Mentoring lasts a long time
- The organization benefits indirectly, as the focus is exclusively on the mentee.

In the European projects aimed at people with disabilities IBB2 and CLINTEV (www.clintev.eu) we applied an informal approach. Within IBB2 an on-the-job mentoring process started at one big organization called Werkstadt für Behinderte (German for "The city working for people with disabilities") in Germany in the department of children for 2 mentees with disabilities. They started their work and for them it was important to have a mentor as a trusted person.

An informal mentoring approach has also been applied in two small companies in Germany working in IT consulting. Cloud computing has not been used in these cases.

Formal mentoring aspects.

Among them we mention:

- Goals are established from the beginning by the organization, mentors and mentees
- Outcomes are measured
- Knowledge which has to be transferred is known at the beginning
- Access is open to all who meet the criteria established by the organizationfor the corresponding mentoring program
- Mentors and mentees are paired based on compatibility
- Organization and employees can benefit directly.

Particularly formal mentoring and KT can be supported by online communities.

A formal mentoring approach started in the project NetKnowing in a small network of German SMES. IAT and University of Craiova work now with providers of Cloud Computing Services taking into consideration a catalogue which has been developed within a workshop with representatives of these SMEs.

4 Support of mentoring in on-line communities via e-learning and cloud computing

We consider that web-based training and cloud computing can improve not only SME staff competencies but also the KT processes within and across companies. SMEs could drastically reduce the costs pertaining to their LLL strategies and processes by adopting the cloud.An ICT-based approach, a web-based one allows mentors and mentees to learn on-line, to communicate and collaborate, and to transfer and share knowledge.

Such an approach has a number of benefits including provision of a 24 hour access of saved knowledge, for training material and communication, accessible anywhere with internet availability, provision of a platform even if face-to-face communication is not possible, learning assessment, feedback and monitoring of the mentor-mentee relationship.

In what concerns cloud computing services, SaaS (software as a service) and PaaS (platform as a service)result to be the most suited categories for SMEs since the supporting IT instruments can be out-sourced and need no longer be managed in-house. PaaS is meant to accommodate the middleware and to improve the performance in using it. It may consist for example of a web-based e-learning development platform containing the web/application server, the integrated development environment, the associated database and all additional utilities for development and testing. PaaS offers SMEs the possibility of acquiring on-demand usage-time for different types of software services. This includes a wide range of applications: office tools, graphic utilities, data storage facilities, etc. SaaS is dynamically scalable, device independent, and most of the applications are collaborative, allowing thus multiple users to share documents and work on them concurrently. Adding social media services through SaaS can only enhance this collaboration.

The LMSs (Learning Management System) used by SMEs have traditionally been associated with management and operational issues such as data back-up, down-time during scheduled educational sessions, business continuation and disaster recovery planning, efficient alerting system, scalability and flexibility planning.From our experience with LMSs, we know that during peak time intervals, the platforms tend to perform slower. This is especially painful for those critical tests in which a user response time limit is enforced in the quizzes. Users will become frustrated if the system seemed to slow down their throughput by slowly posting the responses to the servers and getting new questions in. Such a situation is easily avoided if the LMS was hosted in the cloud. Problems such as bandwidth, hosting space and speed would be delegated to the CSP which is bound through service level agreements to ensure that even during peak hours, the quality of the service will hold.Furthermore, man-

aged cloud services not only ensure the typical cloud services, but also add wrapped management services for customers. It is in fact a slow transition from the traditional hosting world to the cloud-based world. This concerns data back-ups, management at the OS level and also at application-level of the rented virtual servers, monitoring and technical guidance. With this approach it becomes easier to ensure that the LMS platform is running as expected. The CSP may be delegated with monitoring the built-in (or custom developed) performance tracking tools, the consistency of the LMS modules, and the alert system of the hosted LMS. Furthermore, the business continuation and disaster recovery planning of the LMS owner and users are facilitated by the CSP's own business continuity and disaster recovery plans.

Added to this, SMEs will surely be interested in the pay-per-use approach since the only moments in which they need to care about the LMS platform and the quality of the provided e-learning service are during the classes and during the test/quizzes associated to these classes. The costs associated with hosting in-house a learning platform are never to neglect. This is rarely the case with the majority of the European SMEs for their business plans and long-term budgeting.

SMEs agree that long-life learning is a critical process for the long-term success of their businesses. No longer is a firm concerned with the accessibility and scaling up of the learning environment since the cloud reduces the SMEs costs associate with hardware and communication infrastructure on one side, and provides transparently and (almost) in real-time as much hardware and communication infrastructure as needed by their business requirements. Both SMEs and learning content providers are able to save money through this approach as they don't have to hire dedicated IT personnel, they don't have to worry about hosting and servers, there is no downtime for the business, and most importantly, they can focus on their core business that is e-learning, while leaving all the technical aspect to the cloud experts.For the subscription-based services, SMEs and e-learning providers benefit financially by moving the learning offer into a SaaS-like cloud service instead of buying a product (such as for example, the supporting software applications that need to be hosted and administered on the SMEs hardware/network). The same applies for the shared platform within the content-syndication model.Security risks associated with the sensitive e-learning content and the related access control will also be delegated to the cloud service provider.

One important activity for the successful management of knowledge transfer within the mentoring process supported by a CoP is to define common goals for this process in advance. The goals have to be identified and agreed by all members. Other aspects are trust and the depth of relationships. Face-to-face interaction and socialization processes consolidate the relations between members and group membership.

The ICT-based approach, when adequately designed, can reduce the limitations of the classroom and allow the learner to work at his or her own space, speed and depth.For quality reasons and outcome value, traditional elements of monitoring/mentoring have to be affiliated. Experience from other projects demonstrates the need for a constant presence of experienced and qualified mentors in the online community. A trust relationship has to be established online, if WHMCS will be used in the project on a regular basis by the mentors and mentees. The WHMCS should support the motivation and retain students in the learning process.

5 Example of Mentoring for SMEs

The goal of mentoring staff from SMEs is to improve job performance by increasing employee's capability to manage their own performance emphasizing on trust, experience, and supervision, to facilitate performance and KT in the organization, to support retention and leadership development. Within the Net Knowing project workshops with SMEs have been organizedin partner countries to discuss with representatives of SMEs some tactics for implementing a mentoring program in their companies. One possible approach is that experienced at the Virtual Academy Brandenburg, Germany. The coaches and mentors are external persons who should support the sustainable development and advancement of strategic competences of SMEs through informal and organizational learning. Potential learning consultants can be trained to act as mentors. In this case the KT will be very beneficial for the mentee in the own career but and also for the mentor. The mentor could have same benefits from the mentee and at the same time gains leadership skills by the act of mentoring. It is supposed that both individuals developed skills within this sponsored KT process and the company is providing a way for KT before an employee's retires or leaves the organization.

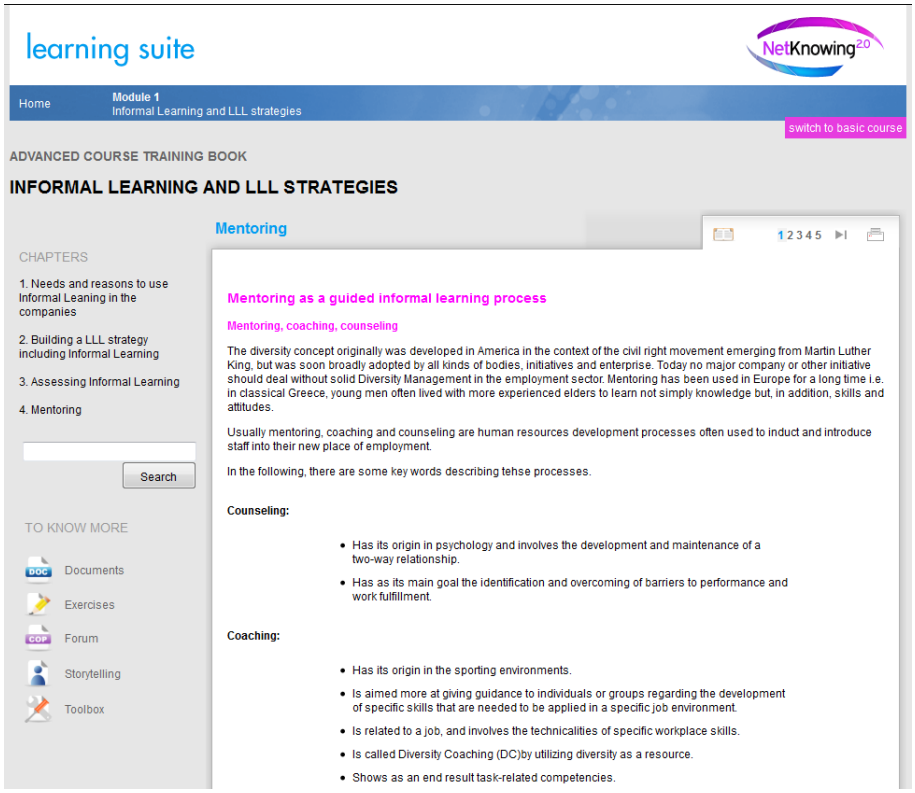

Fig.2. Screenshot of the NetKnowing 2.0 learning suite (source: http://cop.netknowing.eu)

For a successful deployment of a mentoring program within the specific context of a SME environment some factors have to be considered like putting the specific working environment into context, researching the role played by the organizational culture or "climate" in the development, maintenance and success of the SME, determining knowledge gaps which can be reduced by a mentoring systemand qualification needs of the staff. SME managers have to be convincing that a mentoring intervention has real benefits in this context being not bureaucratic. Before the mentoring process starts barriers to effective mentoring/coachingissues that need to be incorporated within the mentoring/coaching intervention have to be cleared.Figure2 presents a screenshot from the learning suite within NetKnowing 2.0 including a mentoring part. This will be adapted and translated in all partner languages and trained with SMEs from these countries by using a blended approach. The formal mentoring process started now in Germany in cooperation with cloud computer experts from the University of Craiova.

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7 Conclusions

Social networks like virtual CoPs, are useful for keeping experts and clients in touch and for informal learning, but work/business-oriented content and suitable learning platforms are needed for more formal activities. It is recognized however, that technology can never become an absolute substitute for face-to-face activity within SMEs.Wikis form an important web presence for many companies but need to be regularly checked and up-dated in order to be useful information sources for staff, customers and the media. SMEs need to survive and to integrate into European/national markets and therefore need to develop a higher interest in the KM subjects. But many aspects can complicate the KM process. A large number of companies, particularly those from new member countries and their employees, tend to be hostile to knowledge management and in particular to knowledge sharing and mutual trust. Missing to most are motivation issues such as sharing mechanisms and user-friendly methods and tools to facilitate knowledge transfer and here cloud computing approaches may be beneficial.

An important aspect of our future work is to help SMEs develop an open and adaptable attitude to web-based and cloud computing tools and methods. This can be achieved by initiating corresponding and cooperative projects.

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Wiki Tools in Teaching English for Specific (Academic) Purposes – Improving Students' Participation

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Abstract
This study is based on an on-going investigation on the impact of Web 2.0 technologies, namely a wiki-based learning environment, part of a blended approach to teaching English for Specific (Academic) Purposes for EFL undergraduate students in a Romanian university. The research aims to determine whether there are statistically significant differences between the degrees of wiki participation recorded in the first semester of two consecutive academic years, starting from the assumption that modifications in the learning environment, namely the change of location for face-to-face meetings from class to computer lab setting and the introduction of more complex individual page templates may lead to increased wiki participation. Due to the project's multiple dimensions, out of which participation and response to the new online environment are particularly important, the results provide information necessary for further decisions regarding specific instructional design needs and wiki components, and changes affecting the teaching/learning process.

Keywords. English for Specific (Academic) Purposes, Web 2.0, Wiki, Blended Learning, Higher Education

1 Introduction

The needs of present day learners are changing at an amazing speed under the pressure of global economic and societal transformations, accompanied by technological anvance and Internet expansion. Paradigmatic shifts in education are being documented by theoretical and evidence-based research and, at all levels, policy makers and stakeholders have put increasingly more reflection and resources into providing better learning opportunities in new educational settings and creating novel and creative openings for teachers and students to experiment and put in action new approaches to teaching and learning.

In European higher education, the reviews on developments of ICTs and their inclusion as key factors in the building of a sustainable knowledge-based economy and

on the use of social software (the so called "Learning 2.0") highlight the advantages and challenges of technology integration in universities and emphasise their capabilities to sustain education reform, support educational management and create what is called a "reflective practicum" with beneficial consequences on academic communities of interest and of practice [1], [2]. Large scale studies commissioned by European agencies on the impact of ICT and new media have also documented positive influences on foreign language learning and learners' participation and degree of involvement in higher education teaching/learning process [3], [4], [5].

While the general motivation for our research may be attributed to the impact of these developments on teaching, a more specific rationale is rooted in the local context. Consequently, a few brief considerations on the adoption of technology in Romanian higher education are needed to account for our choice.

After 2000-2001, and then after its accession to the European Union in 2007, Romania has taken important steps to follow the European strategy for development, with particular emphasis on higher education and the creation of infrastructure for the implementation and development of e-learning. According to some larger-scale quantitative studies regarding these developments, at present most universities seem to have the necessary infrastructure for implementing e-learning but use it mostly for administrative and course management [6], [7]. Issues related to stakeholders' readiness to transfer the learning process in an online environment still need documenting together with in-depth qualitative studies on technology use and its pedagogical implications. While larger scale institutional adoption of e-learning seems to be put on hold, trends highlight students' increasing use of the Internet for study and personal/professional purposes [8] and faculty are engaging increasingly in promoting Web 2.0 technologies, as showed by a fair amount of qualitative and small-scale research published in international and Romanian journals documenting experiences of learners (see, for instance, the latest contributions of Grosseck and Popescu [9], [10])

In this context, we consider that our on-going project could be subsumed to the words of British educational researcher Paul Ramsden: "The aim of teaching is simple: is to make student learning possible" where learning consists of "changing the ways in which the learners understand, experience or conceptualise the world around them". According to Ramsden, the prerequisite of becoming a good teacher is to first understand students' experiences of learning [11]. Therefore, we believe that back in 2009, our decision to create a wiki-based online environment and gradually introduce it in a blended learning design was prompted mostly by the urgent need to reconsider *the multidimensional character of teaching and learning* against the background of 21st century education changes.

Wikis were originally devised to provide "an easy-to-use knowledge management system enabling effective and efficient online collaboration" and "simplify creating online content" without users' having advanced computer skills [12]. They started to be used for instructional purposes for their collaborative features, and potential to sustain the emerging educational paradigm shift from cognitive/behavioural to social constructivism [13].

Consequently, the process of building a new learning environment by integrating technology, particularly Web 2.0 tools, in teaching English for Specific (Academic) Purposes (ESAP) to undergraduate students was an essential step towards finding a variety of solutions for an enhanced teacher and student experience by means of-

which, among other things, we hoped to enable all parties involved to reflect more on the needs of 21st century education, engage in the learning process and, thus, become more empowered as to educational and professional choices.

The aim of the current study is to bring further evidence that, as part of a blended learning design, a wiki-based learning environment has a positive impact on students' learning dynamics, namely participation and response. The results will provide additional data for taking decisions regarding more specific instructional design needs and wiki components, as well as a basis for a more in-depth qualitative research of the changes affecting the language teaching/learning process.

2 Research Background

The wiki environment for the ESAP course for EFL undergraduates from the Faculty of Sociology and Social Work, Babe□-Bolyai University in Cluj-Napoca has been developed over three consecutive academic years (2009-2012). It was set up on the wiki hosting service Wikispaces due mostly to its user-friendly interface that renders it easy to manage and use by teacher and students alike. Additionally, the development of Web 2.0 tools and evidence of their successful use in language learning at tertiary level [14], [15] , as well as the need to cater for a growing variety of learning needs (ranging from general communication to professional, social and personal development), determined us to add the wiki platform as an alternative multidimensional and versatile learning space. At the time, wikis' potential for collaboration and organic growth made them attractive in relation to keeping pace with the accelerated change in teaching and learning. Maximisation of learning opportunities, fostering language awareness, promoting learning autonomy, reflective practice, participation of both teachers and students in curricular and syllabus decisions and choice of most adequate teaching/learning methods were only a few of the long term objectives.

A first study (2009-2010) was aimed at investigating the overall impact of the blended approach, in particular of the online learning environment on the students' capacity to process course information (displayed as individual learning units) by carrying out semester-long individual page edits consisting of sharing personal information and course assignments. Wiki design issues and low frequency of teacher feedback were considered to be responsible for the large number of students with low interest for individual study based on wiki resources. On the other hand, students' low attendance at face-to-face meetings and uneven online involvement, namely a slow start and increased frequency after mid semester and at the end of the semester, a typical behavior due to assessment constraints, were also noticed. [16]. Similar findings were reported by Cole in 2010: "Students prioritize their time according to the greatest perceived benefit with the result that coursework deadlines for other modules and part-time work pressures are automatically awarded a higher priority" (Discussion) [17].

During the following academic year, observations of online and offline behaviour, review of technical issues and the lessons learned during the previous semester together with up-to-date research determined us to introduce several improvements and adaptations to the wiki structure, course organisation and content, all of which al-

lowed us to set a new study (2010-2011) to verify our assumption that in order to learn a language efficiently in an online environment, students need not only basic computer and Internet skills but also a fairly good entry level of English (at least B1-B2 according to the Common European Framework for Reference - CEFR) and certain abilities to work in collaboration. The results of a student survey and statistical analysis of their answers for accuracy versus supposition confirmed that the wiki environment was adopted successfully by the group of students who had more advanced computer and Internet skills, a fairly good level of English and were adepts of collaborative learning. [18]

3 Current Research

Wiki environment: Our choice went to what some authors call a "hybrid wiki," which seems to have beeen more successful in higher education [19] and has been generally associated with a system of incentives, rewards or other motivational enforcement that, according to Ebner et al., contradicts the original spirit of the application [20]. Its features include user and version tracking, permission for users and pages, teacher moderation and feedback for template-driven activities and embedded media. Thus, it displayed the functionalities of a content management system, namely teacher controlled course content pages (home page, course rationale, description, schedule, introduction and welcome pages, wiki related information and tutorials) and student-edited individual pages. The latter were designed with two purposes: firstly, to allow enough time for students to become proficient wiki users (during the first part of the semester) and then to offer them a space for *individual contributions* comprising personal elements (similar to social networking descriptions) and *English language learning related tasks* based on course units.

Hypothesis: The present study is targeted at wiki participation as defined by the two main functions of the wiki environment: accessing content (page views) and production of content (page edits). Our assumption was that during the first semester of the academic year 2011-2012 there would be an increase in wiki participation as compared with the first semester of the previous year (2010-2011) as a result of what we considered important modifications of the blend.

The first hypothesis is that change of location for face-to-face meetings from classroom to the computer lab may increase participation due to more time for hands on activities aimed at getting familiar with wiki environment and at developing independent study skills. In addition to this, activity started sooner than in the previous year due to the bulk accounts creation available on Wikispaces plan for higher education. In this stage, students were also guided gradually through what was to become their semester-long assignment for 50% of the final grade, namely editing their individual pages.

A second hypothesis is that the introduction of a more complex page template, accompanied by detailed instructions as to form and content of the tasks, would generate enhanced response. Its elements were designed (1) to trigger self-expression by means of completing a personal profile (photograph, motto, "about me": maximum

200 words related to interests, hobbies, favourite books/music/movies accompanied by pictures, embedded media etc) and (2) to raise language awareness and take first steps towards taking control and get more reflective in (language) learning (English language profile: initial level, self-assessment, Learning needs/goals for the current year, My learning diary: weekly selection of assignments). .

Participants: For the purpose of our study, we selected the individual pages belonging to first year undergraduates studying social work. Based on a placement test administered during the first week of the semester, students were grouped according to language level (cf. CEFR) as follows: in 2010-2011, one group comprising 42 elementary and lower intermediate students (A2-B1) and another comprising 33 higher intermediate students (B2); in the academic year 2011-2012 three groups: elementary (A2) – 31 students, lower intermediate (B1) – 22 students and higher intermediate (B2) – 25 students. Each student was allocated an individual page for course related assignments. The selection of the participants was based on their more active involvement in class activities (higher attendance included) during the academic year 2010-2011. This means that our conclusions cannot be generalised for now. We hope that a future longitudinal study based on our work-in-progress may show a higher degree of accuracy.

Method: Data were collected with the help of wiki intrinsic statistics which allowed us to quantify students' interaction with the wiki by means of page views and edits statistics for the intervals October 2010- February 2011 and October 2011- February 2012, corresponding to the first semester of the two academic years. They were analysed in two stages: first, the dynamics of page views and edits was computed for the groups with different level of English within each academic year. Based on the results, a second analysis was performed to compare the activity of the A2-B1 students across the two academic years. In order to test the hypotheses, we used SPSS 13.0 and the nonparametric tests Mann-Whitney, Wilcoxon and Friedmann. The decision to apply them was based on the results of the Kolmogorov-Smirnov test.

4 Statistical Study

4.1 Dynamics of page views and edits for academic year 2010-2011

The first step was to test for differences in edits/views between the two academic years. By computing the statistical indicators of centrality, we obtained the following results: in 2010-2011 the median value for edits was 4.29, and that for views was 52.32. In 2011-2012, the median value for edits was 5.136 and that for views was 68.03. Consequently, according to Kruskall-Wallis nonparametric test (χ^2 = 60.66,p=0.000) there are differences between:

1. the number of edits performed in the two years, namely in 2012, the median value of edits was higher than that recorded for the previous year;

2. the number of views recorded in the two years, namely the median value of views recorded in 2012 is higher than the mean values of edits for 2011.

We examined the data sets consisting of the views recorded for the pages of the two groups, namely B2 and A2-B1 from October 2010 through February 2011. In

order to assess their statistical significance, we applied the Kolmogorov-Smirnov test and then we checked if there are statistically significant differences within the B2, respectively A2-B1 groups in regards to the views for the studied months by applying the Friedman nonparametric test (χ^2 =50.31,p=0.000).

Following the application of Friedman test, the results showed statistically significant differences among the monthly data within the B2 group (χ^2 =64.92,p=0.000). The analysis continued with the Wilcoxon test and the results are: January-February(Z=-3.75,p=0.000); December-February (Z=-4.03,p=0.001); November-February (Z=-2.04,p=0.04); November-January (Z=-3.92,p=0.000); October-January (Z=-4.81,p=0.000); October-December(Z=-3.58, p=0.000); October-November (Z=-2.81,p=0.02)

Next, within the A2-B1 group the Friedman test (χ^2 =50.17,p=0.000) showed statistically significant differences among monthly views. The Wilcoxon test was then applied to differences between months and we obtained the following results: January-February (Z=-3.75,p=0.000); October-February (Z=-2.62;p=0.009); December-January (Z=-3.83,p=0.000); November-January (Z=-3.93,p=0.000); October-January (Z=-4.81,p=0.000); November-December(Z=-2.21,p=0.000); October-December (Z=-3.58,p=0.000); October-November(Z=-2.81, p=0.005).Finally, by applying the Mann-Whitney test, statistically significant differences were obtained for the two groups in December (U=620,p=0.04), namely the views median in B2 is higher than the views median in A2-B1 group. The tendency across the study was that the views median was higher in B2 (higher intermediate) group as compared to that computed for A2-B1(elementary-lower intermediate).

In the process of statistical analysis of the page edits, the first step was to compute the statistical indicators of centrality, dispersion and localization for 2010-2011. By applying the Friedman test to find out if there are statistically significant differences among the monthly data within the B2 group we obtained (χ^2 =64.89, p=0.000). The Wilcoxon test was then applied to check which are the statistically different months and we obtained the following results: January and February(Z=-4.79, p=0.000); February and December (Z=-3.21,p=0.001); November-February (Z=-2.01,p=0.04) October-December (Z=-4.17,p=0.000) January-November(Z=-3.71 p=0.000); November-October (Z=-2.42,p=0.001). Statistically significant increases of the medians for the studied months were registered. Next, within the A2-B1 group the Friedman test showed statistically significant differences among monthly edits (χ^2 =50.16,p=0.000). The Wilcoxon test was then applied to check which are the statistically different months and we obtained the following results: January-February (Z=-3.75,p=0.000); October-February (Z=-2.61,p=0.009); December-January (Z=-3.83,p=0.000); November-January (Z=-3.92,p=0.000); October-January (Z=-4.81, p=0.000); October-December (Z=-3.57,p=0.000); October-November (Z=-2.81,p=0.005).Finally, by applying the Mann-Whitney test, statistically significant differences were obtained for the two groups in December (U=490,p=0.04), namely the edits median in B2 is higher than the edits median in A2-B1. The tendency across the study was that the edits median was higher in B2 (higher intermediate) group as compared to that computed for A2-B1(elementary-lower intermediate). To conclude, *during the first semester of*

academic year 2010-2011, the group with a higher level of English performed the most intense activity.

4.2 Dynamics of page views and edits for academic year 2011-2012

In order to further check the above pattern, we examined the data sets consisting of the views recorded for the pages of the three groups, namely B2, A2 and B1 from October 2011 through February 2012. The statistical analysis carried out to determine the views and edits dynamics started with computing statistical indicators of centrality, dispersion and localization for edits and views. The application of the Kolmogorov-Smirnov test, followed by the Friedman nonparametric test showed that there are statistically significant differences between the medians of monthly views (χ^2 =67.92,p=0.000) within the A2 group.

Based on the Wilcoxon test, the following data were obtained: October and February (Z=-2.62,p=0.009); December-January (Z=-3.83,p=0.000); November-January (Z=-3.93,p=0.000); October-January (Z=-4.81,p=0.000); October-December (Z=-3.58,p=0.000); October-November (Z=-2.81,p=0.005). A similar analysis was performed for group B1 and significant differences per months were found (χ^2 =60.32,p=0.000). The Wilcoxon test generated the following results: January-February (Z=-2.14,p=0.03); December-February (Z=-2.81;p=0.005); October-February (Z=-2.42,p=0.02); December-January (Z=-3.003,p=0.003); November-December(Z=-2.28 p=0.001); October-December (Z=-3.22,p=0.001).

The analysis of group B2 showed significant differences between the median of the views/ month (χ^2 =59.43,p=0.000) and the Wilcoxon test showed the following results: January-February (Z=-2.89,p=0.02); December-February (Z=-4.03,p=0.000); November-February (Z=-2.85,p=0.004); October-February (Z=-2.03,p=0.4); December-February (Z=-3.97,p=0.000); November-January (Z=-4.35,p=0.000); November-December (Z=-2.9,p=0.004); October-December (Z=-4.37,p=0.000); October-November (Z=-4.25,p=0.000)

Finally, the Kruskal Wallis test was applied to check if there are differences between the three groups and the computations confirmed statistically significant results in the months of December(χ^2 =4.2, p=0.04)and November (χ^2 =12.004,p=0.001) between the three groups. The median of the views is higher within the A2(elementary) group, followed by B1(lower intermediate) and B2(higher intermediate).The Kruskal Wallis test was applied to check if there are differences between the three groups and the computations confirmed the following statistically significant results: between B1, A2 and B2: November (χ^2 =28.34,p=0.000). The median of the edits is higher within B1, followed by A2 and B2. This hierarchy is maintained across the study. In conclusion, *during the academic year 2011-2012, the students from the group with lower intermediate level performed the most intense activity.*

4.3 Comparative study

The next step was to examine and compare the two data sets consisting of views and edits recorded for the pages of A2-B1 students in 2011 and 2012 to find out if the

modifications introduced in the learning environment had an impact on the students with basic computer skills and lower level of English. Firstly, we assessed the statistical significance of the data set for views by applying the Kolmogorov-Smirnov test, followed by the nonparametric Mann-Whitney test. The result of the Mann-Whitney test is (U=168,p=0.000<0.05), so there are differences between the two years in terms of a significant increase of the views.

Table 1. Statistical indicators of centrality, dispersion and localization for 2011-2012: Views

Views A2-B1	Mean	Standard Deviation	Confidence Interval	Min	Max	Median
2011	45.91	84.89	34.37 ;57.47	0	673	12
2012	74.89	105.13	62.18;87.61	0	892	40

Next, we considered the two data sets comprising the number of page edits recorded for of A2-B1 students in 2011 and 2012. We applied the Kolmogorov-Smirnov test, followed by the nonparametric Mann-Whitney test. The result of the Mann-Whitney test is (U=223.5;p=0.000<0.05). Again, the results indicate that there are differences between the two years, this time in terms of significant increase of the edits.

Table 2. Statistical indicators of centrality, dispersion and localization for 2011-2012: Edits

Edits A2-B1	Mean	Standard Deviation	Confidence Interval	Min	Max	Median
2011	3.56	7.48	2.58 ;4.58	0	49	0
2012	5.40	9.84	4.20 ;6.6	0	85	2

All in all, the application of the two nonparametric tests demonstrated that *the activity of students with elementary and pre-intermediate level of English was more intense in 2012 than in the previous year.*

4.4 Findings and comments

The dynamics of page views and edits within each year shows that the group with higher level of English performed more intensely, with a peak activity in January 2011. In contrast, during 2011-2012 it was the group with lower intermediate level who participated more actively both in terms of views and of edits. During this year, B1 students performed at a relatively steady pace, while A2 students' activity fluctuated and B2 moved more abruptly. All in all, the activity reached a peak in January, with B2 registering the highest values in 2010-2011 and A2-B1 in 2010-2012.

The study of the page view/edits dynamics also confirmed the behaviour pattern (on and offline) noticed in the first study, namely the intensification of activity under the pressure of the imminent assessment constraints.

In terms of changes affecting the behaviour of students with elementary and pre-intermediate level of English, the findings of the comparison between the two academic years point to a more intense activity recorded in 2011-2012, which may be

attributed to the change of location for face-to-face meetings from classroom to the computer lab and the introduction of a more complex page template for students' wiki-based individual assignments. Both these changes also involved an increased teacher presence for the initiation in and tutorials for wiki activities, which triggered an increased online student activity. Certainly, this result has yet to be confirmed by a content analysis of the pages to see if increased number of edits meant also a more confident usage of English for self-expression and assignments.

5 Conclusions

The decision to enhance the experience of teaching/learning ES(A)P by creating a media-enriched online environment and gradually implementing a blended learning design for our course was, in our opinion, an important step towards fulfilling one of our basic aims, namely to provide a variety of ways to make (language) learning possible. The results of our three consecutive research attempts have confirmed numerous other studies that acknowledge the potential and positive impact of web-enhanced teaching. Though small-scale and modest in scope, the present study may be considered as evidence that Web 2.0 tools can be used successfully in higher education, in particular for participation and response to a foreign language course. Yet, additional regular observation of classroom attendance and online activity patterns is needed to corroborate the results and improve on the initiation and early stages of wiki work.

Further on, our research will focus on more in-depth analyses of how the new learning environment can support a systematic and efficient acquisition of the foreign language and can foster the development of collaborative skills for undergraduate students. Consequently, we intend to conduct a content analysis on the various products of individual and collaborative work performed on the wiki platform and analyse and compare the interaction patterns (teacher-students, student-student) resulting from wiki participation in the two academic years.

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AD-HOC BUSINESS PROCESS MANAGEMENT IN ECM SYSTEMS

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Abstract. The article describes the features of an enterprise's business process management that concerns ad-hoc processes. The analysis of the possible implementation problems in ECM system is shown and ways of overcoming. These results were obtained in the fourth stage of the complex project, which is carried in the frame of Government Grant with participation of NRU and IT Corporation (Russia).

Keywords. Enterprise content, ECM, ad-hoc, innovation, semi structured information, subject-oriented approach, business process management, S-BPM, communication network, contact net, Networking.

Modern business, and government services are becoming more dynamic. It is fairly common that businesses need to manage unstructured processes (ad hoc) rather than well predefined business processes. The traditional approach of business process modeling and BPM are poorly suited for the optimization of ad-hoc processes. Ad hoc processes consist of a series of activities which cannot be predefined. In such processes, users must be able to decide what to do and when to do it, and also they must be able to assign work (activities) to other people, creating interactions among various users. It is necessary to support contingency and the interrelations among all the structural units for provision of operational flexibility, so that any innovation can be rapidly spread to all parts of the organization. Companies need to achieve agility when integrating the solution which can satisfy business requirements into the processes, in other words we can see clearly the necessity of SOA implementation relating to business globally. Therefore the main task in searching excellence in business practice is to improve collaboration between people and agents of support. So every human activity can be obtained from an organizational point of view in a sequence of informational transformations. It is one of the main ideas of presented study which can be implemented on a particular platform with predictable benefits.

For this reason ECM R&D processes are one of the most- rapidly growing sectors of IT market, overcoming traditional corporate sector . With reference to AIIM report in the nearest future the actual factors for ECM modification and empowering will be cost reduction and efficiency growth in business processes, and in close conjunction such factors as compliance management and content chaos reduction are followed. But surprisingly, such serious part of enterprise activity as support of innovation activity is not mentioned in AIIM report.

This particular work is dedicated to study of definition of the requirements for developing ad-hoc processes support in a frame of ECM system, existed or planned for implementation.

As any process ad-hoc process is oriented on particular objectives. Ad hoc processes are built around the sharing of common information systems and corporate data sources, correspondence without direct staff assignments, blogs, conferences, internal social networks, etc. The main tool - correspondence and other communications (Q & A, call-center blogs, wikis, online). Example - the corporate social networking company with creation of expert competence centers, where knowledge can be accumulated, stored and distributed enterprise wide. Experts in such centers should be linked by (via) cross-functional principle, thus elaborating solutions for complex interdisciplinary problems.

Implementation of unified information field (UIF) support and management system, which becomes a basis for interdisciplinary links, deploying complex problems and external information environment, scientific and innovation trends monitoring.

Properly speaking, having chosen an innovative way of development an enterprise has to create new structure for managing the specialist's crews, which are able to solve related problems and tasks. In such a case it is possible to seriously consider the importance of knowledge economics or innovative economics, and it could become an answer to the question 'when we (Russia) will stand on a way of innovation development'. Short answer is simple – when we'll create corresponding conditions for:

- Instant improving and management of internal processes and technologies.
- Generation and development of new knowledge of process logic and existed technologies.
- Specialists' motivation to cross-functional experience and knowledge exchange.

Certain step towards the exhibited tasks solution, beyond financial investment, is development and implementation of innovation-oriented ECM platform. That platform has to maintain and support ad-hoc process in all its existence. Consequently, requirements to this platform should depend on organization of innovation development and what methodology is prevailed in its realization, as well as a number of social meaningful factors.

The ultimate goal of innovation is to build a flexible architecture of a corporate enterprise. That can ensure comprehensive functionality in order to support real-time business processes providing a fast reaction to ongoing environmental changes by selecting anappropriate business process optimization. Such an enterprise architecture should include description and allocation of the personnel roles a description of the processes (functions and behavior), as well as an introduction of the required technology used throughout the life cycle of an enterprise, thereby providing business agility. In this regard, many IT professionals understand the necessity of developing new approaches to designing and implementing IT systems. One can believe that the next generation being based on advanced architectural principles and advanced technological solutions will be really able to improve quality of social life

The organizational system has two aspects: the formal (a system of the roles assigned to people) and the informal (the actual performance of roles). Activities of a

company which has implanted such principles of compliance management are built in accordance with a system of norms, rules, activities, relationships, regulations, etc., to ensure standards and controls. Another component is the control subsystem, which coordinates the activities of its members and administrates it. Thus, a continuous monitoring of standards and requirements such as information systems, risks assessment, connected with discrepancy of business allows priority determination of business processes and information systems modernization. For example, the use of ITIL 3 in any organization ensures that the requirements of ISO 9000 , CobiT , SOX (Sarbanes–Oxley Act), and COSO are all met. Active compliance management is the most appropriate tool for this task designed specifically to improve organizational effectiveness. There is a problem related to information systems, as well as the processes themselveswhich are not flexible enough to be easily rebuilt regarding many, often hidden interprocess communications. As a result, the employee of the organization engaged in the process has to do extra work to verify the results due to numerous requirements.

In this article a new model represented a newer approach and can be described as a nonlinear iterative innovation process. In this model multiple interdependent intellectual resources at all process stages are involved; as well parallel, iterative and quickly modified process execution with reference to rapidly changing business requirements. Model of multiple intellectual resources takes into account the diversity of these intellectual resources and creates conditions for their creative networking.

The key issue of such model is ability to self-modification processes (ad-hoc) being inherent in the processes themselves. This approach allows you to modify the process in such a way that it complies with establishedrequirements each time But to achieve this result it is necessary to know everything about the process including the way it is implemented by specific performers, or its ‘natural behavior’. Building such a model using standard modeling, thereby led to increase of the decomposition and, however often is too difficult and impracticable.

It is always obligatory to consider methodological aspects that support the innovation process.

New role of employees

- Employees in most mature organizations realize a new role in organizational structure according to these new requirements.
- Employees should understand the basic goals of the business and participate in achieving them, keeping a balance between business requirements and their capabilities.
- Employees have to understand the responsibility and the consequences for business, caused by mistakes in the work, including the deterioration of customer loyalty, which directly depends on the company's competitiveness.
- Management of division should be predictable and transparent due to unification of its processes, activity based costing and responsibility delegating throughout specialists.

- It is necessary to measure the efficiency and reduce operating costs through reporting and measurement of qualitative and quantitative performance indicators in the process, thus creating KPI culture.
- It is necessary to modernize regularly the IT Infrastructure in conformity with changing requirements of business.
- It is necessary to justify and optimize IT costs.
- To meet some of these requirements, management of IT services has been allocated to a separate management process that was described in ITIL and legally enshrined in the Standard Systems IT Service Management ISO 20000.

Subject-oriented approach

Innovation in IT leads to innovation in the workplace. The catalyst for such innovations is the new methods of management. Processes within these systems have been standardized and automated, but for the sake of the lack of adaptability and flexibility. Automation systems have spread to nearly all areas of business, and in some areas without automation systems it is really impossible to manage.4

Then there were the decisions focused on an employee, various workstations and portals but this interaction was not yet flexible and again the price of change was too high.

Service-oriented approach has brought flexibility but in a number of instances it was too expensive and the claims seeking the necessary changes were questioned.

Synergy between natural and artificial environment

Subject-oriented approach is a new paradigm of business process modeling. This method allows to illuminate and incorporate the true participants of the business activity while modeling the processes and to adopt theirunderstanding of their roles and responsibilities to the real productive system. So process flow involves the effective interaction of staff in accordance with their actual roles, which are defined by their duties. This approach allows to "include" activity of the employees participating in debugging and introduction of business processes, to use reflexivity for changes and to introduce models by the same people who carry out these business processes later. Thus, employees are motivated by their individual contribution to the company. Subject-oriented modeling supportsservice oriented on business and allows trial participants to determine the best process for achieving individual goals and key performance indicators.

Analysts of all the times tried to solve the problem of how to model the activity so it would reflect a desired level of abstraction and at the same time be as close to reality as possible. An answer here could be just one; we have clearly seen the clearance between a model and a reality and always take it to account in our considerations and assumptions. From the management point of view it is a challenge to find a synergy in

combining artificial system as a model and natural system as a reality being controlled. In order to achieve a synergistic effect modeling of

business processes must be considered in terms of describing natural-artificial systems. There are two approaches of modeling processes: Modeling “top-down” and "bottom-up".

Modeling “top-down” is the formation (forming/shaping) of business process models from integrated to detailed decomposition. Modeling of the system “top-down” on each level gives us the requirements for the next level of detailization in terms of business performance as an artificial system.

Modeling “bottom-up” is the formation of the integrated business processes by aggregating detailed processes or procedures. Modeling a system from the "bottom", we create a “natural” model of transmission processes, which are usually based on the principle of minimizing resource performer.

At present, many companies find themselves in a stalemate because they describe only processes with an artificial point of view by modeling the "top-down". They should, on the one hand, automate and standardize processes to reduce costs, improve efficiency and quality, but, on the other hand, be flexible to move on, respectively, considering the fast changing needs of consumers, markets, laws through the introduction of changes in corporate strategy at the operational level.Thus, the research urgency is caused by the problem of effective management of constantly developing and increasingly complex systems and people involved in their operation and development in terms of synergy between artificial and natural components.

The main idea of the subject-oriented approach is to consider the subjects of organization as the main participants in its description. Subject-oriented approach implies that employees quickly and cheaply can integrate their methods of performing the process into the overall scheme of a process, thus achieving self-organize and adapt the system to the external environment.

Execute processes exactly as modeled. This means that process users are always given real information about process runtimes, critical paths, and resource bottlenecks.

The S-BPM refers to participants exhibiting their behavior pattern within a process as “subjects.” Each subject in the process is defined, modeled and documented by the description of its individual actions. Here “subject” is considered not only as a resource which is required to perform a specific action but as rational person who possesses intelligence, creativity and reflection.

The first model type is intended to describe the process of messages exchange between the subjects (this is quite enough!); the second - subjects’ participation in the process which can be described by subjects states and transitions from one state to another.

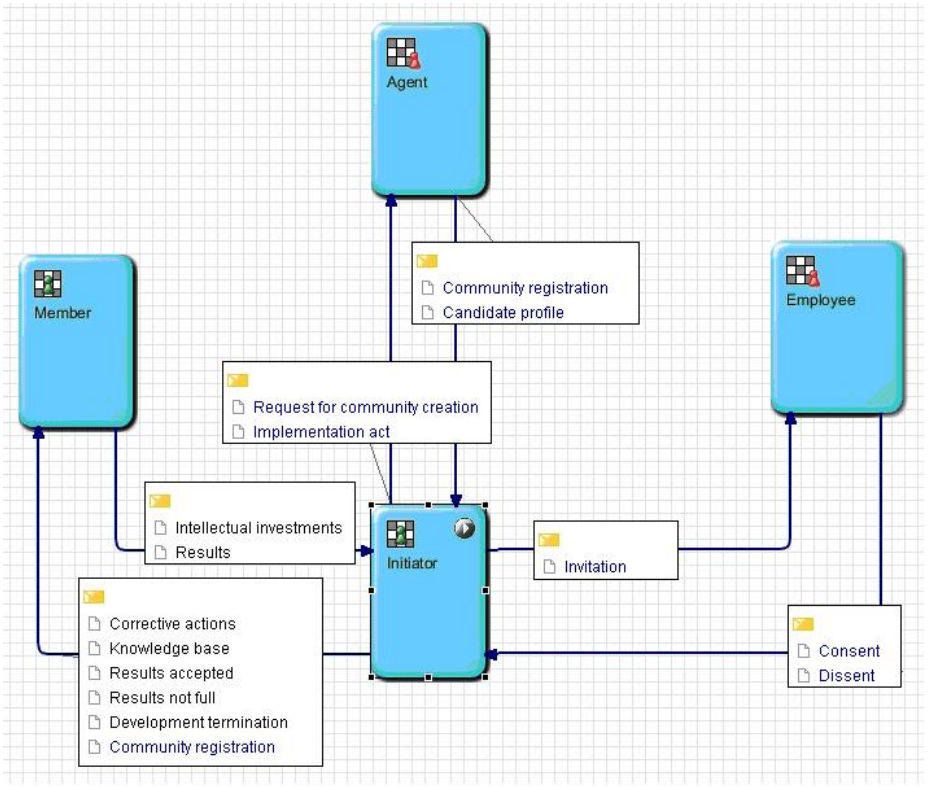

Fig. 1. Model of the innovation process in a "Process manager" looks very simple

The subject "Founder of Innovation" sends message "The application for the community creation" to subject "Agent" (this is not a man, but an element of an IT system). "Agent", who has staff profiles, sends two messages with his recommendations on potential investors of intellectual capital and their profiles to the "Founder of Innovation».

Having examined the recommendations and profiles of candidates, the «Founder of Innovation" sends an invitation to potential investors and, after receiving consent, creates a new community for the innovation development. The formal establishment and registration of community is operated by an Agent. A potential investor becomes a participant in the innovation process. The development of the innovation begins after accumulation of the intellectual investments of the community.

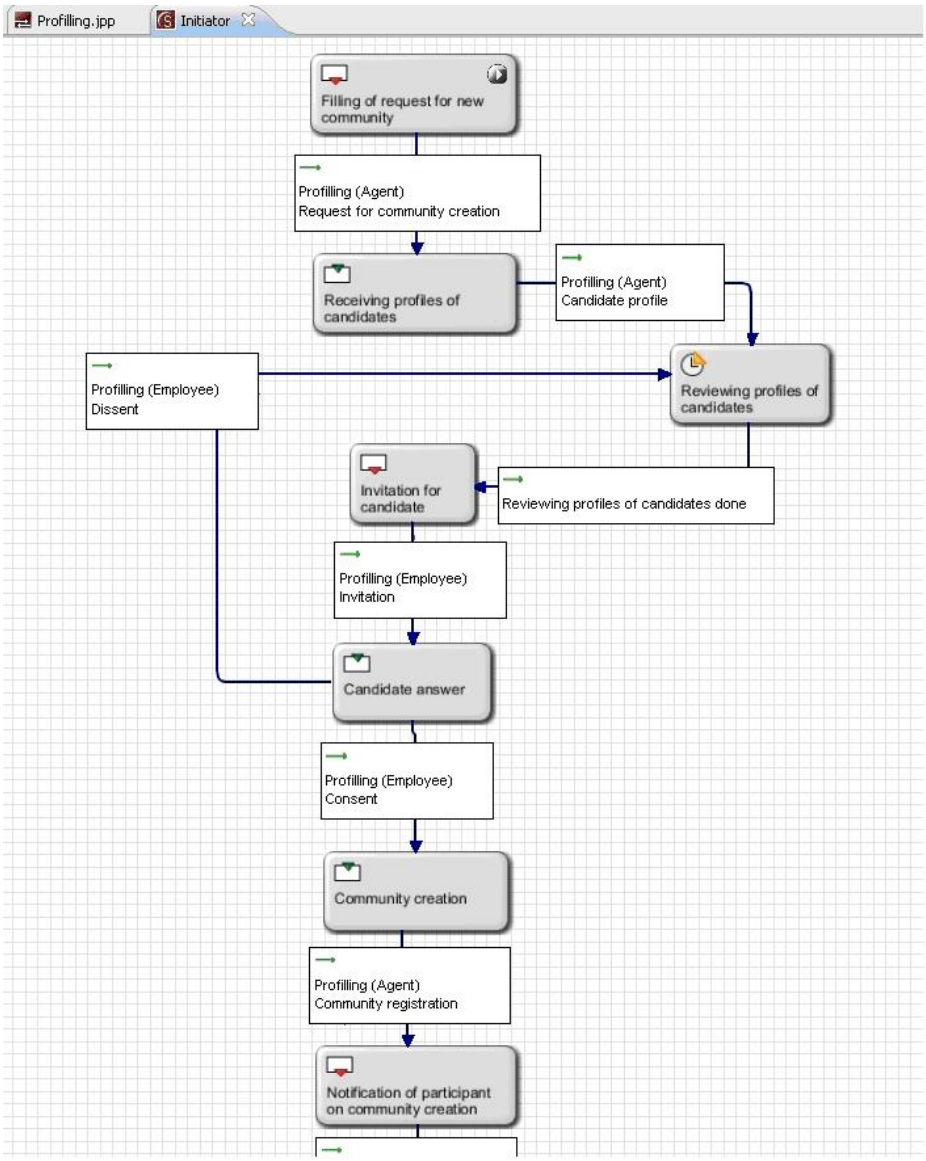

Fig. 2. Example of an innovation creation initiator in «the manager of the subject»

On fig. 2 activity description example of an innovation creation initiator (which has turned into the owner of the process) in «the manager of the subject» is shown. This model is detailed elaboration (decomposition) of the subject «the Initiator of creation of an innovation (the owner of process) », created in «the manager of process» (fig. 1). In this model difficult logic constructions and operators are missing, distinctive for notations of traditional modeling methodologies. All necessary deci-

sions according to the logic of process performance are made by the subject who possesses certain degree of freedom within the limits of given process model.

If there is a necessity to increase or to narrow the degree of subjects' freedom, the subject itself could easily adjust the model respectively (bring respective alterations into the model). For this purpose the real subject (the employee of the enterprise) needs to study only 5 (five) elements of modeling and several ways of their connections. What will come next, after shaping models of two types?

Before answering this question, let us recall the traditional approach to modeling. For example, the methodology and tool system ARIS allows to execute modeling on three of five levels (stages) of life cycle of system development: *Requirement Definition level,* Design *Specification Level and Implementation level.* At the first stage models which define business requirements to the projected system are under (in the course of) construction. Design Specification Level models are transposition of business requirement to information technologies. Specifications level models derive from Requirement Definition Level models. At long last (finally), Implementation Level models describe concrete realization of system; they follow from Design Specification Level models. Is not it too long and too difficult?

The subject-oriented approach allows alternative scenario of the development. In relation to life cycle development these two models presented above are the requirement descriptions of a workflow control system. But, to turn simple models avoiding skills of programmers to the executed applications, it is necessary to fill models and elements (subjects, messages, conditions, transitions) with all necessary attributes and properties. The procedure will provide generation of the high-grade (full-rate) application, including connection to other information systems, electronic documents flows, automatic steps etc., and can be charged to corresponding expert. Thus, the same models in tool system Metasonic S-BPM Suite describe processes at all three levels. Moreover, modeling is combined with programming! It turns out quickly and not too complicated.

After creating the models it is required to: start models in an interactive imitating mode (if necessary), coordinate them with colleagues and load them on the server. That is it! The application starts working at once; it is possible to initialize process copies. For innovative process each participant should have certain degree of freedom in decision-making. This freedom should be enough for stimulating creativity, reflection, and self-organization. If modification of a process is needed, it is brought into corresponding model which is immediately loaded on the server. It is possible to start the updated application at once (the changed copy of innovative process). All copies of innovative process (initial and changed) remain. Information environment remains also. It is necessary for gathering full information on each copy of the process, for accumulation and generalization of experience of innovative activity within the enterprise.

In the process of innovative creativity the most essential risk factor is uncertainty and loses of information applicability. In order to solve formulated task continuous actualization of the investigated information and selection of relevant information is required. Hence, except control system of workflows connection with information services providing reliable, adequate access to the relevant information from unstruc-

tured sources, and coding services, preservation and access to the problem-structured information is necessary.

The described approach on platform S-BPM allows realization of operative connection as plural services of information access to unstructured information and various DBMS with access to data at the fields' level. Thus, access to unstructured information can be carried out via one query executed in several services simultaneously, for example, Yandex, Google, Exalead, Fast, at this moment connected to the system. Therefore, there is an auto-generation of system architecture of innovative process management which in more mature phases of self-realization could be corrected and analyzed by experts group, responsible for processes of innovative development.

It is worth noting that flexibility of an architectural skeleton in this case is the cardinal advantage, which allows reaching innovative results in the optimal way. Morally formulated in 1983 by academician V.A. Legasov [9] concept of flexible production management on a platform of universal informational highway (pipeline), is realized today in the form of services to the information corporate bus (ICB).

The above description gives the confidence to claim that high-grade innovative ECM system can be designed only from the subject-oriented point of view to innovative process management. This approach has advantages not only to innovative processes, but also to all processes which demand flexibility, simplicity and speed of modification. S-BPM implementation as a part of innovative ECM system gives enterprise the powerful tool for independent management of business processes and ECM system services.

The subject-oriented approach to innovative process is integrally combined with necessity of accounting the socially-psychological factors, which are connected with innovations development. The purpose of this article was not in adduction of detailed description of socially-psychological factors, for this reason we result only general reasons and recommendations.

First of all, creativity is a rear human feature. It means that it is worthwhile including in network innovative communities only those employees who want and can be engaged in innovations development. It is a special "elite" network and its participants (subjects) should acknowledge certain ideological principles. Each employee who wishes to be engaged in innovative process has to study and undertake certain common rules for all participants. In capacity of rules perfectly proved in business ideology of contacts network construction - Networking - [9] is offered.

Secondly, for effective performance of innovative process it is necessary to consider psychological features of each subject and, accordingly, conducting additional researches.

Finally, it is necessary to learn (to allocate) to flag among semi structured information that part which contains dramatic distortions, which were consciously or not brought by subjects. In oppose the application of semi-structured information for enterprise governance looks problematic.

Conclusion (Summary)

While creating innovative ECM system it is indispensably to provide the support of nonlinear innovative process considering plurality of intellectual investments sources, interdependence and parallelism of development cycles of an innovation, constant orientation on demand, thus providing agility to holistic process.

Modern requirements to innovative ECM system can be executed only with orientation on innovation subject support and the subject-oriented approach to innovative process management.

During the creation of innovative ECM system it is necessary to consider the essential impact of socially-psychological factors on innovative process.

Generation of methodological basis of innovative activity in all phases of its development is the necessary condition for realization of government program transition to innovative economics. The speed of innovations is directly proportional to degree of intellectual resource integration as for separate enterprise, or group of the enterprises which have set such an ambitious task.

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Collaborative processes in virtual learning spaces – Does structuring make a difference?

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Abstract. This study explores features of successful collaborative learning among university-students in virtual course. Aim is to study what kinds of interactional processes and featured of creativity occurred in students' collaboration while they were working in international teams and how did pedagogical structuring affected to the interactional processes. The data has been collected from 'Technology-Enhanced Learning' –course, where students (N=54) worked together for three months. Data consists of recorded studying sessions in different virtual learning spaces. Preliminary results indicate that students used lot of time discussing about metacognitive issues in their collaboration like how to organize group work in most effective way. Active group members expressed cohesion in their interaction and also some hostility or worry towards passive ones. Pedagogical scripts enhanced students' activity and participation. This study provides teachers, educators and educational coordinators guidelines how to organize and enhance successful collaborative learning in virtual learning spaces.

Keywords: Collaborative learning, CSCL, creative collaboration, university students

1 Introduction

Today's university students are expected to work in teams, which often consist of students of a variety of different nationalities, a pattern which is expected to continue in the workplace. People are required competencies for collaborative problem-solving in complex and unexpected situations, where adequate information is not available (Hyvönen, Impiö, & Järvelä 2010). Teams are working in various contexts, both face-to-face and virtually. In these situations skills for collaborative learning and creative collaboration are

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needed (Sawyer 2007) and students should learn these skills already during their education.

The main arguments for this research raises from three perspectives. First, earlier studies (Dillenbourg, Järvelä, & Fisher 2009; Karpova, Correia, & Baran 2009; Smith, Sorensen, Gump, Heindel, Caris, & Martinez 2011) has indicated that it is challenging to design collaborative learning especially in technology-supported learning environments. More research implemented in authentic learning context is needed (e.g. Kollar 2010).

Secondly, there are a number of studies which have evidenced that applying scripts can improve computer supported collaborative learning (Stahl 2007; Weinberger 2003). However, there are also contradicting evidence (see Dillenbourg 2002). Like Haake & Pfister (2010) highlight there is a lack of research on scripting implemented in extended period, like semester or university course.

Thirdly, according to database review creative collaboration that is based on collaborative tradition has not yet got academic interest, particularly on the point of designing learning.

This study is designed to explore *how pedagogical structuring can support the collaborative activity of individuals working together in various virtual environments*. The collaborative activity that takes place in each condition is considered for the quality and extent of *collaborative learning*, and also for the quality and extent of *creative collaboration*. Specific research questions are:

1. How did *collaborative learning* appear in virtual group work?
   - What kind of interactional processes and features of creative collaboration occurred in group discussions in virtual spaces?
2. How did *pedagogical structuring* affect to collaborative learning processes?
   - How did different kinds of scripts affect to group members' activity, participation and interactional processes?

2 Theoretical framework

2.1 Computer-supported collaborative learning

In this study the definition of collaboration is in line with the notion of Arvaja, Salovaara, Häkkinen, and Järvelä (2007) who define collaboration as shared knowledge construction where knowledge is built jointly on others' thoughts and ideas (Mercer, 2010). In collaborative learning situations learners distribute their own thoughts, listen and elaborate views presented by others and reach common goals by shared and creative knowledge construction (Roschelle & Teasley 1995; Sawyer 2007).

Research on computer supported collaborative learning (CSCL) focuses on possibilities for technology to enhance interaction between learners, group work and sharing expertise. Dillenbourg et al. (2009) have defined a series of principles for CSCL, based on previous studies of CSCL and collaborative learning (Dillenbourg 2005; Rochelle & Teasley 1995; Scardamalia & Bereiter 1994; Shellens & Valce 2005): 1) The focus is on social interaction rather than individualization. 2) Cognition is seen primarily as a social process. Thus activities that foster social interaction foster the means which people construct knowledge. 3) Collaborative learning does not take place just by getting people together. A crucial question is to understand the conditions, environments, technologies, design and interaction that enhance learning. 4) Effectiveness towards learning should be addressed by considering efforts that individuals perform together: how shared understanding can be achieved. 5) Over-expectations of the effectiveness of media should be considered, as should critique of media effectiveness. 6) In addition to virtual interaction, face-to-face interaction is needed.

A CSCL environment is defined as a tool that can shape interaction between participants in both co-present and geographically distributed settings. At its best technology can provide a space for sharing thoughts and knowledge and enhance awareness about group processes (Dillenbourg 1999). Technology, like virtual learning spaces, should also provide tools for negotiation and argumentation (Kolodner & Guzdial 1996; Stahl 2007).

2.2 Features of successful collaborative learning

The core of collaborative learning is building joint understanding, shared meanings and new knowledge through interaction with other learners (Roschelle & Teasley 1995). This requires learners' commitment in joint activities and tasks (Dillenbourg 1999; O'Donnel 2006). Besides shared understanding about content matters learners have to share an understanding about social organization in the group and relationships between group members. (Stahl 2007). Successful collaborative learning requires also learners' active and equal participation (Baker 2002) and argumentative interaction (Barron 2000).

Research on collaboration argues that all collaboration is not effective for learning. The effectiveness depends on characteristics and quality of interaction (Barron 2003). Rummel, Spada & Hauser (2008) characterize good collaboration alongside five dimensions: 1) communication, 2) information processing, 3) coordination, 4) interpersonal relationship and 5) individual motivation. In addition some domain-specific aspect can be defined.

When exploring collaborative learning from the viewpoint of group's strategical behavior Järvelä and Järvenoja (2011) argue that the group has to be able to regulate its' activities by planning, monitoring, coordinating and evaluating. From individual perspective it is also essential that each learner is able to regulate one's own studying process, which includes choosing appropriate learning strategies and motivation to learn together with other learners. (Hadwin, Järvelä & Miller 2011).

2.3 Creative collaboration

In this study creative collaboration is analyzed through following matters: divergent thinking, playfulness and degree of tension. In literature of creativity and creative collaboration (e.g. Wegerif, McLaren, Chamrada, Scheuer, Mansour, Mikšátko, Williams 2010; Dunn 2004; Silvia 2011) these concepts are seen essential elements of successful creative group work.

First, learners must have opportunities for divergent thinking which refers to the generation of novel ideas and associations, and of multiple potential solutions for open-ended, unstructured or loosely structured and multifaceted problems. (Glassner & Schwarz 2007.) Second, in order to promote creative

collaboration the group should have an atmosphere of playfulness, which enables group members to play with different ideas while working on the task (Sullivan 2011). In academic contexts playfulness is characterised by motivation, cognitive curiosity, attentiveness and enthusiasm (Liebermann 1977). Thirdly, the Bakhtinian argument, upheld by Wegerif, Sawyer and deZutter and by Sullivan, that it is through tension and disagreement that new ideas are generated. Karlgren and Sins (2011) suggest that where tensions exist, group members have to reflectively analyse their own activities in the group and they have to question how they deviate from the established norms and established practices that they would favour. Tensions are the basis out of which creative ideas might be generated.

2.4 Scripting approach

Collaborative learning is not a spontaneous process and it needs to be supported. One way to enhance collaborative processes is structure learners' activities through collaborative scripts. Collaborative scripts include supporting activities through which collaboration is specified and structured, and responsibilities between students are divided (Hämäläinen 2008; Kollar, Fischer, & Hesse 2003; Weinberger 2003).Scripts comprise numerous rules how learners should interact in order to achieve a joint task (O'Donnell 2006).

Collaborative scripts differ from each other by the degree of coercion (Ayala 2007). Low degree of coercion means that instructions are more like recommendations than orders to act in certain ways. High degree of coercion refers to situation where learners are asked to study within certain rules and to proceed within beforehand specified order. In this case learners have just a little freedom to diverge from the script.

Scripts differ from each other also by the nature of the task. *Social scripts* aim at supporting social processes between learners. According to Weinberger (2003) social scripts support especially the adoption of roles, because through roles you can promote such social processes that are essential for learning but which rarely occur spontaneously in collaborative knowledge construction. *Cognitive scripts* are related to learning tasks and contents. Aim is that students learn expert-like working methods and to help them to concentrate on relevant issues in the learning task, promote to use relevant strategies and

encourage them to engage in such activities through which they are able to solve the problem (Weinberger, 2003).

3 Research methods

This study follows the principles of the case study method. A case study can be defined as an empirical study that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between the phenomenon and the context are not evident (Yin, 2003).

3.1 Context, participants and research setting

The data has been collected from an international virtual course called 'Technology-Enhanced Learning' (TEL) (6 ects). Students (N=49) were from three different universities: University of Oulu (Finland), University of Tallinn (Estonia) and University of Targoviste (Romania). Most of the participants had their educational background in educational sciences or information technology. Task of the course was to design, implement and evaluate a prototype of an advanced virtual course.

Enabling collaborative learning various technologies were applied. Most of the course activities were taken place in Moodle and SecondLife – environments. Each small group had their own working space in both Moodle and SecondLife. In addition groups used other applications like Skype and Google Docs.

Students were divided into groups of eight and in each group there were participants from each country. However, finally 3-5 students participated actively in virtual group work during the whole course. Each group had an own tutor. TEL –course consisted on six differently structured studying phases (see table 1). Research design is described in table 1.

Table 1: Research design

Course structure	Phase I: Warming up	Phase II: Decision about working methods	Phase III: Writing a pedagogical script	Phase IV: Writing a technical script	Phase V: Implementing virtual course	Phase VI: Evaluation phase
Scripts for groups 1-4	Prompted informal discussion	Prompted discussion	Working with functional roles	Working with functional roles	Loosely structured virtual discussion I	Loosely structured virtual discussion II
Scripts for groups 5-8	Loosely structured virtual discussion I	Loosely structured virtual discussion II	Prompted discussion I	Prompted discussion II	Working with functional roles	Working with functional roles
Groups 9-12	Studying without scripts: basic instructions					
Data	On-line questionnaire	On-line questionnaire + discussions in SecondLife	On-line questionnaire + discussions in small-groups' working spaces	On-line questionnaire + discussions in small-groups' working spaces	On-line questionnaire + discussions in small-groups' working spaces	On-line questionnaire + discussions in Moodle
Analysis	Qualitative content analysis and descriptive statistics					

In this study prompts are questions which are provided for students in order to guide learners towards learning goals (Hmelo & Day 1999; King 2007). Roles enable learners to take multiple perspectives and therefore promote rich interaction. In this study roles applied were initiator-contributor, information-giver, information-seeker and evaluator-critic. (see King 2007.)

3.2 Data collection and analysis

In the beginning of the course 80 students were registered, but 49 students (14 from Romania, 5 from Estonia and 30 from Finland) continued the course after first studying phase. All students signed the consent where they were informed about the data collection and asked a permission to use their product

in research purposes. The data consisted of discussion notes in Moodle and recorded on-line meetings in different virtual spaces.

Analysis procedure is developed based on analysis methods presented by Weinberger & Fischer (2006), Hmelo-Silver (2003) and Järvelä & Häkkinen (2002). Data analysis is progressing through three phases. In the first phase each groups' activities were analyzed in term of 1) script which group has to follow, 2) participants, 3) tools which the group use for communication and group work, 4) amount of written messages/ speech turn per student and tutor, 5) general description about task achievement and 6) grade for the final product of each studying phase.

In the second phase collaborative knowledge construction is analyzed in more detailed. Three groups are selected into more detailed analysis based on following criteria: 1) group work has been active, 2) participation has been equal, 3) group has been successful in terms of course grades and 4) each of these three groups represents different 'script group'. All discussion notes from each of these three groups were stored and recorded on-line discussions were transcribed. Total amount of discussion notes was 1465. Groups had altogether 33 on-line meetings, 6 chat sessions and 34 collaboratively created documents. On-line meetings lasted 30-90 minutes

Interaction processes in these groups are analyzed. Each message or speech turn is categorized into one of following categories and sub categories: 1) task units: presenting new knowledge, argument, question, comment/ answer and interpretation, 2) sosio-emotional units: expressing cohesion or hostility, decreasing tension or expressing tension, agreeing or disagreeing and expressing divergent or convergent thinking, and 3) metacognitive units: monitoring group activities, reflecting/ evaluating group activities and corganizing group work.

In the third phase of the analysis level of collaboration is analyzed. Based on analysis in phase 2 each group's collaboration is classified as high level, developing level or low level collaboration. In high level collaboration most of the messages/ speech turns brings new theory-based contents to discussion or they are content related questions. Most of the comments are related to the task. In developing level discussion new contents, questions and content related comments are presented. However perspective is mostly in participants'

own experiences. In low level discussion comments and opinions are unconnected. Participants don't take previous messages/ speech turns into account in their own contributions. Discussion does not proceed.

4 Preliminary results

More detailed analysis will be carried out during June and August 2012, and the results will be presented in ICWL 2012 conference. However based on organization of data some preliminary results can be presented.

RQ 1: How did *collaborative learning* appear in virtual group work?

First it can be concluded that activity in participation varied a lot between groups. Some groups met online several times a week and discussed actively in both asynchronous and synchronous environments while others discussed mainly in asynchronous Moodle environment. Also equality of participation varied between the groups but the general phenomenon was that in each group were just few active participants who really collaborated with each other. The amount of active participant varied between 2-4 group members while there were altogether 3-6 participants in one group. The amount of members in one group was between 5-8 in the beginning of the course but few members from each group dropped out after the beginning of the course.

Second, it can be noted that discussions were quite often concentrated on metacognitive issues, especially on organizing group work. This phenomena was typical particularly in asynchronous Moodle environment. Students concentrated in task units mostly via real-time discussions in SecondLife, Skype of chat-tool. The amount of socio-emotional unit in participants' interaction increased during the course. Cohesion was expresses by active group members and they decreased the tension by humor in real-time meetings. Correspondingly in few groups occurred tension and even hostility in the latter phases of the course, because active group members were frustrated about passive participation by other group members.

Thirdly, features of creative collaboration (like divergent thinking) occurred rarely. Group members arguments were mostly based on theoretical knowledge of subject matter or one's own experience, and new innovative viewpoints were rare.

RQ2: How did *pedagogical structuring* affect to collaborative learning processes?

Based on the calculation of total amount of sent messages and speech turns it can be concluded that those groups, whose studying was scripted, were more active than groups who studied without a specific script. For example the average amount of sent messages in Moodle was 163 in 'script-groups' and 98 in 'non-scripted groups'. There were also more active group members in 'script-groups' (on the average 4) than in 'non-scripted' groups (on average 2). There were also a light variance in course-grades between 'scripted-groups' (on the average 4,5 in scale 1-5) and 'non-scripted groups' (on the average 3,75).

5 Discussion

The preliminary results are in line with earlier studies (e.g. Hämäläinen 2008; Järvelä & al. 2010; Stahl 2007) which have shown the challenge of collaborative learning. Passive group members, unequal participation and superficial discussions are common phenomena in courses where ideas of CSCL has been applied. However, structuring seems to have a positive effect on students' activity and collaborative learning (see also Hämäläinen 2008; Weinberger 2003). Naturally there is no strait forward connection between scripting and students' success, for example tutoring plays a significant role in promoting collaboration. In TEL –course there were four tutors and they all have an own tutoring style. Some tutors participated actively in coordinating the group work while others concentrated mostly on content issues. One group has to work mainly without tutor's input. It seems that active tutoring can enhance activity and participation, but does not guarantee it.

This study paid an attention also to aspects of creative collaboration in terms of divergent thinking, value of tension and playfulness. The results indicate that creative collaboration is challenging process both for the teachers and the students. Students have to be provided enough freedom to explore contents for unique and new perspectives (Glassner & Schwarz 2007). On the other hand students need support and guidance during their collaboration, and teachers should at some level structure their learning process.

This study provides teachers, educators and educational coordinators guideline how to orchestrate and enhance collaborative learning and creative collaboration. More elaborated implications will be presented after detailed analysis in ICWL 2012 conference in Sinaia.

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Supporting Collaborative Creativity with Educational Visualizations in 3D Virtual Worlds

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Abstract. Social media are known for substantial creativity support, as they allow users exploring, creating, and sharing various types of content. Social 3D virtual worlds, such as Second Life, can also be seen as a social media that have wide possibilities for being creative.

In this paper, we explore how 3D virtual worlds can support creativity in educational settings, including creativity of the collaborative process and creativity of the outcome projects. We propose that this technology can support both. In order to test this proposal, we used the data collected in a case study that we conducted within Cooperation Technology course at the Norwegian University of Science and Technology in 2011. The study was supported by the EU research project CoCreat. The data are discussed to present the challenges for supporting collaborative creativity with 3D virtual worlds, approaches to understanding the concept of creativity, and our experience in creativity evaluation.

1 Introduction

Creativity can be applied to every domain of knowledge and must be seen as an important competence. There is evidence in the literature that creativity is an effective method, key component, and valuable outcome of learning [1-4]. However, creativity is not a spontaneous process and it needs to be promoted with novel solutions.

In this paper, we focus specifically on collaborative creativity in educational context. We present and discuss a part of data from an explorative case study on collaborative educational visualizations conducted using our virtual campus in Second Life within the Cooperation Technology course at the Norwegian University of Science and Technology (NTNU) in 2011. There are three reasons behind the selection of a three-dimensional Virtual World (3D VW) as the main technological platform for this course. First – it offers the opportunity to experience different forms of cooperation and mediation. Second – being unfamiliar, it forces discussion on appropriate use of technologies, critical thinking, and reflective learning [5]. Third – Second Life is

known for the wide possibilities for self-expression, as it allows users to create and share any content in the world.

Schneiderman sees creativity as a process. He identifies the following main phases in a collaborative *creative process* [6]: collect (searching for material and visualizing it), relate (consulting with peers), create (trying out solutions, creating associations, composing artifacts), and finally donate (disseminating results). These phases can be supported by social media and 3D VW that are known for significant creativity support, as they allow users interacting with each other, exploring, creating and sharing content [7,8].

Creativity can also be thought as a *characteristic of a process outcome*, a product. In a 3D VW, such a product becomes visualization or construction. However, besides the 3D graphics, this technology provides many additional creative ways of communicating ideas, such as dynamic presentations and interaction between avatars.

The objective of this paper is to discuss collaborative creativity of the student project work, including *creativity of the collaborative process* and *creativity of the resultant constructions*. In both cases, we explored the role of a 3D VW as a platform and a mediating tool. We designed the activities of the course using Schneiderman's framework and analyzed how the phases of creative collaborative process were supported. Continuing the research into the use of educational visualizations in 3D VWs, we also explore the creativity of the resultant constructions.

The scope of the concept of creativity was not pre-defined in the course, and therefore, another objective of the paper is to explore how the students understand this concept in application to the project work in a 3D VW. In addition, we present some of the results of creativity evaluation and discuss the challenges of this task.

2 Study settings

The study was conducted with 37 students working on projects in small groups (10 groups of 3–4 students in each), in which they were learning collaboration through experiences. They were forced to communicate intensively, cooperate, and collaborate in a technological environment to complete the task. They were required to create 3D visualizations of major curriculum concepts. The resultant constructions were presented to an international audience at the joint sessions and seminars (Fig. 1).

Each group was required to create and keep a blog for sharing and discussing proposals, reflecting and documenting the progress, and for the final discussion after the constructions were completed and presented. In addition, each student was required to create and keep an individual blog for weekly reflection.

Fig. 1. Visualization project Awareness Lab – student role play

As part of the course, the students participated in the Second International Virtual Summer School on Collaborative Technologies, Serious Games, and Educational Visualizations, organized by two EU projects, TARGET and CoCreat. The goal of the summer school was to demonstrate affordances of the 3D VW technology and let the participants experience different types of collaborative activities.

Two international events were conducted as part of the summer school. One of them was organized as a seminar on EU projects, which included five presentations and a question-and-answer session. The objective of this event was to demonstrate to the students how international cooperation can be established and supported using modern technologies. Another objective was to expose the students to the novel ideas and technologies behind these projects, such as serious games in corporate learning and collaborative creativity. The second event was organized as a virtual tour to the virtual campus of the College of Education (COE) at the University of Hawaii at Manoa (UHM) and augmented with feedback sessions with an invited expert (Fig. 2). Both events of the school and the role-play session attracted international visitors.

Fig. 2. Feedback sessions with an invited expert – virtual event

3 Method and data collection

Our approach to using educational visualizations in 3D VW for learning has been developed in several previous studies [9]. The methodology is based on constructionism – an educational philosophy which implies that learning is more effective through the design and building of personally meaningful artifacts than consuming information alone [10]. Constructionism is related to the social constructivist approach, which proposes that learners co-construct their environment and understanding together with their peers [11]. In addition, we applied role-playing, which is a widely used and effective learning and teaching method. It implies an active behavior in accordance with a specific role [12].

We consider a student group a subject within a learning community. The results of activities performed by students is an artifact, a reification of experience [13] that is shared with other community members, e.g. future generations of students.

The data were collected from the direct observation of students' activities online, pre- and post-questionnaires, virtual artifacts, such as chat log and 3D constructions, and users' feedback in the form of group blogs. For data analysis, we use the constant comparative method [14] that was originally developed for use in grounded theory methodology and is now applied as a method of analysis in qualitative research.

4 Data and results

All 10 groups managed to complete the task. As a result, we got 10 constructions visualizing different topics. Students applied different metaphors and design approaches that can be sorted into three main categories.

Groups 6, 7, and 11have made constructions to be mostly the *scenes for their role-plays*. Even though these constructions were very different and had different level of detail, their purposes were too unclear without the presentations. Three other groups (1, 5, and 9) made their constructions as *facilities*; workplaces, which visitors could use, games, where they could play, or tools, where a single user could learn. Groups 3 and 10 have made their visualizations as *museums* or exhibitions. These groups offered a guided tour through their constructions instead of the role-play. Finally, groups 4 and 8 combined the exhibition/museum metaphor as introductions to the topic and facilities as a fun and practical experience.

In order to assess creativity, we applied different approaches. The question on creativity support in 3D virtual worlds was asked in the individual pre- and post-questionnaires. The feedback was negative, especially against the background of other similar questions, in which 3D VW were evaluated as moderately suitable for collaboration and visualization. Nevertheless, we looked into detail and analyzed the data from discussions in the group blogs, where the students reflected on their experience after completing constructions in Second Life. The discussions included the analysis of their own constructions and peer-evaluations. In addition, a group of post-graduate students from the COE UHM was invited to explore and evaluate the constructions.

We provided similar guidelines for these evaluations in the form of a set of questions to discuss and aspects to consider.

In the following, we present how the students discussed creativity in the collaborative process and creativity in the resultant constructions.

4.1 Creativity in the collaborative process

Within the final task, the students reflected generally on their collaborative process during the exercise, including a reflection on how creative it was.

Creative process versus planning. Six groups explicitly stated that the process of their project work was creative. Moreover, four groups (including some of already mentioned) noted that they had a creative and productive idea generation process. One group stated that it was hard to assess their own creativity.

– Generally, we are of the opinion that our construction process was somewhat more creative than in real life since.

– So, in regards to the process we are quite happy with our level of creativity.

Two other groups stated that their construction process was not creative. These students also stressed that they had a plan from the very beginning and just worked towards the goal.

– Our construction process has been fairly straightforward and perhaps not overly creative. We decided on a suitable topic to elaborate, and worked together […] to make a construction that could illustrate this topic in an acceptable way.

In addition, it should be noted that two of the groups recognized the possibilities creativity expression in 3D VW and that they could be much more creative, however without experience, the technology is rather difficult to use.

3D environment affects creativity. Half of the groups stated that 3D VW positively affects creativity and supports generation of new ideas.

– New ideas were often generated by "playing around" with objects without a concrete plan of what we wanted to achieve but by combining elements (prims) which we liked into a greater construct.

At the same time the other groups argued that the technology, being unknown, hinders creativity.

– It affected our creativity in that manner that neither of us had any experience working in 3D CVEs. So when we were supposed to start building, we did not know what was possible, and how to do the things that were possible.

Three of the groups noted that their creativity was not affected by the technology as they were brainstorming the constructions before starting to work in Second Life and designing on paper.

– In the beginning, we spent time brainstorming about our project, at this point we ignored any technical limitations and decided that we would adapt our idea to these limitations when we started to build.

Resources affect creativity. The students discussed how resources and examples of similar projects available in the Virtual Campus affected their creativity.

Only one student group stated that their creativity was positively affected by the resources and other constructions in the Virtual Campus. The other groups were to

different degrees certain that their creativity was not affected. However, five groups stated that they were inspired by the available resources and examples of constructions. In addition, three groups argued that resources in the campus ease the constructing process.

– We looked at the earlier projects to get a feeling of what is possible of achieving in the given time for the project. Of course, our building was a bit inspired of the style of building with multiple floors and walls surrounding the building.

Sharing 3D constructions also received a positive feedback, as the students get additional motivation from exhibiting their construction for other people.

– Sharing and exhibiting constructions in the Virtual Gallery is good because it can help newcomers introduce what 3D CVEs are capable of, what is possible to do, what types of collaboration are possible.

4.2 Creativity in the resultant constructions

The *resultant constructions* were analyzed by the students from NTNU, including self- and peer-evaluations, and by the post-graduate students from COE UHM. Students from both universities had similar guidance that included the question on creativity. In addition, the Norwegian students discussed how resources and examples of similar projects available in the Virtual Campus affected their creativity.

Self-evaluations. Five groups explicitly called their constructions creative. Explaining this statement, the students mentioned a number of factors. Elaborated aesthetics was the most popular indicator of creativity, but in addition, visual symbols, variety of visualization means, and the difference from other constructions were mentioned.

– We think our construction is pretty creative, because we are the only one of the groups who chose to create a round, and pretty colourful, house.

– Based on the end result we would consider the construction as very creative, as we had to use all of our creative skills to make it as good working in both design [and] conveying a message.

– We have used several means of communication, 3D objects, signs, a browser and sound. We were the only group applying "talking objects".

Three groups expressed against creativity in such constructions. They all argued that clearly presented information and intuitive functionality are more important should be elaborated before the creative elements.

– We chose to focus on displaying how it could be used through actually using it in a CVE. Functionality prior to creativity.

– The creation of the building itself was however not that creative, and we rather haphazardly joined together pieces into creating what in the end resembles a house. Here we wanted an exhibition that displayed some text about the topic as well as instructions for the game.

Peer-evaluations. Each group evaluated projects of two other groups, following the same scheme that was used for the self-evaluations. In peer-evaluations, the students discussed the ideas behind the projects more often than the constructions or the role-plays. There were two times more positive evaluations than there were negative.

– […] to meet up with a company through this job portal, to get to know the company and an introduction to how they work and what they work with, is in fact a great idea.

In half of the peer-evaluations, the students discussed the relations between creativity and functionality, though they were not asked about that. Two common trends were most visible. First, the students often argued that elaborated functionality (including reality resemblance) of the constructions hinders creativity.

– The construction was very detailed (it really looked like a lab)! The idea of the construction was creative, but since the construction should look like a real lab, it's difficult to discuss the creativeness of it.

Second, creative ideas were recognized as hindering functionality and adding ambiguity into the constructions. In addition, in two cases creative ideas were connected with incomplete implementation of the constructions, as they would require more effort.

– In spite of bold attempt, it is not quite wise choice that combine maze with information. When one explores the maze, useful information is easily to overlook in some extent.

External evaluations. The resultant constructions were also evaluated by a group of post-graduate students from COE UHM. They were asked to evaluate constructions without seeing the role-plays and provide feedback for the students from NTNU.

In their feedback, all the students from COE UHM stated that constructions are creative to some degree. They appreciated that such visualizations have potential to be used in educational settings as an exciting, fun, and motivating/creative activity.

– Very creative. They used a lot of visual tools. […] I think they could use a URL loader. They did represent the different types of social media well, but could have used other types of tools such as video or URLs to display them better.

However, without attending the role-plays, it was difficult to understand fully the purpose of the constructions. Therefore, many students expressed doubts about whole constructions or particular elements and suggested ways of clarifying their meaning.

– It seemed like there needed a professor available to utilize each site as it was unclear what the objectives are without someone to guide you.

In the second part, the students discussed how working in a 3D environment affected their creativity, how it supported generating new ideas or caused problems.

5 Discussion

5.1 Approaches to understanding creativity

Creativity turned out to be a complex phenomenon, especially for assessment and evaluation. The feedback shows that students have different understanding of what should be called creativity and creative. However, we were able to discover certain trends and regularities, which will be discussed in the following.

The first approach for identifying creativity was found in selecting certain *creative elements* in the constructions: elaborated aesthetics, visual symbols, variety of visualization means, and the difference from other constructions. The latter category implies

that creativity might be seen not as an absolute value, but it is related to the community. Most of these indicators were discussed by students in self-evaluations.

However, when evaluating projects of other groups, the second approach appeared. The students stated that the *ideas* behind certain projects were creative, while the constructions themselves were called either simple or incomplete. This implies that creativity can lie also in a way of conveying the message.

Moreover, some of the projects were evaluated as creative by the reason of *creative presentations* performed live by the students. Most of such projects had simple constructions and the main message was conveyed by the role-play. Therefore, the main problem with such constructions was to understand their purpose and the idea behind for the visitors who could not see the role-play.

For example, group 1 made a tool for training aphasia patients. The construction has the design different from the others. They used interactive 3D symbolic elements, audio and textual media content. The metaphor type used is facility – learning tool, which can be used without role-play. The construction is clearly explained by text and a graphic poster, so the message is clear. However, the overall design (big blue cylinder house) of the construction has no connection either with the topic they visualized (communication), or with aphasia/medical theme.

Another example can be group 6 that made a visualization of awareness as two chemical/biological labs, working in cooperation. The construction has a more realistic design, replicating the appearance of real labs. The groups also used various media content, interactive elements, graphics, and text. They used the construction as an environment for the role-play, so without the play, it was very unclear what was the purpose of the construction. However, even those who were present at the role-play did not rate the construction very high as the play was very dynamic and some of the audience did not manage to follow. Overall, the construction visualized an example of applying the concept of awareness.

5.2 Challenges for supporting collaborative creativity in 3D virtual worlds

Creative collaborative process. The design of the study and the design of the 3D environment for this course were based on Schneiderman's framework of creative collaborative process. Student self-, peer-, and external evaluation indicate that all four phases of creative collaborative process were supported. As presented in the Data and results section, the students explicitly mentioned that activities of all four phases affected the creativity of the process.

However, we identified two major challenges in applying 3D VWs for supporting creative collaborative process in educational settings. First, the technology is difficult to use or at least it appears to be. In total, more than half of the groups stated that it hinders creativity. Some were using other technologies to support idea generation process. Some others reported that they could be more creative if they knew how to use the 3D VW efficiently. Second, the community level of communication and collaboration is limited. Even though the students recognized the positive effect of interacting with the visitors and sharing of the constructions, they also noted that the community is too small and the time span is too short to be beneficial.

Creativity of the constructions. The analysis of the data indicates that most of the groups consider the resultant constructions creative or, in some cases, potentially creative.

However, we discovered a number of challenges for creativity of educational visualizations in 3D VWs, the most important of which are presented below. First, creativity is often in conflict with functionality. Creativity goes together with new interesting ideas and unusual experience. However, too much focus on creativity makes the purpose of the constructions unclear and hinders their functionality. Consequently, it requires more effort on a clear explanation or a presentation. On the other hand, too much focus on functionality and clear presentation of the information makes construction boring and less engaging. Second, there is a difference between a creative construction and a creative way of presenting information. In other words, creativity can be found in the structure of the construction and its content (in our case, how the construction is built) or in the presentation form (how the concept is visualized).

5.3 Creativity evaluation

The evaluation of creativity support is rather complicated by objective and qualitative measures. In the study design, we proposed how creativity can be measured [15]. We were planning to study "symmetry of ignorance" and creativity. In this perspective, we put particular attention in studying interaction among participants with different backgrounds to observe the impact on creativity. Our hypothesis was that groups with students with varied background would be more creative than homogeneous groups. However, the results present no significant difference.

At the community level, we hypothesized that sessions with the presence of external experts and students from other universities would trigger high level of creativity. The feedback indicates that the students acknowledged the possibilities of 3D VWs for international collaboration, virtual visits, and knowledge sharing as it was done during the virtual events. Some of the groups also noted that virtual events helped generating new ideas. Sharing 3D constructions and exploring the projects of other students also received positive feedback.

Different resources were provided to make construction process easier. Though this is essential to promote usage of the system, it might also hinder creativity. We evaluated the final constructions and identified that they all can be considered as original and not as a re-use of the provided resources. Self- and peer-evaluations also confirm that resources ease construction process, but do not affect creativity.

Breakdowns in construction process were studied since they might actually have led to creative problem solving. Though the 3D technology was generally found unfamiliar and challenging, it made the groups collaborate more closely as they needed to consult each other and rely on each other’s support to achieve their goals.

Finally, we attempted to explore the relation between learning and creativity. Though the constructions might be very creative from an aesthetic or experiential perspective, this does not necessarily lead to learning. Most of the groups reflected that the visualization process deepened their understanding of the course concepts. However, we could not identify a strong enough connection to creativity.

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Towards increasing learners' creativity based on a fuzzy collaborative learning model

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Abstract. The collaborative online learning is an online learning situation in which more participants organized in small groups collaborate to solve a problem. Finding methods to facilitate creativity in this kind of learning situations is challenging. The problems that arise in creating of genuine online creative collaborative learning environments are numerous: constitution of the online creative learners' groups, organization of the online learning process, adoption of the appropriate instructional strategies, defining the "creativity triggers" that have to be included in the online learning situations. All these challenges are taken into consideration in this paper, and a collaborative learning model based on the fuzzy theory is proposed. This model can be integrated in online learning environments to increase both learners' creativity and their complex development. The results presented here are obtained through questioning our university staff related to the creativity issues in the instructional process, followed by simulation. Also, the necessity of a systemic approach of the online learning process aiming to achieve the objectives of the instructional process is emphasized.

Keywords: creative teaching and learning, creativity, fuzzy control, fuzzy collaborative learning model

1 Introduction and background

There are no doubts concerning the importance of creativity in everyday activities. Educational systems have to get a new dimension creativity-wise. It is necessary to prepare learners not only to apply the acquired knowledge and to solve problems in a classical way but also to generate new solutions, ideas, novelty and performance.

The concept of creativity has had many definitions over the time, most of them being centered on the idea of novelty. Research regarding creativity began in the 1950s. In [13], the author presents three waves of creativity research: first wave focuses "on studying the personalities of exceptional creators", while the second and the third one are based on cognitive psychology. Thus, the second wave is "focused on the internal mental processes" whilst the third wave, called the "sociocultural approach", focuses on "creative social systems: groups of people in social and cultural contexts" [13]. The outputs of creativity can be divided in three dimensions: *little c* (creativity), *mid-*

dle c (creativity), and *big C* (Creativity) [7, 12]. Each dimension is defined by the importance and implications of the novelty produced in the society. The "little c" means the creativity at individual level: "everyday, life-wide creativity as well as the creativity inherent within domains studied as subjects in schools" [2]. The "big C" represents the "historical" creativity: great ideas that change the world emerge [1]. The outputs of the "middle c" affect a small community of people [1].

According to Csikszentmihalyi, the components of creativity are: the domains, the fields and the individuals [3]. The domain consists of a set of symbolic rules and procedures. The field includes "all the individuals who act as gatekeepers to the domain" in the sense that they certify the novelty and the individuals "come up with a new idea or see a new pattern" [3]. Csikszentmihalyi said about a creative person that "His or her thoughts or actions change a domain, or establish a new domain" [3]. A detailed description of the Csikszentmihalyi's Systems Model of Creativity can be found in [4].

The concept of creative learning has been developed in England, and it can be defined as the *learning process which facilitates the development of the persons' creativity, along with the complex development of the individuals*: "self-affirmation, social identity, social role and social relations" [8, 9]. In the research studies undertaken in the project entitled Creative Learning and Student Perspectives, the following common characteristic of teaching and learning practices have been identified: relevance, ownership of knowledge, control of learning process and innovation. The relevance refers to the correlation of the learning objectives with both interests and needs of learners. The ownership of knowledge belongs to learners. They learn for themselves, not for someone else's acknowledgement. The control of learning processes adjusts both learner control and machine control, and innovation refers to something newly created [9].

The creative learning situations are complex: the participants of the instructional process interchange their roles and the relationships between them are altered: learners become authors of their learning, and teachers become learners [9]. All participants of the instructional process work collaboratively, learners' experiences are used, learners are engaged in diverse and multiple activities at a time, theoretical and practical activities are tied.

In this paper, we consider the definition of creativity from the sociocultural approach point of view: "Creativity is the generation of a product that is judged to be novel and also to be appropriate, useful, or valuable by a suitably knowledgeable social group" [13]. Also, we present the results obtained during a questioning session realized with our academic staff. Moreover, we propose a collaborative learning model based on the fuzzy theory that can be integrated in online collaborative learning environments.

The remaining part of the paper is organized as follows: in section 2, an analysis of our academic staff answers is presented; in section 3 a fuzzy system to control the learners' creativity is proposed, along with presentation of the theoretical results, while section 4 includes paper's summary, the advantages of using the proposed model, and the conclusions.

2 Analysis of the Academic Staff Creativity's Questionnaire

The purpose of this study is to identify the "manifestation" of the creativity in the instructional process from our university. We are interested in both the perception of creativity in the classroom and the teachers' points of view regarding the enhancement of creativity in our educational system.

We have interviewed eleven academic staff members from various fields/with various backgrounds: 5 -Computer Science and Engineering, 1-Mechanical Engineering, 2-Mathematics, 1-Physics, and 2-Philology.

The proposed questionnaire includes the following questions:

1. Give a definition of creativity.
2. Name an activity undertaken during the teaching and learning process, in which the students have demonstrated creativity.
3. Are your students creative? Give a percentage.
4. The creativity can be assessed?
5. Intelligence and creativity – which is the relationship between them?
6. Do you believe that traditional face to face learning supports creativity?
7. Do you believe that online learning supports creativity?
8. Do you believe that collaborative learning supports creativity?

The obtained answers are presented in the table no. 1.

Table 1. Academic staff responses

Q1	Q2	Q3	Q4
a mental process which implies new concepts and ideas, always resulting something new	developing projects	15%	approx.
the capacity to generate novelty	performing analysis	1%	no
the novelty in a domain	developing applications	10%	yes
the capacity to create something original, new	developing projects	2.5%	approx.
the capacity to meet some practical and theoretical challenges using the existing material, human, and cognitive resources	developing applications	35.5%	no
the capacity to invent something new, to have new ideas leading to the creation of something useful, advancing in knowledge	developing applications and projects, group working	0%	approx.
the capacity to imagine/ create/ develop new ideas/things	performing analysis	5%	approx.
the ability to offer new solution for problems without any indications to approach them	problem solving, developing projects	12.5%	approx.

the ability to generate new ideas/concepts	performing analysis	12.5%	approx.
the capacity to resolve new applications; knowledge + understanding imply creativity	problem solving	0%	yes
the capacity to solve problems in other areas; to find new solutions.	problem solving	17.5%	yes

Q5	Q6	Q7	Q8
interdependent relation	no	yes	yes
imprecise answer	yes	yes	yes
imprecise answer	imprecise answer	no	yes
intelligent person means creative person	no	no	yes
interdependent relation	imprecise answer	yes	yes
a creative person is intelligent but a creative person is not necessary intelligent	imprecise answer	yes	yes
interdependent relation	yes	it depends on the e-learning programme.	yes
interdependent relation	yes	no	yes
interdependent relation	yes	it depends on the e-learning programme.	yes
a creative person is intelligent but a creative person is not necessary intelligent	imprecise answer	no	yes
intelligent person means creative person	imprecise answer	no	yes

In most cases, our teaching staff defines creativity as a personal capability to generate something new, original, which generates changes in a domain. The learning activities used in the instructional process are problem solving, developing applications and projects, group working, and analysis making. The percentage of creative learners is very small: 11.15%, that means that our academic staff has to make steady efforts to change their teaching strategies in order to increase learners' creativity. Learners needs to be encouraged to be creative, they have to learn not to "memorize" only. Intelligence and creativity are related according to the received answers: 5 persons affirm that intelligence and creativity are interdependent, 2 say that a creative person is intelligent but a creative person is not necessary intelligent, 2 say that an intelligent person is also creative, and 2 offer imprecise answers. At question no. 6, the answers are: 4 yes, 2 no, and 5 persons don't offer convincing answers. Only 36% from teachers believe that online learning supports creativity. All teachers (100%) believe that collaborative learning supports creativity. Creativity can be approximate-

ly measured in the view of most interviewed persons. This is the rationale of proposing a fuzzy control based model to enhance the learners' creativity. Based on the results obtained at the question regarding the relation between collaborative learning and creativity, we have tested the fuzzy controller meaning to define the composition of the learners' group that could increase learners' creativity.

The literature provides many assessment tools for creativity. An interesting study can be found in [14], where different creative assessment tools are compared. Conclusions drawn out from [14] are as follows: autophotography is a creativity-relevant measure, and the openness to experience is a relevant factor to creativity [14]. Usually, the creative potential is measured using the creative personality scales based on ACL (Adjective Check List). In the fuzzy based model proposed in this paper, the Gough's (1979) Creative personality scale is used [5, 6]. The general assertions made by the teachers of PGU are that face-to-face learning enhances the learners' creativity better than online learning. The agreed opinion is that online learning environments have to integrate specific tools in order to stimulate the creativity of the learners. Collaborative learning is firmly seen as facilitating creativity. Despite being considered very important in the instructional process, creativity is hardly encountered in.

3 Fuzzy system to control learners' creativity

Elaboration of an e-learning system is a complex activity requiring an analysis of the instructional process in all its aspects: target groups, learning objectives, pedagogical contents, resources, instructional design, etc. How to teach, in order to increase learners' creativity, in a given learning contextual environment, is an issue to be considered here. So, an e-learning system is composed by a set of sub-systems, which deal with the above aspects. The fuzzy controller described in this paper should be used within such a system for setting up learning and teaching scenarios, and for tailoring learners' groups in collaborative learning.

A fuzzy system to control the online instruction process working regime (learner control vs. machine control) was proposed in [10]. In this paper, the author applies the fuzzy controller from [10] "to control the creativity" in online learning collaborative systems. We subscribe to the description of the e-learning process rooted in the systemic theory proposed in [11]. A challenge to e-learning developers is to build collaborative online learning environments, which support creativity. The schema of the proposed fuzzy system to enhance the learners' creativity is presented in figure 1.

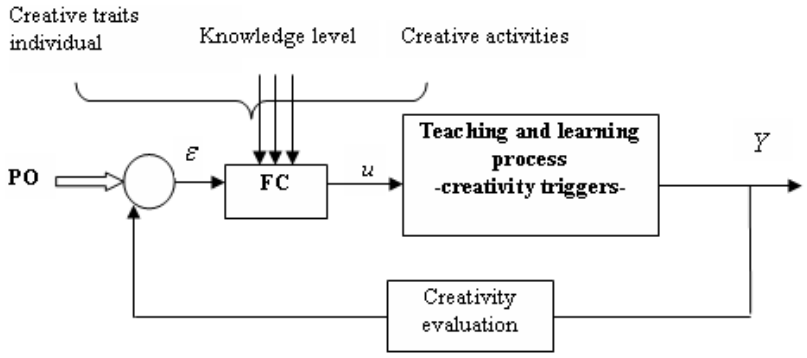

Fig. 1. Fuzzy system to control creativity

The objective of the system is a Performance Objective (PO) related to the creativity of the learners' groups. According to the classification presented above the performance objective can be a *little c*, a *middle c* or a *big C*.

The "creativity triggers" are the objects that influence learners' creativity. These "creativity triggers" can be the composition of the groups, the creative teaching and learning scenarios etc. The order u consists in activation of the creativity triggers. The output variable, u is a vector (u_1, u_2), where u_1 defines orders on the structure of the group and it can take a value in the range [0, 1]. A value closed to 1 for u_1 means that the composition of the group needs to be changed. u_2 defines the orders on the creative teaching and learning scenarios and it can take values from a predefined range. For example, we consider the range [0, 2] where a value closed to 0 means that the system uses the scenario 1; a value closed to 1, the scenario 2, and, finally, a value closed to 2, the scenario no. 3.

The native creativity of individuals is established using the CPS Gough [5], or other creativity tests [16].

The creative scenarios consist of a series of learning and teaching activities, which increase the individual's and group's creativity. Creative scenarios can be constructed based on the Shneiderman's four-phase genex framework consisting in *collect*, *relate*, *create*, and *donate* [15]. The creative activities comprised in Shneiderman's genex are as follows:

- "Searching and browsing digital libraries
- Consulting with peers and mentors
- Visualizing data and processes
- Thinking by free associations
- Exploring solutions—what-if tools
- Composing artifacts and performances
- Reviewing and replaying session histories
- Disseminating results" [15].

A creative online learning space is defined by all the elements, which contribute to increasing of learners' creativity in the online learning environment. The goal of the

proposed system is to provide for a creative online learning space. Attributes of a creative online learning space are presented below:

- Uses a creative learning-teaching scenario,
- Provides deeply understanding, rather than simply memorisation,
- Uses various communication channels,
- Promotes multidisciplinarity, integrates various topics,
- Elicits learners' ideas.

The output of the system (*Y*) is the individual creativity. The creativity is assessed by qualified persons, who define the component field of the Csikszentmihalyi's Systems Model of Creativity. A group of persons (teachers or not, but all capable of certifying creativity) evaluates the outcomes of the learning process, and estimates the level of creativity. So, the output of the system *Y* is a number in the range [0, 3]. For example: 0 means no creativity; value 1 means little c; value 2 means middle c; value 3 means big C. The PO is 1 for little c, 2 for middle c, or 3 for big C.

The error $\mathcal{E}$ is defined by the difference between PO and *Y*. In the case of PO=1, if the error is positive, the fuzzy controller emits orders to change the structure of the groups, or to use another creative scenario. In the case of *PO*=1 and if the error has a negative value, one sets the value of *PO* to 2 or 3 and the fuzzy controller regulates the process in order to achieve a higher level of the creativity.

The fuzzy controller is a Mamdani controller; the accumulation of the activated conclusions uses the max operator. Three linguistic input variables are defined: a creative level of the group, the knowledge level and the error $\mathcal{E}$.

The creative level of the group variable has the range of discrete values from -12*pers_group to 18*pers_groups, where pers_group represents no. of persons in a group. The total of adjectives in Gough's scale is 30 (18 are pro creative individuals and 12 are contra creative individuals). The universe of discourse of the knowledge level is the range [0, 10]. The knowledge level of the groups has in the range [0, 40] (pers_groups=4). The range [0,3] gives the universe of discourse of the *Y* variable. The universe of discourse of the error is the range [-2, 1] in the case of PO=1, [-1, 2] in the case of PO=2, and [0,3] in the case of PO=3.

The fuzzification transforms input data to degree of membership. The defuzzification method is a COG (Center of Gravity) method. The linguistic variables and terms are presented in the table no. 2.

Table 2. List of variables used in fuzzy system

Linguistic variables	Type of variable	Linguistic terms
Creative level of the group (CG)	Input	B, M, S
Knowledge level of the group (KG)	Input	B, M, S
Error ($\mathcal{E}$)	Input	NB, NM, NS, ZE, PS, PM, PB
U=(u_1,u_2)	Output	B, M, S

In the case PO=1, the rules of the fuzzy controller are presented in the figure no. 2.

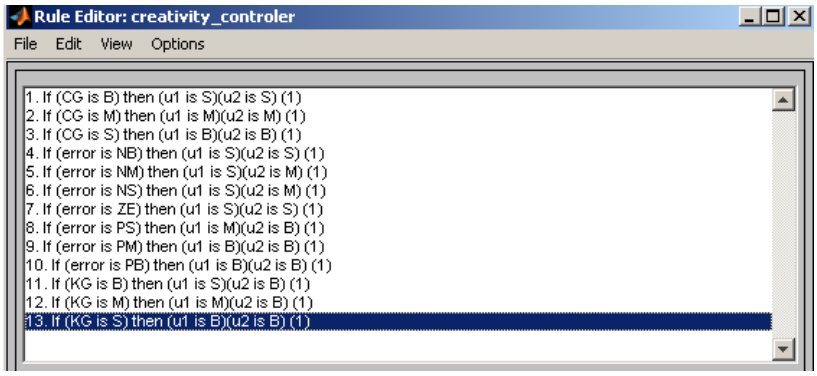

Fig. 2. Rules of fuzzy controller

The memberships functions are triangular, and they have the form presented in (1).

$$\varphi_{m,d}(x)=\begin{cases}1-\left|\frac{m-x}{d}\right|, m-d\le x\le m+d \\ 0, otherwise\end{cases},\ m\in R,\ d>0 \qquad (1)$$

To simulate the way the fuzzy system works, we have used the MATLAB 7.1 software. The fuzzy coverings of error is presented in figure no.3.

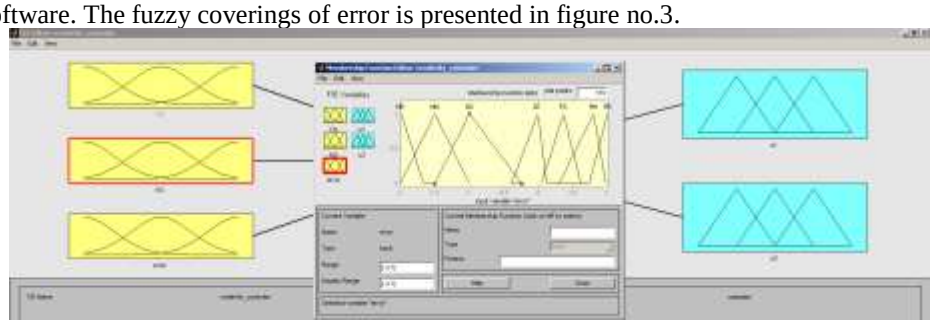

Fig. 3. Fuzzy covering of error

The inference rules model for $\varepsilon = 0.614$ is presented in figure 4.

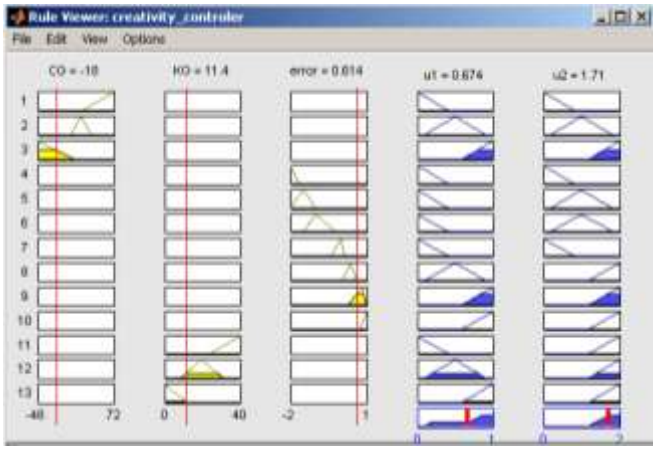

Fig. 4. Fuzzy covering of error

The interpretation of the results is: if error is 0.614, and the level of group's creativity is low (-18), and the knowledge level is 11,4, then u1=0.674 and u2=1.71, that means the structure of the group has to be changed and the scenario to be used is the scenario no. 3. According to the results above, we conclude that if the error increases, then both the structure of the group and the creative scenario need to be changed.

4 Summary and conclusions

The results obtained in our research study show the necessity of development and implementation of creativity-centered learning and teaching strategies. Online learning environments have to include specialized software modules to boost students creativity. The proposed fuzzy controller is easy to implement, and it offers a control of learners' creativity in the online learning and teaching process. Also, collaborative learning, classroom-based or online, provides for building of appropriate frameworks that trigger learners' creativity.

We will pursue future research on the concept of "creativity control", aiming to find ways to stimulate creativity through a guided learning process.

The proposed approach may be applied in instructional processes in various fields: Mathematics, Computer Science, Literature, Engineering Science etc. In our view, the future of online learning and teaching technologies will have to include tools that facilitate learners' creativity.

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Creative re-instrumentation of collective learning activity

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Abstract. The implementation of networked digital media applications in formal higher education provides opportunities for supporting and re-instrumenting various conversational and productive actions of creative collaboration. Successful re-instrumentation of collective learning activity depends to a large degree on the construction of viable, distributed environments of instruments and resources and a compatible perception of the potentials for actions (affordances) within its boundaries. This paper discusses some selected examples from an intervention study in higher education that focused on the self-directed re-instrumentation of collective learning activity and the formation and development of distributed learning environments.

Keywords: **r**e-instrumentation, creative collaboration, learning contract, affordances, collective learning activity, distributed learning environment

1 Introduction

In many ways we can currently witness how more and more areas of human activity, including education, get gradually augmented and transformed through the expansive growth of digitisation and networking in our societies. Through the co-evolutionary development of this increasingly dominating medium and our human dispositions new instruments and affordances (perceived potentials for action) emerge. Thus, a growing number of individuals experience that the digital realm is gradually penetrating a wide range of activities in their life. They experience and experiment with the digital instrumentation of all types of activities individually and collectively (in the workplace, in their social life with friends and family, related to hobbies and leisure, and so forth). This opens up opportunities for new forms of creative collaboration in all kinds of areas of human activity in general, and for networked, collective learning activity in particular. Learning activity (German: Lerntätigkeit) is here understood as the specific cultural-historical form of intentional human learning (see for example, Erdmann & Rückriem, 2010; Lompscher & Hedegaard, 1999) that emerged as the main instrument to adapt and shape the self, according to the cultural demands of the print and book culture (Giesecke, 2002). Fiedler (2012) argues, for example, that in the light of the ongoing digital transformation, educational research practise in formal higher education should construct the currently dominating forms

of individual and collective learning activity as an explicit object of inquiry and intentional change. It should aim for the development of "qualitative new forms of emancipated learning activity" (p. 28) that is increasingly de-coupled from teaching activity and its particular patterns of control and responsibility. The systematic re-instrumentation of learning activity through digital, networked tools and services is considered an important and potentially powerful lever of change in this regard.

In the remaining paragraphs we explore how networked, digital media applications can be used to re-instrument collective learning activity in higher education to support new forms of digitally mediated, creative collaboration. Furthermore, we discuss the use of learning contracts as conversational artefacts for the gradual explication and formation of inter-personal learning projects and the specific, distributed environments of (potential) instruments for its mediation and realisation. The paper continues with the presentation of some condensed, illustrative examples from an intervention study in which students had to establish and further develop their own distributed environments of instruments to mediate the range of conversational and productive actions that were necessary to realise their creative collaborative effort. The paper ends with a discussion and some concluding remarks.

2 Re-instrumentation of Collective Learning Activity

The continuously expanding array of digital media applications enables a new level of openness and flexibility of instrumentation for creative collaboration. Combining various (often loosely-coupled) tools and services offers quite powerful ways of managing, repurposing, and remixing digital artefacts of all kinds of granularity in order to support various conversational (regulative, coordinative, and so forth) and productive actions in the context of co-creation. They offer the potential to create shared (and quite often distributed) "learning through-doing" environments that are available anywhere, anytime, and on demand (Dede, 1996). Collectives may form temporary, distributed environments for collaboration, where parts of each collaborator's personal (learning) environment partially overlap. Personal learning environments entail all the instruments and resources that an individual is aware of and has access to in the context of a project of intentional learning at a given point in time (Fiedler & Pata, 2009; Henri, Charlier, & Limpens, 2008; Jones, 2008).

A distributed learning environment emerges when individuals engage in collaborative actions to realise a specific, inter-personal learning project. They are initially maintained for the duration of the collaboration (Fiedler & Pata, 2009) but can be re-activated and further developed over time. These distributed environments are also dynamic in terms of their components, structure, and extension. They are adjusted and defined according to the needs, preferences, and abilities of the collaborating actors. Collectives can alter or extend their environments by replacing its components or by complementing them with additional ones. Some components can also be eliminated or temporarily excluded if they do not longer serve the conversational and productive action objectives of the collective.

Digital tools and services enable, support, and mediate conversations on subject matter (terminology, concepts), processes (distribution of work, roles, media), and

production (Fiedler & Pata, 2009). However, all types of actions are highly intertwined and individuals can switch rapidly from one to another. In distributed, loosely coupled, networked settings, these actions need to be mediated by an appropriate selection of tools and services. Collaborative settings require explanation, negotiation, and mutual acceptance of selected technologies in order to form a functional, distributed environment for digitally mediated collective action (Väljataga & Fiedler, 2008). However, selecting tools and services for creative collaboration requires the construction of a shared, or rather compatible, understanding of their affordances (perceived potentials for action).

3 Perceived Potentials for Actions

The term "affordances" was coined by Gibson (1979) as part of his ecological framework of perception and action. This framework considers perception more as a direct process of translating environmental action potentialities into action. Gibson originally defined the affordances provided by an environment as opportunities for action. According to him, mutuality between an actor and the environment constitutes the basis for the actor's perception and action. However, alternative definitions of and approaches to affordances exist. For example, Greeno (1994) sees affordances as an opportunity to describe the properties of the environment that permit certain activities. Albrechtsen et al. (2001) extended the affordance definition as follows: affordances are "cues for action relevance, displayed in the context of a virtual ecology of work" (p. 32). Chemero (2003) understands affordances as features of whole situations.

In this paper affordances are understood as perceived potentials for actions and are evoked and changed dynamically. This happens in the interplay of individual task objectives, the activation of previously experienced emotions, a history of realised learning activities, and the human and the material resources students have at hand (see, for example, Fiedler & Pata, 2009; Barab & Roth, 2006). For an individual actor the affordances within a distributed (learning) environment are influenced and somewhat limited by the collective perceptions of her collaborating co-actors (Gaver, 1996; Kreijns, Kirschner, & Jochems, 2002). Thus, the affordances (as perceived potentials for action) of certain instruments need to be explicated, negotiated and monitored within the collective to enable the formation of a distributed environment of instruments and resources that enables the realisation of collective learning activity through concrete inter-personal projects of creative collaboration and co-production.

4 Learning Contract Procedure as a Support Instrument for Collaboration

Just as in creative collaborative work, collective learning activity engages people in a reflective process in which people construct their own personal meanings through conversational engagement with others or the inner self. However, conducting "learning conversations" unaided with oneself and others (Harri-Augstein & Thomas, 2008) is a formidable task for many. Carrying out successful collaborative work

requires not only an increasing awareness of collaborators' skills, habits, activity models, and so forth, but also an understanding of their personal deficits and developing needs.

In adult education the use of "learning contracts" (sometimes called learning agreements, learning plans) to support personal learning projects and the development of learning activity is a well-documented and evaluated approach (see for example Anderson, Boud, & Sampson, 1996; Boak, 1998; Harri-Augstein & Cameron-Webb, 1996; Stephenson & Laycock, 1993). In general, a learning contract is understood as a negotiated and explicated agreement about what and how an individual (or collective) will "learn" and how possible outcomes and products will be measured (Boak, 1998). It can be used as a systematic, conceptual vehicle for externalising, guiding, monitoring, and managing learning activity (Anderson & Boud, 1996) and can be an effective tool to help adult learners become (self-determining) subjects of their own learning project and self-development.

Harri-Augstein & Thomas (1991) have embedded the use of such instruments in an elaborate, conversational, coaching framework. Initially, "Personal Learning Contracts" (PLCs) are drafted in the form of a structured, written outline of what and how an individual or collective intends to achieve within an intentional project of learning and change (Harri-Augstein & Cameron-Webb, 1996). The minimal structural components of a learning contract consist of: a topic or a task; specific purposes in relation to the topic or the task that drives one's project and describes what one wants to achieve; a statement on "strategies" explicating what actions one intends to carry out and what resources might be used for achieving the intended purposes; the anticipated and actual "outcome" together with criteria for allowing to evaluate if or how successful a project was (Harri-Augstein & Thomas, 1991).

The initial draft of a PLC is typically shared, discussed and negotiated with facilitators and/or peers to clarify, explicate, and elaborate its essential, descriptive components. These descriptions remain open for revision and adaptation through the majority of the overall run-time of the actual learning project because learning trajectories and paths can change in unpredictable ways, leading to significant changes of needs and priorities (Anderson, et al., 1996). What is actually carried out during the run-time is documented through *records of action* of various forms.

Reviewing PLCs systematically at various stages provides individuals and collectives with a chance to reflect upon their expectations and intentions on one hand, and the effectiveness of their actions and use of instruments on the other hand. Over time, they can also begin to analyse whether valued changes in their own way of thinking and perceiving have actually occurred. Participants can draw parallels between their tentative plans and their actual progress and analyse the differences. This helps participants to document and examine their struggles, dilemmas, uncertainties, or breakthroughs (Väljataga, 2010). Occasions when certain aspects of a PLC have not been executed successfully can be interpreted as particularly significant opportunities for reflection. They can be used to identify the direction of development and the formulation of the next personal or inter-personal learning project and PLC respectively (Harri-Augstein & Cameron-Webb, 1996).

5 Contextual Framework of the Intervention Study

In the autumn semester 2009 (September to December) we carried out an intervention study at Tallinn University, Estonia. The study was set in the formal context of the course "e-learning methods & technology" that is offered to students of different master programs administered by the Institute of Informatics. This "course" had been fundamentally re-designed in 2007. It had become a test-bed for the iterative implementation and evaluation of intervention ideas and concepts related to various aspects of individual and collective learning activity and its manifestation through personal and inter-personal learning projects (and their instrumentation) and the systematic re-configuration of patterns of control and responsibility over instructional functions (see for example Väljataga & Fiedler, 2009) in higher education.

In 2009, 41 participants registered for the course of which 35 actually completed the full period. The formal objective of the "course" is the acquisition of important dispositions (knowledge, skills, orientations, and so forth) for the execution and further development of individual and collective learning activity and its instrumentation with networked tools and services. The overall period was broken down and structured into two separate learning projects. The first project was carried out individually, while the second was based on collaborative group work (5-7 participants, 9 groups). Only three official face-to-face meetings were scheduled during the study and collaboration period. These meetings were dedicated to participants' presentations of their work and related feedback and discussion. The rest of the project work was first organised and carried out individually and then within the various groups. This was mostly done on the distance, though some groups decided to organise additional face-to-face work sessions for their collaborative projects. Both, the individual and group work were originally mediated only by a minimal "seed" configuration of Web tools (Wikiversity page, individual Weblogs). This, however, was only presented as a starting point for further explorations of instrumentation options and the gradual development of distributed environments of instruments and resources within the various groups.

6 Collaborative Use of Applications and Students' Experiences

The following paragraphs provide some rather condensed, illustrative accounts of how four (out of nine) student groups formed and developed their distributed learning environments. The accounts focus on the aspect of digital media applications as instruments for mediating various conversational (regulative, coordinative, and so forth) and productive actions while carrying out inter-personal learning projects. Part of our intervention study focused on the retrospective reproduction of how the various groups explored, selected, and combined various digital instruments over time to mediate their particular projects. This was achieved through the analysis of qualitative data gathered through the explication and iterative elaboration of interpersonal learning contracts developed within a group, their records of action, and the student's reflective writing about their collaboration experiences. In addition, digital traces of group work (conversational and productive actions) were used to cross-validate our

understanding of the boundaries of the particular distributed learning environments the various groups had developed.

Group 1

Formation and development of distributed learning environments

Group 1 decided first to carry out an analysis of every group member's personal landscape of tools and services to indentify a common set of instruments, which could potentially support their various regulative, coordinative, and productive actions during the collaborative work. During the initial face-to-face meeting (in the early stage of the "course") the group members shared their e-mail and Skype accounts and decided to carry out a joint session making use of GoogleDocs. One of the group members created a common document in GoogleDocs for all members. As the members of group 1 were active users of social media tools and services, the initial list of potential instruments for collaboration was rather impressive. For instance one student was an active user of Twitter, Del.icio.us, Google Calendar, Google Map, Skype, MSN; the other one made regular use of Wordpress, Pageflakes, iGoogle, Yahoo messenger. After presenting and analysing every group member's landscape of tools and services in the group's GoogleDocs, the group decided to use Skype and GoogleDocs as the main instruments for supporting their collaboration. They explained their choice by the fact that GoogleDocs enabled the group members to share and access documents while offering core tools for co-production as they can be found in stand alone applications such as Word, Excel and Powerpoint. In addition the group pointed out that all its members could see changes and their respective time of occurrence. It was added that GoogleDocs also allowed for synchronous presentations and parallel text-based discussions. In addition the group settled on a joint Google calendar for coordination.

Reflection on collaboration

All the members of this group claimed that their collaborative actions and setting up their distributed environment of digital instruments went rather smoothly and without major challenges. Group member 1 claimed that "*already in the beginning it was clear that GoogleDocs is our most popular tool. That's why we also decided to choose this one. The actual reason for using it is that most of us already had a Google account and using GoogleDocs doesn't require to create an additional account. Our purpose was to have a quick and comfortable information flow between group members. One of the advantages of GoogleDocs was also its easy way to present schemas, which was important for our collaborative work*". Group member 2 added that *"to be able to share documents between group members makes collaboration much easier; to work on a joint artifact, which is accessible for all the group members equally, which can be changed by everybody and is visible to everybody, is a great advantage for a collaborative work"*. Group member 3 admitted, *"this is a great example of doing great collaborative work from distance and discuss about it"*. Group member 4 claimed that "*thanks to the group work I managed to start using social media applications*".

Group 2

Formation and development of distributed learning environments

Group 2 started with a face-to-face brainstorming session. For brainstorming very traditional tools such as a pencil, paper and laptop with a MS Word program were used in addition to group members' previous experiences with different tools and services. The brainstorming session ended with distributing work tasks among group members. The next steps were carried out from distance. The group continued with researching tasks for their learning project using Google and Bing. In addition a lot of inspiration was gathered from various Weblogs, webpages of companies, Youtube and Vimeo. Regulatory tasks were supported by Skype, MSN, e-mails, but also mobile phones were used. GoogleDocs and Wordpress were used for supporting their co-production efforts and for presenting their final artefact. Writing tasks for their joint project were divided in a way that every member had a dual role of writer and reviewer.

Reflection on collaboration

Group member 1 in group 2 declared, "*the group work worked out very well. Our chosen communication channels functioned well and served our purposes. I must say that all the required roles were presented for a successful group work. Everybody dedicated to group work with great responsibility*". Another group member found the first face-to-face meeting very entertaining, which provided a good basis for future collaboration. She said that "*we had not talked to each other and we were all very different in terms of our jobs beyond study activities, mental frameworks, interests and ages. However, in a few minutes it felt that we had known each other for years. We found a topic for our group work very quickly and from the beginning finding compromises was easy. I realised again that an old e-mail works very well for collaborative work. I also had a chance to work on a GoogleDocs document, which turned out to be quite useful for our purposes*". Group member 3 pointed out that "*using social media applications for supporting our group work was a very positive experience as it also provided an opportunity to learn from the group members"*.

Group 6

Formation and development of distributed learning environments

Group 6 started their work by sending e-mails to every group member with some initial ideas about the potential final artefact (the product of their intended collaboration) as a starting point. These ideas were discussed and negotiated using the MSN texting client. Time for these MSN enabled discussions was negotiated and agreed via e-mails. The MSN conversations were also used to set up a common goal for their collaborative work, to discuss and divide tasks, and to give feedback to group members' work in progress. In addition, evaluation criteria of their intended outcome were defined during these MSN conversations. The final product of their collaboration was realised through a joint group weblog (Blogger). In order to get information about new posts in the group weblog, a common Pageflake page was created. All the members of the group made use of RSS webfeeds. The group members had access to the group weblog for posting and commenting. Furthermore, new information related to the development of the final artefact was also shared via e-mail. MS Visio and Mind24 were used to present ideas visually.

Reflection on collaboration

All members of group 6 were satisfied with their contribution. They claimed that "*everybody in the group worked hard, was present and was very eager to comment*

each other's work". One of the group members noted that they managed "*to divide tasks in a way that everybody was satisfied and could do exactly what was their expertise and according to their liking. Even the final presentation was done all together, which gave a real group feeling*". Group member 2 added that "*I also liked that we were active by sending e-mails for commenting, sharing ideas and complementing each other's ideas*". Group member 3 admitted with surprise that "*it is really possible to carry out successful and creative collaborative work supported by social media applications. It is demonstrated with our group work. I learned to get to know my group members, and none of us become a social loafer. I like to do group work via MSN discussions"*. Group member 4 added that "*this collaborative work taught me how to do a group work if every member sits geographically in a different location*".

Group 8

Formation and development of distributed learning environments

Group 8 started their work with face-to-face meetings to discuss about the potential product of their collaboration and how to go about its creation. As they decided to dedicate their final artefact to a specific portal for teachers in Estonia, group 8 chose this platform also as their main workspace for mediating regulative, coordinative, and productive actions. Thus, all group members created an account for this portal and one of them also created a dynamic community weblog (within that portal) to collect their ideas, observations and analysis. In addition, a wiki page was used to write down their initial ideas. This wiki was later turned into the final artifact of their collaborative work effort. Every group member was also using her own weblog for reflecting on the overall collaborative work process and for presenting her findings and ideas.

Reflection on collaboration

All the members of group 8 admitted that their collaboration efforts worked out very well and that they were able to achieve synergy among themselves. Group member 1 said that "*we understood each other perfectly, we had a very clear common understanding of the outcome of the group work and its process, but it was great that everybody of us brought in some small details and nuances making the collaborative work more fruitful*". Another group member added that they would like to continue as a group in other occasions. Group member 3 claimed that "*we didn't spend a single minute on discussing who is doing what. It was already clear who is drawing, who is writing and who is presenting*". Group member 4 added that "*the tension and dependency in our group was positive and motivating. With the group work one can learn a lot, for example to explore what kind of tools the other group members are using, because being alone one is not that eager to test out new tools. A group inspires, because everybody comes with different ideas and experiences"*.

7 Discussion and Concluding Remarks

The aforementioned examples demonstrate the retrospective reproduction of the students' use of various digital media applications for supporting the formation of

distributed environments to mediate their conversational and productive actions. These illustrative accounts show how the various student groups engaged in the exploration and negotiation of networked media applications that could potentially serve as instruments within their collaborative efforts. The examples demonstrate how students explicated, reviewed, and adapted their individually perceived affordances of particular applications within their group work context. By temporarily merging some parts of their personal learning environments (of instruments and resources) they gradually constructed a viable, distributed environment for mediating their collaborative actions and a shared, compatible understanding of perceived potentials for action within its boundaries.

The examples have shown that intervening into current teaching and studying practices with the attempt to de-couple collective learning activity from teaching activity and its particular patterns of control and responsibility, actually produces viable and creative realisations of collective learning activity. Altogether, students reflected rather positively on the process of constructing and negotiating mutual understanding of how to mediate their collective learning activity.

For creative collaboration in physical settings individuals should be able to transform their environments themselves, move things around and create what they need for the work they're doing at the moment. The same applies also to creative collaboration mediated by networked, digital media applications. Distributed environments organised and developed by the group members can be seen as an instrument for creative collaboration. Mediating media applications should not be treated as a given. Only within self-directed instrumentation of activities particular new patterns of control and responsibility, ownership, provision, and so forth, can emerge. Thus, we hold the perspective that digital instruments for creative collaboration should be freely chosen and adapted by students according to the specific purposes of their collective learning activity and concrete learning projects they attempt to carry out.

Any initial understanding and conception of what tools and services might be successfully drawn into a particular group work needs to be tested against its actual execution. Through the run-time of a learning project a whole variety of adjustments to what makes up its environment are normally required. Our series of intervention studies (see also Väljataga & Fiedler, 2009; Fiedler & Väljataga, 2010, 2011) have demonstrated that the use of a learning contract procedure can be an useful instrument for supporting the explication of the boundaries and components of a particular project, its environment, and intended outcome. It can serve as a conversational artefact that allows group members to construct a compatible understanding of how to carry out and mediate collaborative work in a digitally mediated and networked setting.

We would like to claim that higher education needs to promote experimental, self-directed re-instrumentation of learning activity within its boundaries to allow for the advancement of dispositions (knowledge, skills, attitudes, and so forth) that are necessary to operate and collaborate creatively within the digital realm. Individuals and collectives need to be put systematically in a position where they can actualise and develop dispositions that help them to model and shape their own learning projects and their specific environments within the ongoing digital transformation.

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Towards Assessing Quality of Open Courseware

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Abstract. Despite the momentum of the open courseware movement around the world, no quality criteria and metrics for evaluation of both open courseware resources and open educational resources' repositories are available yet. Therefore, learners and instructors have no support and guidance in their quest for locating the most suitable learning resource that fulfills their educational aims. The same is true for developers, who have no guidelines for designing and building such educational resources. We present here an evaluation and comparison between two open courseware on data structures and algorithms, which are available from two important open courseware providers, and that comply with different open courseware paradigms. Both evaluation and comparison rely on our socio-constructivist quality model, which consists of a set of quality criteria that serve as general guidelines for development, use, modification, evaluation, and comparison of open educational resources and open courseware.

Keywords. open courseware, quality assessment, quality criteria, open courseware on data structures and algorithms

1 Introduction

Nowadays learning is more and more a continuous lifelong and life-wide process that is no longer limited to dedicated spaces, times or modalities, in which learners themselves are both consumers and providers of knowledge, which evolves towards a public good that can be accessed, shared, used and reused, adapted etc. Thus, users and communities contribute to social construction of knowledge, based on today's ubiquitous technologies. They provide further for open educational paradigms that are expected to provide for fulfillment of both needs and challenges of the 21st Century's knowledge economy and learning society. The growing number of open courseware and open educational resources projects worldwide has a key contribution to these emerging open educational models.

Such initiatives have developed either as a unique university project or as a repository or consortium that cumulate educational resources from various sources. The most well-known it is, of course, the MIT OCW program – now having more than 2100 courses online, with which has started the OpenCourseWare movement more than a decade ago. Since then, more and more universities have been offering open access to a growing number of their courses: Stanford, Carnegie Mellon, Harvard, Yale, Berkeley, Rice, Open University, Michigan, Carlos III and Politécnica of

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Madrid, and so on. In addition to these open courseware programs that are hosted by top universities, wide-ranging open courseware repositories are available, the most prominent being OpenCourseWare Consortium, Open Education Resources (OER) Commons, and The Saylor Foundation's Free Education Initiative [1, 2].

In spite of the scale, pervasiveness, and impact on users worldwide, the open courseware movement lacks a quality assessment framework on which users, being them learners, teachers, faculty, or developers, to rely on when they evaluate, choose, compare, design, or develop open courseware and open educational resources. Thus, learners need support when choosing the most suitable instructional resources that match their educational needs. Instructors are interested in locating those instructional resources that support meaningful instructional activities, which provide for reaching the expected learning goals, objectives, and outcomes, and for achieving reflective learning. Faculty who are or want to become involved with open courseware may be interested in how challenging and rewarding this participation can be [3]. Developers need guidance when approaching the construction of such resources.

Related work is extremely thin with just a few works approaching the general subject of quality assurance for OCW and OERs in the context of assessing the impact of these paradigms in education nowadays. All these works emphasize on the importance of OCW/OER quality, and on the need for continuous quality evaluation and assurance [4-11]. However, despite of their concern, none of these works has attempted to elaborate criteria to be used for quality evaluation and assurance. In one of our previous works, we introduced a set of such criteria *that serve as general guidelines for development, use, modification, evaluation, and comparison of OERs and open courseware, from a social and constructivist perspective* [12].

In this paper we evaluate and compare two open courseware on data structures and algorithms, which are available at two providers that comply with two different open courseware paradigms. The evaluation and comparison are performed against our proposed set of quality criteria. Moreover, this work attempts to work those quality criteria on the chosen open courseware, and to learn from this experience how to develop further the initial set of quality criteria towards a quality assessment framework.

The structure of the paper is as follows: the second section presents briefly our set of quality criteria, the third one presents the evaluation of the two open courseware versus the quality criteria, followed by their comparison, while the last one includes the conclusions and some future work ideas.

2 Set of Criteria for Quality Assurance of OCW and OER

We summarize here our set of criteria for quality assurance of open educational resources and open courseware, which we have introduced and presented in much more detail in [12]. They are applicable for assessing quality of either small learning units or an entire courseware. These criteria have been grouped in four categories that refer to content, instructional design, technology, and courseware evaluation. In the remaining of this section these quality criteria will be briefly outlined in Table 1. For the time being the evaluation is subjective, being based on more than 20 years of author's experience in Higher Education, particularly here, in teaching data structures and algorithms.

Table 1. Criteria for Quality Assurance of OCW and OER

Content related	*Criteria that reveal to what degree an educational resource allows learners to have engaging learning experiences that provide for mastery of the content.*
	• readability • uniformity of language, terminology, and notations • availability of the course syllabus • comprehensiveness of the lecture notes • modularity of the course content • possibility to select the most suitable learning unit • opportunity to choose the most appropriate learning path • top-down, bottom-up or combined approach • availability of assignments (with or without solutions) • *resource related*: accuracy, reasonableness, self-containedness, context, relevance, availability of multi-media inserts, and correlation with the entire course
Instructional design	*Criteria that address the instructional design, and other pedagogical aspects of teaching and learning for that resource.*
	• goal and learning objectives • appropriate instructional activities • learning outcomes • availability of the evaluation and auto-evaluation means • learning theory • instructional design model • *reflective learning opportunities* in which the desired outcome of education becomes the construction of coherent functional knowledge structures adaptable to further lifelong learning [13-16].
Technology related	*Both open educational resources and open courseware are expected to benefit fully from ICT technologies, to have user-friendly interfaces, and to comply with various standards.*
	• conformity with standards for interoperability • compliance with standards for accessibility • extensibility (both instructors and learners) • user interface's navigational consistency and easiness, along with its multimedia appearance • supporting technology requirements at user's end • the prerequisite skills to use the supporting technology • multi-platform capability • supporting tools • security of users' confidential information.
Courseware evaluation	*Despite of the original claim of just offering high quality educational materials, all major open courseware initiatives have recently become more involved with their learners. Hence, regu-*

	lar assessment of effectiveness of open courseware becomes essential, along with using the results for further improvements.
	• *courseware overview*: content scope and sequence, intended audience, grade level, periodicity of updating the content, author's credentials, source credibility, multiple-languages, instructor facilitation or semi-automated support, suitableness for self-study and/or classroom-based study and/or peer collaborative study, time requirements, grading policy, instructions on using the courseware • availability of prerequisite knowledge • availability of required competencies • matching the course schedule with learner's own pace • availability of repository or institutional policies • bias and advertising freeness • providing a formal degree or a certificate of completion • appropriate user interface • suitable design and presentation of educational content • *participatory culture and Web 2.0 facets*: contribution to the content, collection of users' feedback, collaboration with fellows, sharing the development/using experience.

3 Evaluation and Comparison of the Two Open Courseware

This section includes the evaluation of the two open courseware on data structures and algorithms that have been announced in the Introduction. They have been assessed using the quality criteria introduced and explained in very much detail in [12], and summarized here in Section 2. The evaluation is followed by a comparison between the two open courseware "candidates", based on the proposed quality criteria.

3.1 University of Washington's Open Courseware on Data Structures and Algorithms against the Quality Criteria

This section includes a short description of the University of Washington's Open Courseware on Data Structures and Algorithms [17], followed by our quality assessment for this courseware, against the proposed set of quality criteria. The evaluation will be performed for each category of quality criteria in turn. The Computer Science and Engineering 373 course entitled *Data Structures and Algorithms* covers the fundamental data structures and algorithms. The available courseware includes the lecture notes, the homework assignments, some solved problems and exams, along with the grading policy for the enrolled students. For the time being, beside its obvious openness, this courseware does not address any other issues related to the open courseware paradigm. While some of the available information is of interest only for University of Washington's students, most of it is useful for external users as well.

Content-related. The lectures that are available in two formats, namely .pdf and .ppt, are easy *readable* and very *uniform* in terms of language, terminology and notations, as they have a unique author. In addition to the lectures, learners have access to java programs and animation in javascript that are useful when learning about data structures and algorithms. The offered materials are characterized by uniformity, except for the animations, which come from various online sources. The *course syllabus* for the course taught in Spring 2012 is available. The courseware is *modular* and quite *comprehensive*, covering all the necessary topics related to the subject. As the courseware main target is the enrolled students, the *assigned homework* is available without solutions, some of them being accompanied though by some support links or files. However, the homework specification includes more detailed *how to* instructions, along with style guidelines and grading information. The selection of the *most suitable learning unit and learning path* can be done simply provided that the learner has some previous knowledge of the subject. The courseware may be approached *top-down, bottom up or combined*. Each available instructional resource is *accurate, reasonable, self-contained*, and *relevant in the context* of learning about data structures and algorithms, being *correlated* with the entire course as well. Some very nice *multimedia inserts* are available. Further podcasting is expected as well. They illustrate by folk dancing some well-known sorting algorithms. The courseware comes with various *links* to several resources: the textbook, which is available to buy, rent or loan – for regular students only, supporting development environment's manual and tutorial, java programming and data structures and algorithms' materials, along with links to other external resources such as wikipedia or wikihow entries.

Instructional design related. The general *instructional goal* is presented both in the course description and in the *course syllabus*, which presents also the *learning objectives* of the entire course, while for the learning units no *learning objectives or learning outcomes* are available. Most of the available instructional materials provide only for *basic instructional activities*. For *auto-evaluation* or *evaluation*, learners may use practice problems and exams – with solutions - both for midterm and final exams. The actual midterm and exam of Spring 2012 are available with solutions as well. *Reflective learning* has not been yet taken into account for this courseware. No aspects related to the *learning theory* or to the *instructional design* are available.

Technology related. The courseware complies with *interoperability* standards. However, no *web accessibility* issues are considered yet. Only the instructors may *extend the instructional resources*. The user interface is basic. The course syllabus presents briefly the *technical requirements*, while the *prerequisite skills* of using the supporting technology are left out, being probably considered basic. The courseware is *multi-platform*, and the *supporting tools* are described in the Links page. No interaction of external users with the courseware is allowed, and therefore no approaching of issues regarding *privacy and security of confidential information* is necessary.

Courseware evaluation. The *content scope and sequence* may be deduced from the Lectures' page. The intended *audience* or *grade level* is not explicitly affirmed in the

course web site. No information about periodicity of updating is available. *Authors' credentials* and *source credibility* are of superior quality. No availability in *multiple languages* or *support for learners* have been provided. The courseware may be used for *self-study* or *classroom based study*. *Time requirements* to cover the course materials are not available. *Grading policy* is presented, but it refers only to University of Washington's students. No *instructions on "how to"* use the courseware and its components are available. The *prerequisite knowledge* and *required competencies* are stated both in the Syllabus and in the course home page. The *learning pace* is independent by the *course schedule*. No *repository policies* are presented. The courseware is *free of bias and advertising*. No *degree or certificate of completion* is envisaged for now. Learners may not *contribute* to the resources. Very thin *collaboration* with fellow learners is allowed for enrolled students only. The discussion forum is also closed to external learners. Anonymous *feedback* from users may be given only via the form available via the home page. No inside information about the *development journey* or about the *experience* of using this open courseware, since beside its openness as such, no other issues related to open courseware are taken into account. The *user interface, design and presentation of the instructional content* are basic.

3.2 The Saylor Foundation's Open Courseware on Elementary Data Structures against the Quality Criteria

Saylor.org has been launched by The Saylor Foundation as a free online university and it is *seen as a zero-cost alternative to those who lack the resources to attend traditional brick-and-mortar institutions, and as a complement to mainstream education providers that will both motivate people ..., and lead to institutional change amongst education providers* [18]. The Foundation's goal is to offer to learners the chance to overcome the barriers of pursuing mainstream college education: fixed class schedule, physical distance to a campus, rising costs of tuition, fees, and of textbooks etc. Currently, saylor.org provides appropriate content that is necessary to earn the equivalent of a degree in any of the top majors in the USA. The course CS 201 - *Elementary Data Structures* is one of the 200 courses freely available at The Saylor Foundation site, which is mandatory for the Computer Science program [19]. This course provides students with an introduction to elementary data structures and algorithms. The courseware overview includes the learning outcomes, the course requirements, and the learning units. Syllabus, readings, web media lectures, automated assessments, and the final exam are also available from the course home page. In addition to these components, the course homepage offers also the course's description in a nutshell, as the *course information*, which includes general information about the course designer, the primary resources, the necessary requirements for completion, the needed time commitment, along with tips and suggestions on how to navigate through the course materials, on how to proceed when a learner struggles with a concept, and on the usefulness of taking notes while covering the available instructional resources. Further on, we detail our quality assessment for this courseware based on the quality criteria.

Content-related. The *readability and uniformity* of the course materials varies as the learning units have several authors. The course content is a mix of HTML readings, web media lectures, and assignments (quizzes), along with the final exam. The instructional materials may come from other educational institutions, collections or repositories, all of them being free, online materials. Saylor.org states that all the materials have been carefully *selected, framed, and/or developed by their professors* so that they will provide for achievement of the announced learning goal. As for any Saylor's course, the detailed *course syllabus* is available from the course home page. The courseware is *modular* and very *comprehensive* as shown above. *Assignments (quizzes with solutions)* are offered. Selection of the *most suitable learning unit and learning path* can be done straightforwardly as the courseware is very intuitively developed. The courseware may be approached *top-down, bottom up or combined*. However, the general recommendation for beginners is to follow through all the materials in the sequence that they are presented. Each instructional resource is *accurate, reasonable, self-contained, relevant in the context* of learning about elementary data structures and algorithms, and it is properly *correlated* with the entire course. *Multimedia inserts* are available. Only *links* to the course readings are offered.

Instructional design related. Both the *course's syllabus* and home page state the general *instructional goal* of the courseware. Unlike most of the open courseware, in Saylor's case, the *learning objectives and outcomes* of each course are available at two levels: *course*-wide and *learning unit*-wide. The existing *instructional activities* are very limited in offering meaningful learning experiences, while *reflective learning* is not taken in consideration yet. As for *auto-evaluation or evaluation* means, only *quizzes with solutions* (the assignments) or *without solutions* (the exam) are available for now. Each time the final exam is taken, learners are offered different questions. No information about the *learning theory* or the *instructional design* is presented.

Technology related. The courseware fulfills the basic *interoperability standards*. Accessibility is approached only in its larger sense rather than as *web accessibility*. For the time being, only the instructors may *extend the instructional resources.* The *user interface* is advanced and suitable. The supporting *technical requirements*, the *supporting tools*, and the *prerequisite skills* of using the technology are presented in The Saylor Student Handbook. The courseware is *multi-platform*. Both the Terms of Use page and the Handbook show the saylor.org policy regarding *privacy and security of confidential information*.

Courseware evaluation has shown the following: the *content scope and sequence* are shown both in the course syllabus and in the course home page. The course's *intended audience* and *grade level* are explicitly addressed only on saylor.org home page. No information about periodicity of updating is available for now. For some learning units *author's credentials* are obvious, as they are professors at prestigious universities, while for others learners have to rely on *source credibility*, which is substantial in our opinion. The course materials are available only in English. Some *semi-automated* support with respect to the assignments is available. Currently, the courseware may be

used only for *self-study* and *classroom based study*. However, when considering the latest saylor.org's developments (forums, e-portfolios etc.), it seems that *peer collaborative study* is envisioned as well. The syllabus and the course information page provide a *time advisory*, which shows the needed time requirements for completion of each learning unit, and of the entire courseware as well. Student handbook details the *grading policy* and *instructions on "how to"* use the courseware and its components (the latter is available also in the course information page). The *prerequisite knowledge* and *required competencies* are presented in the course home page. There is no predefined schedule, so learners may use the courseware at *their own pace*. The Student Handbook includes also the community standards, i. e. the *repository policies*, along with the statement regarding the *freeness of bias* and *advertising*. *A certificate of completion* having a unique identification code is provided to each learner after she has passed the exam with a score of more than 70%. For the moment, learners may not *contribute* directly to the resources or *collaborate* with fellow learners. However, they may submit materials that might get chosen to be published on the saylor.org, and the forums are starting to grow. *Feedback* from users is collected via a user survey. The *development journey* and the *experience* of using saylor.org are presented briefly in the student handbook. The *user interface, design* and *presentation of the instructional content* are well elaborated and user-friendly in our opinion.

3.3 Comparison of the Two Open Courseware based on the Quality Criteria

We present here a comparison of the two open courseware. To make the comparison easier to follow, two acronyms will be used, namely UW-DSA and SaylorDS.

First, we have to acknowledge that each of the two evaluated open courseware has strong points and weak points, so we cannot state which one is the most beneficial for users, being them learners, teachers or developers. The main merit of UW-DSA is, in our opinion, the broadness of the covered topics, the large range of instructional materials, and the source's credibility. What it misses the most it is its engagement with prospective external users, and the participatory culture aspects. SaylorDS has a far better user interface and supporting framework, most probably due to the fact that Saylor.org is aiming at becoming an open online university, where *independent learners are ought to return with pleasure and confidence that the courseware materials are connected to them in a meaningful, unique, transformative way* [18]. It also covers a suitable variety of topics in the field, offering high-quality OERs, many of them coming from top universities and educational organizations worldwide.

Neither of the two open courseware provides for true engaging, reflective learning, but it seems that saylor.org starts to address this issue, even though for the time being this is true only for some other courses, and not for SaylorDS. Moreover, they provide some sort of certificate of completion for each of their courses. Related to that, cheating issues are acknowledged as well. What is also worth mentioning is that both courseware build up on other *open educational resources and open courseware*, which increases the expectations, the benefits, and the confidence of users worldwide with respect to the open courseware movement.

4 Conclusions and Future Work

The OCW initiative has appeared in the larger context of open systems, building up on the reality that opening of the software infrastructure has unleashed the creativity of software developers in unimagined ways, and thinking that something very similar will happen to education, as Charles Vest, the President of MIT, declared when OCW was launched [20]. In our opinion, opening the courseware to people worldwide, and therefore providing for *the dissemination of knowledge for the public good* [21], will create promising opportunities for boosting creativity, because no creativity may appear in absence of knowledge, as creativity may be seen as *the mastery of information and skills in the service of dreams* [22].

This paper's contribution consists in the evaluation and comparison of two open courseware on data structures and algorithms, which is based on our proposed set of quality criteria. Basically, this work has attempted to validate those quality criteria, to put them into practice, and, to learn how to improve them during this process. The choice of the two "candidates" is due to their provenance, i.e. two different open course providers, which comply with two very different open courseware paradigms.

During the evaluation process we have learned that some criteria need to modified or extended, e.g. the security of confidential information is just a component of the terms of use that need to include further aspects such as netiquette, anonymity, various restrictions applicable, copyright and licensing etc. Also, links to other related relevant resources has been added as a criterion. Furthermore, accessibility needs to be seen not only as web accessibility, but in a larger context, as it concerns access of as many people as possible to open education. New quality criteria have proven to be necessary as well, which concern learner's support for other learners, opportunity for peer collaborative learning, and availability of quick guides of relevant software. First future work idea refers to devising a suitable scoring or rubric system that will help elaborate some metrics for open courseware, based on existing quality standards (such as ISO/IEC 25000 SQuaRE standard), educational theories and best practice. This way, users may be provided with a valuable mechanism for choosing the most suitable educational resource and the appropriate learning path to fulfill their educational needs. More, developers may also use that mechanism to tailor their "final products".

Second, the learning theory and the instructional design model are not yet considered by the open courseware designers and, in our view, they could benefit massively by relying on pedagogical theories and valuable practice in this respect. We have to research further how the close the gap between educational specialists and developers, maybe by offering the latter ones some semi-automated frameworks for approaching the pedagogical aspects. Finally, our final conclusion is more of a hope, but at the same time, a belief that having many open courseware and open educational resources available the struggle for quality will be encouraged for users' benefit, being them learners, instructors, faculty, developers, and even educational institutions.

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The Development of a Scale to Assess Creative Collaboration via Online Tools

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Abstract. The CoCreat project aims to explore the potential of mobile technology and web based social media to enhance creativity in a variety of spaces and amongst a range of age groups by supporting collaboration. The project itself studies a series of different collaborative spaces in which a variety of web based technologies are applied, developed and tested. The environments vary from urban and rural contexts, to higher education and elementary school contexts, and elderly people. In order to develop the proposed models that show how creative collaboration is structured and can be scaffolded, we need first to identify how creative collaboration occurs in the different collaborative spaces. In order to do this we have reviewed a wide range of previous literature on creativity and collaboration to inform the development of an assessment scale for creative collaboration. This paper presents the most relevant literature, the resulting criteria identified as having potential to be used to assess levels of creative collaboration and the scale itself.

1 Introduction

Nowadays people are living in changing and multifaceted environments, where they confront complex problems and situations. Previously learned ways of acting are no longer useful in solving these problems. New, creative and innovative solutions are needed. In this respect creative collaboration seems to be crucial. The generation of creative ideas and of innovative solutions to problems can be fostered through enabling and encouraging collaboration between people with different perspectives, and, in workplace settings, between people from different disciplines. Alongside the recognition that creativity frequently arises amongst groups of diverse people collaborating in particular ways, there is a groundswell of interest in regarding creativity as a fundamental competence that may be developed at school (European Commission, 2009: Cachia et al, 2009). Whether at school, or in the workplace, creative collaboration is seen as process where different topics and problems are explored from novel perspectives and where the results of collaboration and collaborative learning are not defined in advance (e.g. Sternberg, 2006).

There is already research evidence to suggest that social computing tools and approaches can provide new opportunities for creativity and thereby enhance learning outcomes (Ala-Mutka, Punie, & Redecker, 2008: Redecker, 2009), but concrete models and guidelines for enhancing creativity are still needed. Our primary focus in the study of technology enhanced collaboration is not the technology alone but in understanding the nature of the experience that is made possible by technologies together with pedagogical tasks. Thus the project integrates and adapts context-aware social mobile media technology (e.g. mobile phones, handheld computers) and social media applications (e.g. wikis, weblogs, 3d spaces) for collaborative learning purposes.

2 Previous Research into Creativity and Collaboration

2.1 Creativity as the property of an individual

At one time, much research on creativity was based on the notion that some people are creative and others less so, and sought to understand the reasons why this should be the case (Sternberg, 2006). Early psychologists such as Guilford and Torrance invested significant amounts of time in developing psychometric measures of creativity. This focus on the individual extended throughout much of the 21st century, and has provided us with a concept that is widely used in creativity studies, namely divergent thinking (Guilford 1959; 1967).

Divergent thinking, the generation of novel ideas and associations, is considered to provide the foundation for creative production on the basis that it requires ideational searching without directional boundaries and is determined by fluency, flexibility and originality. It has also been

asserted that an individual's ability to think divergently does not by itself produce creativity; critical thinking skills are also required (Glassner & Schwarz, 2007) i.e. there are "different sides of divergent thinking"; a generative and an evaluative side (e.g. Silvia, 2011, p 29). Importantly, for those interested in learning individuals can enhance their divergent thinking, e.g., by training cognitive and neural mechanisms and engaging in improvisation (Gibson, Folley, & Park, 2009).

However, we are concerned with the question of how to activate divergent thinking in *collaborative* situations in different contexts, we therefore now turn to consider how collaborative creativity has been conceptualised.

2.2 Approaches to Collaborative Creativity

Contemporary research on collaborative creativity has moved away from regarding creativity as a property of an individual and towards a consideration of creativity as emerging from processes of human activity within a social and physical context. This development was spurred by both the recognition that significant creations are almost always the result of complex collaborations, and by theoretical developments that embraced the social and environmental as well as the individual. A well-known empirical study of collaborative creativity that takes this approach is that of John-Steiner who surveyed famous creative couples in the field of science and art (John-Steiner, 2000). John-Steiner's work belongs to a sociocultural tradition based on Vygotskian approaches to thinking, learning and acting. A further example of research in this tradition is that of Sawyer and DeZutter (2009) whose notion of '*distributed creativity*' is developed from distributed cognition (Hutchins, 1995), an approach concerned with how cognition is distributed across people, tools, and environments. Accordingly, Sawyer and deZutter's approach takes as a starting point that creative activity takes place in real-world settings that are deeply contextualized and in activity structures that are fundamentally collaborative. Their work focuses on groups that are organised such that the outcome of collaboration is unscripted (and therefore unexpected creativity could result).

The relatively unconstrained and unstructured groups that Sawyer and DeZutter studied may be contrasted with the more constrained and structured groups that one might expect to find in workplace settings, which Paulus and Nifstad (2003) observe have more generally been the site for the study of group creativity, the exception being some early work by Torrance (1972) in educational settings. Furthermore, Grossen (2008) and Glăveanu (2011) point out that earlier studies on creativity in groups can be distinguished by the researchers' conception of collaborative creativity as well as by their settings. Whether creativity within the group is '*embedded primarily at an individual level and, furthermore, localized within individual cognitive processes* '(Glăveanu, 2011, p.476) or the '*emphasis is put on mutuality, sharing, negotiation of a joint perspective or shared meaning, coordination, intersubjectivity*' (Grossen, 2008, p. 248). An example of the former approach is Amabile's (1983, 1996) studies of social and contextual factors in creativity, which were found to include mentoring, modeling, family influence and social reward. The latter approach though belongs to a sociocultural tradition and has been a key influence on research concerned with ways of facilitating creative collaboration using Information and Communication Technologies (ICTs).

2.3 Creative Collaboration and ICT: a key concern of contemporary research.

A review that predates our own was prepared by Loveless in 2003 for the UK based research organization Futurelab and this review was updated in 2007. Within her review, Loveless (2003, 2007) describes a number of creative activities where schoolchildren used digital technologies to support collaboration. These included: videoconferencing with artists, sharing digital images and works of art with peers in other schools, story-telling and role play in virtual reality environments and virtual puppet play. Simple digital communication tools (Messenger, Chat, Notes) have also been found to support group creativity (Dennis and Williams, 2003). In the following sections we focus on the variety of ways in which researchers have approached the task of designing ICT tools to support such creative collaboration.

Amongst studies in which technology is used to support creative collaboration the trend is to analyse the process of creative collaboration into stages. However, before we begin to discuss stages we feel it necessary to clarify what we understand as 'creative collaboration' in terms of two models of

collaboration described by Mamykina et al (2002). These are, firstly, the assistant, or conveyor model, common in commercial creative team settings, in which a leader oversees a process and divides work between team members, and, secondly, the partnership model, in which individual control is relinquished and team members with complementary interests work for mutual benefit, although not necessarily for the achievement of a single task. The partnership model does not exclude leadership but it may appear in a less explicit form than in the form described as 'the assistant model'; for example, leadership can be shared, distributed or not present at all. An example is seen in Keskitalo and colleagues' (2011) study of global teams collaborating on a task using Second Life. Successful collaboration was seen in a team in which members established a plan and separated responsibility for different tasks early in the creative process, effectively distributing leadership between members and across timescales. There is a developing breadth of interest in such regulation of creativity in group processes (to include self-regulation, the regulation of others, and collective regulation) and this is discussed in section 2.7.

Several authors whose work investigates the partnership model identify creative collaboration as involving two stages. The first is the building, or establishing, of a shared language, shared vision and shared knowledge between collaborators. The second stage is the communication through which ideas are generated and developed (see for example, Weakley and Edmonds (2005), Mamykina et al (2002). Furthermore Vass et al (2008), who studied children's classroom based, collaborative, creative writing, divide this second stage into the generation of ideas and the review of ideas. From their study of artists working with technologists Edmonds et al (2005) suggest there are three stages to the development of creative collaboration once common ground is reached: creative conceptualizations, construction and evaluation. Runco (2004) goes so far as to consider a six-phase model in the context of individual creativity process (see Section 2.7), emphasizing the social validation that occurs in the last phases of the process. It is noteworthy that each of the frameworks outlined above include stages that correspond to the generative and an evaluative sides of creativity suggested by Silvia (2011). For other authors, such as McFadzean (1998) who conceptualises creativity as a continuum, the processes of building common ground and the generation of ideas are inseparable, and together understood as the building of intersubjectivity (e.g. Craft, 2008) or interdependence (Sundholm et al, 2004).

2.4 The design of technologies to support stages of creative collaboration

For Weakley and Edmonds (2005) a necessary condition for collaborative creativity is the development of common ground between collaborators. Their paper reports on a study in which they devised and tested a prototype virtual space to support the exchange of knowledge and expertise between physically distant collaborators. They also acknowledge the desirability of supporting the development of interpersonal relationships and discuss ways in which the development of trust can be supported by technological means. Edmonds et al (2005) go on to suggest the following characteristics as being desirable for software designed to support creative collaboration.

- Support for communication (verbal and non-verbal)
- Support for the establishment of common ground
- A way of establishing trust between users
- A way of recording and reviewing past decisions
- A stable identity for group members
- A way of establishing user profiles (who knows about what)
- Support for sharing prototypes

One of the points that Weakley and Edmonds (2005) also highlight is the role of non-verbal communication between co-present collaborators. Co-presence is thus an advantage to collaborators, yet, as Sundholm et al (2004) and Ramberg et al (2004) make clear, even experienced, co-located collaborators face difficulties.

Sundholm et al (2004) were using Schneiderman's (2000) framework of eight staged activities (searching and browsing, consulting with peers and mentors; visualizing data and processes; thinking by free associations; exploring solutions; composing artefacts and performances; reviewing sessions and disseminating results) as a basis for studying different design teams' use of an interactive lab space. Meanwhile, a study by Ramberg et al (2004), carried out in the same lab, focused more closely on the use of technology that facilitates the production of representations (drawings, sketches) of design ideas produced by co-located members of a team.

These investigations focused on the potential of teams to produce and to use external representation, and the role of technology in facilitating that activity. A similar emphasis on the role of technology to support representations also found in the work of Facer and Williamson (2004) who made a study of children using prototypes of digital environments designed to support collaborative approaches to creative storytelling and to explore the potential of multimodality. Facer and Williamson concluded that the rich multimedia environment of the prototypes allowed the children to externalise their ideas for sharing with each in other in a variety of representations which children of all ages could manipulate and around which they could discuss and refine their ideas.

2.5 Creative Collaboration and the role of the emotions

In their studies of technological environments to support creative collaboration, all the authors whose work was described in the previous section also refer in some way to the role of emotions or trust between collaborators. A good example of this is Ramberg's (2004) reporting of the embarrassment of participants in making sketches in public, or Sternberg's (2006) reporting of the creative contributions of members as interruptions to the process, often in the form of jokes. Mamykina et al (2002) observed that relationships of trust are important for facilitating the development of creative ideas between collaborators, while Kimbell (2000) makes the point that for creative collaboration to occur between schoolchildren using digital tools and environments the relationship between the children and their teacher must involve trust and allow for some risk.

This theme, of trust, was also highlighted by Sullivan (2011) in her study of creative solutions found by sixth graders working on a robotics problem in a science lesson. Sullivan's main finding was that a mixture of both playfulness and seriousness was effective in supporting design process. Similar findings were made by Eteläpelto and Lahti (2008). Other researchers have emphasised the role of playfulness in creativity. Examples are Barnet & Kleiber (1982) who identify playfulness as being the basis for creative thoughts.

Further support for such an emphasis in research is provided by Craft (2008) in a review of papers on collaborative creativity "*acknowledging cognitive, emotional, social and spiritual dimensions and offering ways of understanding 'co-construction' as a new consciousness, understanding better the role of emotions in particular in developing trust at emotional, social and cognitive levels*. Turvey (2006) pays tribute to Craft's earlier work as he explores the development of a conceptual framework for studying primary school children's engagement in online communities centered around designing websites. Turvey's (2006) framework includes space for exploration of personal identities, increased socialization through the use of collaborative online tools and the potential for group cohesion as participants work towards a common goal of creating and sharing knowledge.

2.6 Creative Collaboration, the space of dialogue and the value of tensions

Wegerif (2008) explored whether and how it was possible to assess the creative moment in shared thinking. His study considered the role all playful, informal interactions between participants, regardless of whether the interactions appeared to be relevant to the creative task, which collaborators were working on. Through reference to the dialogic approach of Bakhtin (Bakhtin, 1986) Wegerif demonstrated that the involvement of potential and actual collaborators in off-task talk can be understood as 'opening of a space of dialogue'.

The Bakhtinian argument, that it is through tension and disagreement (although clearly within an atmosphere of trust and collaboration) that new ideas are generated, adds a significant thread to this discussion. This notion of a tension is implicit in the work of some other authors. For example, Luther

and Bruckman (2008) pointed out that one of the roles of the leader is his or her role of placing constraints on collaborators. In Wegerif's terms this constraint can be considered to be a different voice, in tension with the free-floating, infinite variety of possibilities that the creative members of the team might express. Though Luther and Bruckman describe it more as a 'relationship between innovation and convention, a good example is the genre convention of the story that provides a constraint in relation to which children were able to generate ideas (Vass et al, 2008).

Several authors, including Loi & Dillon (2006), Dillon et al (2001) and Fischer and Shipman (2011) explore the role of tension in creativity. Karlgren and Sins (2011) suggest that where tensions exist, group members have to reflectively analyse their own activities in the group questioning how they deviate from the established norms and practices that they would favour. Engagement in doing so is itself part of a creative process since they have to search for solutions to overcome the tensions. Karlgren and Sins also argue that externalizing tensions is a means through which opportunities for creative efforts in collaboration can be increased. Indeed some designers of technological environments to support collaborative creativity go so far as to base their work on tension, breakdown, or conceptual collision. Fischer and Shipman (2011) base their designs on the premise that where situations are sufficiently open-ended and complex, collaborators will encounter breakdowns. For them the challenge for designers of ICT tools and environments to support creativity is not to reduce heterogeneity and specialization, but to support it, manage it, and integrate it.

Tensions are therefore the basis out of which creative ideas might be generated but are also of crucial importance for the co-ordination of the process. Skills in regulation are important in this context; these skills include the regulation of self, of ones emotions, and skills in regulating others. The importance of the full variety of regulation skills is made clear in the study by Eteläpelto and Lahti (2008) who found that the emotional atmosphere and power relations within groups of student teachers in their study were significant obstacles to creative collaboration.

Other studies of regulation focus on temporal regulation and its relationship to creativity.

2.7 Time Regulation in Creative Collaboration through Supportive Technologies

Considering creativity as a series of of stages as discussed earlier or as a process, for example, Lubart's (2001, p. 295) "*sequence of thoughts and actions that leads to novel, adaptive productions*" leads us to consider the temporal dimension of this process both in the individual and collectively. According to Runco (2004, p.1) the creative process consists of six phases.

> *'In the first stage, "orientation" (a time of intense interest and curiosity), the creative individual gathers information. The second stage, "incubation," consists of defining the problem and seeking a solution and involves processing large amounts of information; this can occur at a conscious or an unconscious level. "Illumination," the third stage, is marked by divergent thinking, openness, and excitement. In the fourth stage, "verification," the individual evaluates his own work and compares it with what is known in the field. Next, in the "communication" stage, the individual submits his work to the field, making it available to experts who will judge its quality and usefulness. "Validation" occurs in the sixth stage, in which the work becomes available to society and is consequently supported or rejected.'*

The collaborative process has a longitudinal nature because the general duration of the activities. According to Reimann (2009) half of the CSCL activities analyzed in the ijCSCL between 2005 and 2007 have duration of more than a week. Considering the long-term duration of collaborative activities, we should consider the stages of development of the groups of people engaged in these activities.

Thus learning time regulation in CSCL considers "time perception, allocation and regulation as a capacity bounded both at the individual and collective level by the temporal script of the task and the temporal patterns of each of the team members" (Romero, 2010, p.1). Time regulation in creative collaboration could be a challenge, because of the need for combining individual and collaborative levels of regulation. Under the general learning regulation approaches (Hadwin, Järvelä & Miller, 2011), we consider the time regulation as the specific regulation of the academic time that is carry out by students (time self regulation), two students (time co-regulation) or the group (socially shared

time regulation). It should be noted that in the collaborative spaces of the Co-Creat project we will be considering learning time regulation not only in traditional Virtual Learning Environments (VLE) but also in mobile learning environments, which increase the time span of accessibility from the students' point of view.

3 Summary

Creative collaboration in the Co-Creat project has been dissected through three different levels. The first level refers to feelings for belonging together or in same group. In the second level people act together and in the third level they construct new knowledge and creation. Technology can be used in each level for enhancing rich interaction and consequently richer opportunities for learning. The following criteria have arisen from the above literature review(s) as being criteria necessary to, and therefore having potential to be used to assess levels of, creative collaboration:

- Extent of use of imagination and divergent thinking (see Section 2.1)
- How the setting provides opportunities for collaboration itself such as the degree of co-presence (see Section 2.2)
- Existence of common ground (shared knowledge and goals) and opportunity to develop awareness of it (see Section 2.3)
- Extent to which possibilities of externalizing representations (sketching, writing, modelling) are exploited (see Section 2.4)
- Extent to which participants feel that atmosphere identifies with the following (see Sections 2.5 and 2.6):
    - an atmosphere of playfulness or joking as well as seriousness
    - safe atmosphere and trust between participants
    - a degree of apprehension, or of disagreement or tension
    - problem boundaries stretched or broken
    - tolerance of ambiguity
    - engagement in the task
- Extent of expression and exploratory talk enabled (see Section 2.6)
- Self-regulation and socially shared regulation of time spent on learning (see Section 2.7)

4 Assessment scale for Creative Collaboration

The following scale addresses the factors first presented in Section 3 above as being suitable for the assessment of the extent of creative collaboration in a group task however; they have been reordered with the aim of preventing response set.

A rating scale has been chosen so as to shorten the questionnaire, gaining the same level of information using Likert scales results in many more statements than shown above. A scale of 1 to 7 has been chosen to enable Spearman's rho correlations between variables to be conducted without challenging the parameters required for the accuracy of the statistic.

Instructions for completing the questionnaire are:

Please rate the factor described in each sentence on a scale between 1 and 7 according to

a. How much it was present during your project

b. How important it was to your group's success

Where 1 is 'not at all present/ important' and 7 is very much present/important

Criterion		'Presence' Rating	'Importance to Success' Rating
Existence of common ground i.e. shared knowledge and goals	I had a good idea of what the others in my group knew that is relevant to this activity.	1 2 3 4 5 6 7	1 2 3 4 5 6 7
	Everyone in my group wanted to make a successful product.	1 2 3 4 5 6 7	1 2 3 4 5 6 7
	We understood each other's viewpoints at the start of the project.	1 2 3 4 5 6 7	1 2 3 4 5 6 7
	Our group had the necessary knowledge to be able to complete our task.	1 2 3 4 5 6 7	1 2 3 4 5 6 7
An atmosphere of playfulness as well as seriousness	We played with ideas while we were working on the project	1 2 3 4 5 6 7	1 2 3 4 5 6 7
	We had fun playing with ideas	1 2 3 4 5 6 7	1 2 3 4 5 6 7
	Playfulness helped to innovate new ideas	1 2 3 4 5 6 7	1 2 3 4 5 6 7
Safe atmosphere and trust between participants	My classmates/colleagues in my group trust each other	1 2 3 4 5 6 7	1 2 3 4 5 6 7
	We were all able to express our ideas, even controversial ones freely.	1 2 3 4 5 6 7	1 2 3 4 5 6 7
	We all listened to/read each others' ideas respectfully.	1 2 3 4 5 6 7	1 2 3 4 5 6 7
A degree of disagreement or tension	We sometimes disagreed about the task and we discussed our different points of view.	1 2 3 4 5 6 7	1 2 3 4 5 6 7
	We sometimes had personal conflicts.	1 2 3 4 5 6 7	1 2 3 4 5 6 7
Possibilities for externalizing representations (sketching, writing, modelling)	We could see or find out what other people knew or were thinking about. For example, we could draw, write or build models on the computer that the other group members could see and/or read.	1 2 3 4 5 6 7	1 2 3 4 5 6 7

Criterion (cont)		'Presence' Rating	'Importance to Success' Rating
Degree of co-presence during the task (select from these before printing according to task)	We were able to text or chat with the other group members.	1 2 3 4 5 6 7	1 2 3 4 5 6 7
	We were able to share information with the other group members in Second Life.	1 2 3 4 5 6 7	1 2 3 4 5 6 7
	We were able to video conference with the other group members.	1 2 3 4 5 6 7	1 2 3 4 5 6 7
	We were able to talk face to face with the other group members in person.	1 2 3 4 5 6 7	1 2 3 4 5 6 7
	We were able to communicate through other social networking tools like Facebook.	1 2 3 4 5 6 7	1 2 3 4 5 6 7
Use of imagination and opportunities for divergent thinking	My group generated different and novel ideas in response to the task.	1 2 3 4 5 6 7	1 2 3 4 5 6 7
Tolerance of ambiguity	We weren't always certain about how to carry out the task which led us to explore different possibilities.	1 2 3 4 5 6 7	1 2 3 4 5 6 7
Engagement/interest in task	Everyone in our group was interested in the task.	1 2 3 4 5 6 7	1 2 3 4 5 6 7
	Everyone in our group was engaged in the task.	1 2 3 4 5 6 7	1 2 3 4 5 6 7
Level of collaboration itself	We had a feeling of belonging together.	1 2 3 4 5 6 7	1 2 3 4 5 6 7
	Our group worked together well.	1 2 3 4 5 6 7	1 2 3 4 5 6 7
	We learned new things from each other.	1 2 3 4 5 6 7	1 2 3 4 5 6 7
	The technology we used helped us to collaborate.	1 2 3 4 5 6 7	1 2 3 4 5 6 7
	Working together enabled us to create a completely new product.	1 2 3 4 5 6 7	1 2 3 4 5 6 7
Opportunities for exploratory talk.	We were able to discuss our early ideas with each other.	1 2 3 4 5 6 7	1 2 3 4 5 6 7
Problem boundaries stretched or broken	We went beyond the set task.	1 2 3 4 5 6 7	1 2 3 4 5 6 7
Amount of use of imagination	Between us we used a lot of imagination.	1 2 3 4 5 6 7	1 2 3 4 5 6 7
Degree of expression enabled	The set task/activity enabled us to express our emotions.	1 2 3 4 5 6 7	1 2 3 4 5 6 7
Time management during the collaborative creativity task	I organised my time for learning well.	1 2 3 4 5 6 7	1 2 3 4 5 6 7
	Our group organised our time for learning well.	1 2 3 4 5 6 7	1 2 3 4 5 6 7
	My group were pressured to complete in time.	1 2 3 4 5 6 7	1 2 3 4 5 6 7

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Computer-Based Creative Collaboration in Online Learning

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Abstract. Creativity is a key learning objective in higher education, both in face-to-face and online learning contexts. In this study we discuss the concept of creative collaboration and the way this competency could be supported by the use of computer-based environments in online learning. The analysis of the creative process in the context of individual creativity is carried out using McFadzean's [1] creative continuum and the Assessment Scale for Creative Collaboration (ASCC), which has been developed in the context of the CoCreat Lifelong Learning Project. The results of the collaborative creative process show a high relation between the creative process and the social interrelations between the students, but do not show a relation between the collaborative creative process and the time pressure perceived by the students.

1 Creativity in Higher Education

Creativity has been defined as one of the strategic learning objectives in higher education in recent years. The big changes produced in the world in recent years have made it necessary to consider creativity as a strategy for enabling future citizens to succeed in an increasingly complex world. Creativity refers to the generation of ideas that are original, valuable or useful [2]. For years, creativity has been conceived as an individual trait, but also as a process and the product of the process [3;4;5]. In this paper we consider creativity from a socio-cognitive viewpoint as both an individual and shared process. We also define the concept of creativity individually and collectively, before considering the importance of collaboration in the creative process.

Creativity is not merely an original act or idea, it is also an accepted new solution that is collaboratively (co)constructed and shared by a group. Creativity output may result in an act transcending the creativity creator [6] and producing "changes in an existing domain, or transforms an existing domain into a new one. What counts is whether the novelty he or she produces is accepted for inclusion in the domain" [7]. The importance of the usefulness of the ideas or acts that are considered as creative is highlighted by Franken [8]. This author considers "creativity as the tendency to generate or recognize ideas, alternatives, or possibilities that may be useful in solving problems, communicating with others, and entertaining ourselves and others". In

recent years, the increase of collaborative learning and teamwork in the workplace in a context of increasing productivity has underlined he relevance of the collaborative creative process in the contexts of group work. Moreover, in recent studies, creativity has been considered as a collaborative and situated process [9] that could not be understood as an individual process. Technology has been seen as an opportunity to support creativity both in individual and collaborative modalities [10] despite there not being an agreement on the impact that technology has on the development of the creative collaboration process.

2 Creativity as a collaborative process

The analysis of the creative process in the context of individual creativity is carried out using McFadzean's [1] creative continuum, which considers the different stages of the creative process of collaboration that could be applied both in individual and collective settings. The time factor and the time quality is an important aspect of understanding learning activities [11; 12; 13], and especially in the creative process of collaboration. McFadzean's creativity continuum is a model for analysing the collaborative creativity process by considering a continuum ranging from paradigm preserving to paradigm breaking.

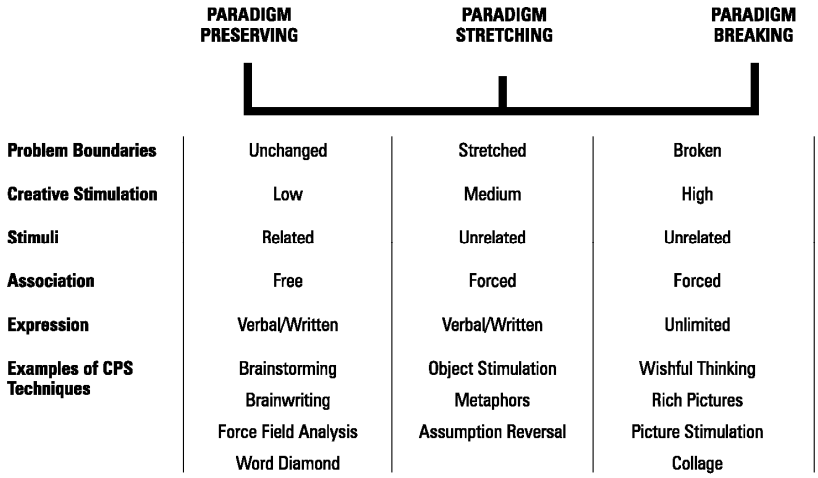

Fig. 1. Creativity continuum adapted from McFadzean [1].

In addition to analysing the creative collaborative learning process using McFadzean's [1] creative continuum model , this study also investigates the students' perception of creative collaboration and the contextual variables of interest. A first element analysed is the degree of perceived co-presence during the teammates' task . The teammates' engagement perception is one of the main factors of students' satisfaction in collaborative tasks [14]. If the teammates' perceived engagement could support the

creative collaboration process, the students' perception of an imbalance in their teammates' engagement could make them feel frustrated by the collaborative activity [15]. Tolerance of ambiguity has been analysed as another of the factors related to creativity [16]; the novelty of the creative solution implies a certain playfulness and acceptance of ambiguity in the creative process and outcome definition. The degree of disagreement or tension between the team members is also considered as one of the factors that could be involved in the teammates' creative collaboration. A certain degree of disagreement and tension could support the creative collaboration [17]. The Assessment Scale for Creative Collaboration (ASCC) [18] has been developed to consider these different factors involved in the creative collaboration process. The ASCC has been created within the context of the CoCreat Lifelong Learning Project. One of the research objectives of this study will also be to analyse the reliability of the ASCC instrument in the analysis of creative collaboration.

3 Time pressure and creativity

Within the different factors analysed in the ASCC [18], the time pressure experienced by the students is considered a key factor to understanding the creative collaboration process as a continuum in the context of a flexible long-term task in online learning. Time pressure is defined as a specific kind of stress that is experienced by an individual who perceives that they have less time than required to develop a task. McGrath [19] explains time pressures as the imbalance between individuals' resources and the situational demands. Time pressure is defined as either subjectively perceived time pressure or the imposition of a deadline [20]. In this study, the time pressure is understood as a subjective perception of stress in the context of a long-term task where the students have several weeks to complete the collaborative task.
Prior research on performance effects has demonstrated clearly that time pressure increases the rate of individual and group performance [21; 22]. However, results have been much less consistent on the quality of performance and creativity. Amabile and colleagues [23] and Andrews and Smith [24] observed that time pressure influenced negatively on creativity.

4 Hypothesis

Three hypotheses are analysed in this study. The first hypothesis (H1) proposes that in creative collaboration, a higher level of social interaction will lead to a higher level of creativity. The second hypothesis (H2) states that a low perception of time pressure will lead to higher creativity, in the context of creative collaboration tasks. Finally, the third hypothesis (H3) proposes that in the creative collaboration context, the creative continuum phases of McFadzean's [1] creative continuum will be observed.

5 Methodology

The study involved 64 online learners of the Bachelor's degree in Audio-visual Communication. The students were engaged in the course "Introduction to Creativity in Advertising". The task proposed to the students during the course was carried out in dyads. The students were required to develop a creative advertising project during 4 weeks. In terms of temporal resources, the task is considered as a long-term task [25] with a high institutional temporal flexibility [26]. The students were invited to answer the ASCC [18] at the end of the creative activity.

5.1 Methodology

The Assessment Scale for Creative Collaboration (ASCC) aims to analyse the students' perception of creative collaboration and the contextual variables of interest, such as the degree of co-presence during the task, the tolerance of ambiguity, the interest in the task, the degree of disagreement or tension between the team members and the time pressure.
The ASCC is based on 16 criteria that have been related to the creative collaboration process of the learners. For each of the criterion the students should answer one or more specific questions on a scale between 1 and 7 according to (1) how much it was present during their project (presence subscale) and (2) how important it was to their group's success (importance to success subscale) :

1. Shared knowledge and goals
2. An atmosphere of playfulness as well as seriousness
3. Safe atmosphere and trust between participants
4. A degree of disagreement or tension
5. Possibilities for externalizing representations (sketching, writing, modelling)
6. Degree of co-presence during the task
7. Opportunities for divergent thinking
8. Tolerance of ambiguity
9. Engagement/interest in task
10. Level of collaboration itself
11. Opportunities for exploratory talk
12. Adequate knowledge base
13. Problem boundaries stretched or broken
14. Amount of use of imagination
15. Degree of expression enabled
16. Time Management during the creativity task

A rating scale has been chosen so as to shorten the questionnaire, as obtaining the same level of information using Likert scales results in many more statements than shown above. A scale of 1 to 7 has been chosen to enable Spearman's rho correlations between variables to be conducted without challenging the parameters required for the accuracy of the statistic.

6 Results

The preliminary objective of this study is the analysis of the ASCC [18] developed for analysing the factors involved in the creative collaboration process. The analysis of the reliability of the analytical instrument "Assessment Scale for Creative Collaboration" shows a high Cronbach's alpha ($\alpha = .833$) in the presence subscale and in the importance to success subscale ($\alpha = .892$), which leads us to consider this a reliable instrument for the self-assessment of the collaborative creative process.

After analysing the reliability of the ASCC survey, we analysed the results of the creativity level achieved by the students in relation to each of the hypotheses of this study. The first hypothesis (H1) could be maintained because the results of the collaborative creative collaboration show a high relation between the creative process and the social interrelations between the students. The second hypothesis (H2) should be rejected in this study because the results do not show a relation between the collaborative creative process and the time pressure perceived by the students. The third hypothesis (H3) should be partially rejected because McFadzean's [1] creative continuum phases were only observed in a small number of the dyads. The students did not show a resistance to changing their paradigm.

6 Discussion and prospective

The creative process in collaborative learning should be analysed by considering the students' experience in their creative process and their collaborative learning, but also by observing the creative process in time. McFadzean's [1] creative continuum is particularly suitable for observing the creative collaborative process in the dyads, allowing the completion of the information provided by the ASCC [18].

As observed by Eteläpelto and Lahti [9], group settings are related to creative collaboration. In this study we observed a higher number of interactions in students showing a higher level of creativity. The interaction process in creative collaboration is observed as one of the important factors in the level of creativity showed by students. In addition to this quantitative observation of the interaction activity between the dyads in the creative collaboration tasks, further studies should consider the specific episodes developed in these interactions to analyse the specific processes that contribute to supporting creative collaboration.

In this study, the perceived time pressure did not affect the creativity levels of the dyads. This could be explained by the high institutional temporal flexibility [26] within a long-term task [25]. In this context, the students developing the task over four weeks perceived a low level of time pressure. In future studies we will increase the time pressure by reducing the number of days devoted to the task.

Finally, in the creative collaboration context of the observed dyads, McFadzean's [1] creative continuum phases were only observed in a small proportion of the dyads. The

dyads showed a diversity of different patterns in their creative collaboration. In this sense, each dyad showed a specific temporal pattern in their collaboration [27]. In most of them there were no "paradigm preserving" phases. This could be analysed also in terms of the topic of the course, related to creativity in advertising, where the students did not have an initial paradigm to preserve, and showed a high degree of openness to the creative solutions proposed by their teammates and themselves.

Further research should allow for better characterisation of creative collaboration and control of the time pressure to enable the influence of this temporal factor in the quality of the creative collaboration to be observed. Moreover, future research in the field of creative collaboration could contribute towards consolidating the mixed-method analysis considered in this study and consider not only the specific population of the online campus but also students in face-to-face universities.

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Trust as leverage for supporting learning creativity in online learning communities

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Abstract. This paper addresses the effort to investigate the potential of using real time data for delivery helps teachers in assessing and monitoring learner's trust. This is due to the believe that by supporting trustful interactions (within Technology Enhanced Learning scenarios) we are recognizing group vulnerabilities. And being able to assess and monitor learners' trust vulnerabilities teachers can interveine (when needed) and support positive actions and contributions among learners and therefore reinforce learners autonomy and motivations to engage in everyday creativity skills and innovations. Main results achieved so far are translated in an attempt to report a deeply understand of how and at what level is such evidence as well as described and observes (as a pilot test) a real case scenario (a international Technology enhanced-learning course) aiming to understand three major aspect of the potential of trust in leverage support positive actions and creative contributions. This case study first observes (1) how learners perceive others intentions in a given context, (2) second observes learner's commitments changes towards a particular activity (level of cooperation) and final (3) observes learners perceptions towards the use of the communication mediums for learning purpose (reactions, intentions of use and actual use). Results provide a linking evidence towards trust and group vulnerabilities regarding the need for support positive actions and contributions.

Keywords: Creativity, Trust, innovation, learning interactions, e-participation, Technology Enhanced Learning

1 Introduction

Today's learning becomes a phenomena of participation and the reunification of skills that allows them the ability to interact online and reunify those social experiences. A point of view that indicates that nowadays there is no such thing as "learning" suis generis, but only changing participation in culturally design settings. Competency, nowadays, need to come together with innovation skills [9]. Growing the need for collaboratively support learning environments where everyone seeks for an digital identity and to innovate. Even though technology help to support this shift change, they still cannot reach our ability to engage in everyday creative skills [1], learners need to be motivated to positively engaged in their collaborative learning actions. Trust is a potential keys for activate the

interest of learners, and foster participation, which eventually leads to support work cooperative practices, skills that indirectly contributes for supporting creativity and learning innovation [4,6,11]. Trusting ensures effective commitments and reduce the level of uncertainty [5].

Though, this is a rather complex issues to address. Due to is dynamic in nature, people's trust beliefs can change through time, also trust is a factor hard to measure as it can be affected by many indirect indicators. Our previous research, though, lead us to believe that trust is an important element in today's social learning structures. Therefore our aim to contribute towards alert educators for it importance in supporting online learning interactions and for diminishing the risk of learning failure. Where is trust, activities proceed more smoothly, actions are more decisive, and people work with greater confidence. We start then, by provide a background setting on trust interrelation with supporting learning activities, and then describe our research approach, present achieved results and delineate final considerations.

2 Background

Our first research step was to establish a contextual framework, which provided an attempt to understand the potential of supporting trustful interactions as a leverage for develop creativity and innovation among online learners. We fist focus our aims in understanding what is an online learning community [10] and then observe possible implications of trust in such contexts. Conclusions lead us to believe that in general, students motivations towards online learning mail for handling information, Communicate, prepare assignments and integrate their learning at a distance process [3].

We then focus our efforts on understand trust in context. Concluding that trust from this perspective can be seen as a process of believing. Believing, that when doing a sort of activities we will be capable of achieving pretended results. This believe perspective can be examined from two angles, one represents a believe that someone (individual, community or working group) will be capable of doing what is expected, and second represents the believe that certain tool will be able to support us in achieved pretended results.

This above prespective points out to another trust issue, that is, the degree of uncertainty of the environment (medium of communication, interaction process and learning process). Uncertainty that represents a risk from the learner's point of view. While some leaners are willing to take risks (of failure in some degree), others don't. So the trust factor is by nature needs to be differentiated individually. But, the trusting risk factor is not something new, as it comes together with a relationship. What changes here is the learning context, the use o technology enhance learning tools and the distance factor. What people due in present (face to face) situations is to observe signs that indicates if they can trust or not, signs with reduce their level of uncertainty towards the interaction environment. So the presence factor can support their trust judgments. What

about in the online environment how can we read those signs to support our trust judgments?

We call it in this case the environment trustworthy signs, or the incentives to be involve. Incentives that lead me to believe that trustee actions (someone or something) will in fact fulfill my needs. The problem here (online distance context) is that each person acts in a trustful manner differently, i.e. people's predisposition to be involved changes from person to person and depends on how she perceives the degree of uncertainty of a situation. So, we conclude that people's predispositions are directly influenced or depends much on how they perceive others pretended actions, i.e. if those actions in fact lead to pretended results.

Trusting then, depends on how we are able to determine if a situation is in fact trustworthy or not [8]. Depended on our capacity to determine how reliable are those trust warranty signs [2, 12]. Perceptions that influence our commitments towards the process (level of cooperation) and therefore influence our actions towards someone or something [4, 7]. Notions that connects trust with reputation and the ability of observing environment trust warranty signs. Signs that are observed online in direct and indirect manner. For example though people's physiognomic aspects (photos), gestual or written signs (synchronous/asynchronous communication), language (voice communication), style of writing (social personality). Or can be observed online from a more indirect manner, through signs that return sensations and feelings or even perceptions gained throughout others attitudes, commitment, expectations are in fact reliable.

This above conclusions lead us to the second step of our research, that is proposing a model, see figure 1, a model that represents our attempt to contemplate above ideas into define possible trust attributions that could affects learner's capacity to perceive how reliable are those trust warranty signs and eventually lead to the support of online learning interactions.

Those "trust warranty attributes" are: Trust predisposition, Reciprocity, Predictability, Honesty, Benevolence and Competency. We describe this trust commitment process as cyclic (see figure 1) that is in constant re-feeding. In others words, learners are constantly re-evaluating their trust perceptions and therefore re-examine their believe in others actions, which affects their predisposition towards collaborate, and their level of commitment towards the situation.

This process, starts by taking into consideration peoples' predispositions to trust as starting point, and then others attributes like reciprocity, honesty or competence help learners' to evaluate their perception and believes towards the situation.

Trust predisposition, represents the inclination to depend on each other, with a felling of relative security. Influencing the level of commitment of the group (two or more people) towards the situation (a learning activity or process).

Reciprocity, believing that other's have confidence on my actions increases my motivation to trust and my disposition to trust.

Predictability, be able to perceiving others' intentions in a given context and if the attitudes and behaviors match the expectations and performance. Also

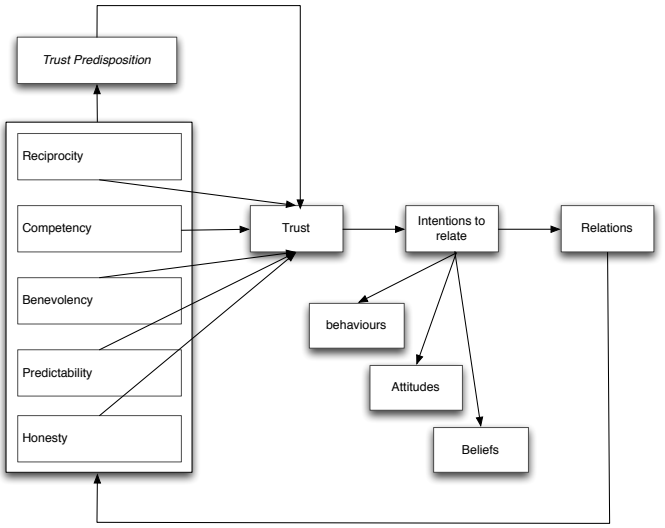

Fig.1. Trust social-technical model in TEL contexts

could be observed through signs of interface stability (security), level of user control (privacy).

Honesty, as predictability, honesty is a belief that depends on perceiving nature of the intentions of others. Open and transparent attitudes ensures security that person is not deceiving and will act accordingly.

Benevolence, indicates attitudes of caring about the benefits of others. 'kindness' raises trustworthiness but, it needs for a declaration of good intentions which results in the increasing of confidence on others

Competency, in this contexts is believing that all parts involved will act in a competently and dutifully way. Inferred by the online identities and reputations of the people involved in the process (teacher, institution, staff and colleagues). Indicators like professional paths and past achievements, photos, friends, personal aims, collective networks, style of writing. Also, could be observed throughout level of tool efficiency.

We, also, consider three main moments in time. A initial moment (the articulation), where attributes like reciprocity, predictability or honesty are important because they help to create learners' empathy and commitments towards group work. The empathy support the shift where the learner stops to see as individual and become part of a working community.

A second moment in time (the connecting), ensure the success of the interaction and the success of precious working commitments. This moment provide necessary group support and continuity for the interaction process and the motivation to be positively engaged in the working task.

The end moment (the reflection) is where students re-evaluate their experience and decide how this will effect future relations.

3 Research Approach

This research approach provide an efforts towards not only understand trust and it's implications in a real case context, but also to understand how we (teachers) can use it to support and mediate learner's interactions. The work described below is an attempt to clarify this understanding, from teacher perspective, and to examine learners' trust comitments during the articulation and connection moment.

The instrument: to achieve above research goals we applied a course observation procedure which included a initial survey instrument and diary logs. The survey was conducted online and explores students background profile information (gender, age, nationality etc). Explores students learning views and patterns (on safeness perceptions, privacy preferences,) and finally explores students use of social media towards learning. Accounted for fifteen (15) questions. The diary Log procedure observed students discussion, group interactions and final achievements) and make possible interconnections between (1) how learners perceive others intentions and how this affects the collaboration context, second (2) how learner's commitments (level of cooperation) towards particular activity changed collaboration patterns; and final (3) How the communication medium (reactions, intentions of use and actual use) affected learners' trust perceptions.

The course, started in 24th of February and was about "Designing technology enhanced learning (TEL)". Was a international distance learning course, with participants from four different countries, Finland (University of Oulu); Norway (Norwegian University of Science and Technology Trondheim); Romania (Valahia University of Targoviste); and Estonia (Tallinn University). The courses lasts 14 weeks (a semester). Course learning environment are SecondLife and Moodle and learning activities are planed to foster international students collaboration. Evaluation process, includes peer-evaluation discussions, reading tasks; commenting on weekly topic and individual and collaborative studying. Students are expected by the end of the course to design, development and implementation a TEL course. Course load and contact hours include 15 hours of lectures and individual and collaborative studying in virtual learning environment for 145 hours. *Course contextualization:* The observed TEL course is part of a European project called *CoCreat — "Enabling Creative Collaboration through Supportive Technologies"* (http://let.oulu.fi/cocreat). This course is deployed by nine (9) partners from eight (8) different European countries. Project main purpose is to find new solutions for promoting creative collaboration in terms of new and innovative learning models based on social media and mobile technology. Most activities performed in the course involve collaborative tasks, collaborative thinking and reflection. In the course students were initially divided into small groups (from 4 to 9 students maximum) and different tutors were assigned to the groups. All learning activities were design and coordinated by a teacher who coordinate overall group activities. The kick-off meeting was made via Adobe Connect Pro in 24th of February, and students had face-to-face meetings with the local facilitators twos week before the start. *Participants:* forty-nine (49) students answered to the survey from a sample of fifty-five (55)

students. From those three were consider invalid due to be incomplete. Which resulted in Six (6) Estonian participants, eighteen (18) Finnish, one (1) Norwegian and twenty-two (22) Romanians. Most participant had a higher degree and their age average was of 31 year old. The youngest had nineteen years old and the oldest 52 years old. Majority uses Internet and social applications in a daily bases (85,71%) and consider very useful activities like reading and sending e-mail, search for information, learning activities and sharing ideas in formal education contexts, see figure 2.

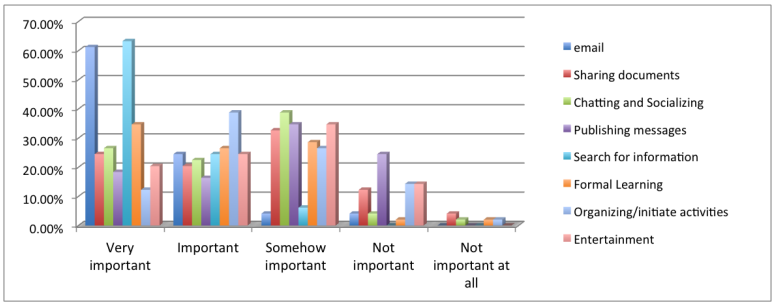

Fig.2. Activity and daily routines

4 Achieved results

We will address and describe the results from two perspectives, one analysis students' answer in the questionnaire and then analysis observation diaries.

The survey analysis indicate that students feel safe to share in e-collaborative learning context (57.14%) or in social network (44.90%), (e.g. Google docs, EtherPad, dropbox, Facebook, google+, Twitter). Feel safe as well when sharing in close learning environments (42.86%). And, by safe we mean felling a degree of control who will read or have access to their shared resources, comments and assignments. Results also reveled, that students are undecided on regard the safety of open environments (e.g.blog-post in Wordpress/Blogger, Wikiversity), public blog-posts, public forum discussions or Second Life, see figure 3.

Regarding students privacy preference, seams students prefer to keep the information private by default, especially the grading (36.73%) information, feedback and comments (36.73%).

The inquired students claimed to publish very often. Especially information about friends or themselves. They, also, use online tools or services in a daily bases. Tools most used are mobile wireless devices (32.65%), search engines (59.18%) and social networks (40.82%). Regularly, collaborative sharing tools (42.86%). Sometimes students use computer assessments and close learning environments. Not use at all, or used at least a few times collaborative drawing and social bookmarking services. Students expect, as well, that teacher clearly

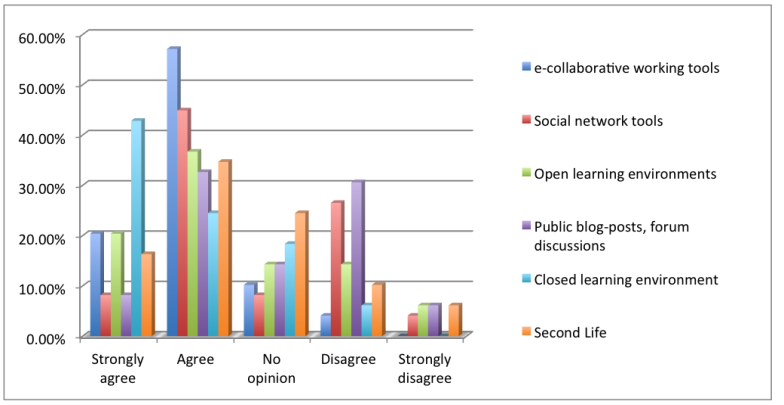

Fig.3. Privacy awareness towards eLearning tools

define course privacy rules (42.86%), in regarding what will remain private or public in the course.

Regarding the diaries analysis logs, results first observed changes possible towards a particular activities and examine learner's level of cooperation towards the activity.

This course in fact gave much emphasis to students' collaboration and online social activity, fostering as well group participation whenever needed. Activities were performed always at a distance and online. To fulfill the learning assignments students needed to actively collaborate and cooperate with each other (in groups). Tools used to deploy the course were Moodle or SecondLife.

The tutor role in here consisted in observing the interaction context (discussion, interactions and fulfillment of tasks) and find patters that lead to understand learner's trust behaviors and attitudes and write them in a weekly diaries.

The observation period included a 10 week and two group were observed "TechDesigners" and the "ThoseTwoLives"

[OBs1] Week 1 and 2, "Get to know each other" (asynchronous).
[OBs2] Week 3 and 4, Decide about working methods (asynchronous and synchronous).
[OBs3] Week 5 and 6, write the pedagogical script (asynchronous and synchronous).
[OBs4] Week 7 and 8, provide peer-to-peer feedback (asynchronous).
[OBs5] Week 9 and 10, write the pedagogical script (asynchronous and synchronous).

The results revealed XXX important issues to address, that is

Students' trust commitments. During the first two weeks was for students to introduce themselves (social enagagement). In here was when Learner's should start to establish their trust commitments, but this really happen on week 3 and 4, when students' decided their working methods. Though, this was a week start because they did not articulate much their ideias.

The set work of the work climate in fact took place on week 5 and 6 during the design of the pedagogical script. Until then they seamed confuse and not understand what actions they need to do. They where more interested in understand what actions they will take throughout the course to achieved pretended results. So observation results until week 5, indicate that the articulation phase only started in fact in the end of week 4 (deliver deadline) and lasted until week 5, when students had to meet synchronously (via Second Life).

Also, more committed students tend to be more successful in perform their activities. Group learning capacity and competency was affected by this as well. Again, students efforts became higher near an assignment deadline or during and synchronous communications activities (Second Life). During those periods they seamed more committed towards the group and the level of empathy between them seamed higher. Those students more committed to the process, also achieved better results in the end and develop and defined the group working bound and commitments.

Communication and support. Tutor support during the synchronous communication, was also important to mediate the decisions and to establishes the communication climate (the initial trust bound). Also, here the log showed a cultural bias towards students, when interacting and socialize patterns.

Students' trust perceptions towards the medium (reactions, intentions of use and actual use) revealed that students privacy awareness and the level o sharing and with Technology change the usage patterns (efficiency). For example, for some (those who are more aware of what information is available online and how tend to be less willing to share if they do not know, or are familiar with the communication tool. Suspicious was one word used when referring to safety procedures. So the grow tend to choose to work with the tools they were more familiar and believe where more efficient for the activity.

The articulation moment During Week 5 and 6 the tutor participation, together with students initiator-contributor role were vital elements to initiate cooperation. Here we notice that both trust commitment building moments become important, and students easily interchange between articulation and connection. Though, there was those who waited and only assume their commitment towards working, after someone in the group (tutor, initiator-contributors or group colleague) took the initiative and decide what to do, when and by whom (articulation).

The initiator-contributor role was effitient to start the discussion process, propose ideas or approaches to group problem solving and suggest an approach for procedure. People's initial commitment towards the course represented and important issues for those who tended to assumed more this initiator-contributor role. Tutor support also help to achieve that commitment but those who where supported by tutor tended to become less commited and less motivated to work easily.

Also, observed discussion and interactions during activities, demonstrate that students' level of commitment also depends on others reactions (reciprocity). For example: during week 9 and 10 we observe that in spite of a student attempted

to initiate the interaction process, the activity and the articulation only started on week 10, because few reacted to the message and took to much time to answer back.

Again, after the initial articulation attempt was lost, that needed to be recovered during an synchronous meeting. Until then students found difficulties in collaboratively working together.

International perspective: observation reveled some cultural and generation miss understandings in the the beginning of the relations (when students tried to established rules on how to act and how to behave in the group). Those were more early dismissed in synchronous conversation and through the tutor mediation support.

Group initiatives: More committed students expected more active discussion and more participation from their colleagues (daily base asynchronous communications) when compared to others. Those where also the more social active students, created the group bound link and established the rules on how to behave in the environment. Usually they took the initiative and articulated the group work committed and collaboration.

The synchronous meetings help to established this bound and commitment more easily and it seamed that in here the element that created the bound and established group working behaviour was not the social active student but instead the more competent and innovative student. In this context the competency and benevolency of participants seamed to be the most important skills for achieving the initial work articulation. Then, during the connection phase, competency, honesty and predictability assumed an important role. Reciprocity actions in the group seamed valid in both communication phases special when initiated a task activity. The role of the teacher was mainly for provide support and scaffolding.

Working methods, Group working methods differentiated from group to group, though in the end the majority of the groups achieved pretended results. In here group trust commitments were more vital and often stressed in the end of a task and when needed to articulate a working process. Second Life discussions helped in developing the initial trust bound, then the work became stronger and group collaboration higher through during connection phase students work individually in their task and connect ideias asynchronously.

5 Closing Remarks

This work's major contributions are the intersection of areas such as trust, creativity and collaboration.

So far the achieved results clearly distinguish learners commitments as an important key tows establishing group colaboration and to ensure the success of the learning activity. Contradictory to what expect open or close activities seamed less important for ensure the success of the activity and the group interaction than their commitment towards the work and the group.

Competency, reciprocity and benevolence were important attributes to ensure students initial work articulation. Predictability, honesty and competency as well as reciprocity were important attributes for engaging the group bound through time and ensure group overall group commitment.

In return, tool familiarity and usefulness were important attributes for select the communication tool and to guarantee the communication efficency. Safe communications were related more with this attributes that privacy or tool secureness.

As future aims, towards this work is to development a tool which support teachers on designing instruments and activities that foster students and group commitments. This tool aims as well to assess learners' trust commitments during the articulation and the connection phases so, it allows teachers to identify variations on students' trust commitments and apply interventions if needed.

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Exploring creativity with e-learning 2.0: a personal account

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Abstract. This article shares a personal account on the effect of learning with access to a wide range of information and computational tools on personal creativity. It is an ethnographic narrative study, presented as a first person account on the perceived creative added value of learning within an open, very flexible and constantly evolving curriculum, deployed over a heterogeneous and assumingly experimental learning space.
Creativity,

1 Introduction

Creativity is an important human attribute and although computers are becoming more and more complex, their technology still fails to reach the human ability to engage in everyday creative skills [1]. However, technology can be seen as a means of supporting the realization of one's creative potential and expressing creativity by providing convenient access to a wide range of information and computational tools [2], such as it happens in the case of Tallinn University's master program on Interactive Media and Knowledge Environments (IMKE).

IMKE is a six years old international master program with an open, very flexible and constantly evolving curriculum: Open and very flexible in the sense that students are encouraged to get part of the necessary credits by enrolling in courses from other curriculae, either from the university, from Estonia or from elsewhere; and Constantly evolving in the sense that the set of freely elective courses is updated yearly to reflect an always evolving understanding of what interactive media and knowledge environments are and also to provide our students the necessary edge in a highly competitive professional field. On top of this, we should add that part of IMKE's courses is tough by foreign specialists, whose contributions play a important role on every instance of the program.

From the scenario introduced above results a master program, which has as main characteristics a dynamic morphology and a very heterogeneous learning environment. While IMKE's dynamic morphology is mainly fostered by flexible university regulations and all the external contributions, its heterogeneous learning environment is encouraged by our vision that every lecturer should used the approach she or he sees as the fittest in each course. As a result, IMKE course modalities range from strictly face-to-face to fully online without any face-to-face contact; from simple (pa-

per) file sharing to intensive use of a specific learning management system; some open learning environment agreed upon by students and lecturers. IMKE's community welcomes this heterogeneity as it allows for a hands-on experimental approach to many of the topics addressed in the curriculum but also raises questions and problems. One being, just as an example, the difficulty students feel in keeping up with everything related to their master program and their colleagues, as all are encouraged to keep personal blogs on top of every system account they must get hold of to participate in the program's activities (this issue was actually partially addressed by a team of students that developed and deployed an aggregation service to help them cope with all the details).

2 e-Learning 2.0 and creativity

e-Learning focused mainly on using technology as supportive factor in the learning process. The concept however, evolved into e-learning 2.0 [3], a neologism for Computer Supported Collaborative Learning, when social software was added to the equation. From this point on, content was not only produced by the teachers, but also students were able to contribute to the creation of course content, in a bottom-up way, handing students more control over their studies [4].

As a technological infrastructure, e-learning 2.0 affords [5]:

- Accessibility: online and easy access to vast amount of information through different mechanisms like gateways, portals, websites, knowledge networks and shared communities of users;
- Speed of change: the immediate access to rapidly changing information is the most important feature of new technologies, which enables unprecedented speed of access to materials as they change;
- Diversity: learning is not happening in one place, but you can inform learning via overseas web sites, access to subject experts or use simulations to replicate complex behavior;
- Communication and collaboration: because the wide use of technology, new means of communication and sharing information have occurred (emailing lists, forae, chat rooms). At the same time, physical appearance is no longer mandatory and new forms of groups have developed – communities of practice;
- Reflection: mainly the use of asynchronous technologies, which decrease the importance of simultaneous appearance of members of one group. There for, building archived materials available from earlier discussions becomes easier;
- Multimodal and non-linear activities: learning has been promoted as a linear activity, where in fact new knowledge is acquired through non-linear approach [6]. Non-linear learning on the contrary, encourages learning in the "natural" way by looking information for that topic which has attracted the interest at the very specific point. Multi-modality supports this approach;

- Immediacy: the speed of information exchange has increased enormously leading into consequential intensification of working patterns of the request to immediate responses.

Affordances thus providing the necessary and convenient access to a wide range of information and computational tools as a way to support the realization of the students' creative potential while fostering the expression of their creativity [2].

However and while these affordances account for what we do with e-learning 2.0, they should not be mistaken by causes as the production of practical effects depends of each others intentions [7].

With these notions in mind, we now proceed for a first person account of studying Tallinn University's Interactive Media and Knowledge Environments master program.

3 The context

As a student in the Interactive Media and Knowledge Environments master program at Tallinn University, which combines intensive week-long study sessions with flexible independent study, allowing the students to combine their studies with full-time work, the personal experience revealed, how the emphasis is put on promoting an open and flexible learning environment. Various course descriptions of the curriculum revealed the high usage of different communication tools and social media forms for conducting learning activities. Most courses used blogs or wikis instead of paper-based materials and also students' were required to keep a personal blog, as a digital portfolio, for their studies. Some of the courses had face-to-face meetings, whereas others put a lot of effort into using different communication tools (*Skype*, *FlashMeeting*) and study environments (*iCamp*, *Moodle*, *Sakai*, *IVA*).

During the two years of master studies, one of the authors participated in 26 different courses and made personal observation on how the courses were structured, conducted and facilitated. Out of these 26 courses, two were fully conducted online; 15 used a blended learning approach combining face-to-face meetings with course blogs or wikis and other e-learning 2.0 tools; and 9 were classroom based.

In fully online courses, like the New Interactive Environments (NIE), the study materials were uploaded in a course blog, the results of individual assignments were presented in each students' personal blog, the meetings conducted via *FlashMeeting* and all participants could get feedback through *EduFeedr*. With the Ethics and Law in New Media (ELNM), the study materials were uploaded in *Wikiversity* and discussions were carried both in the course's forum and via weekly Skype meetings, while the results of individual assignments were also presented in each students' personal blog.

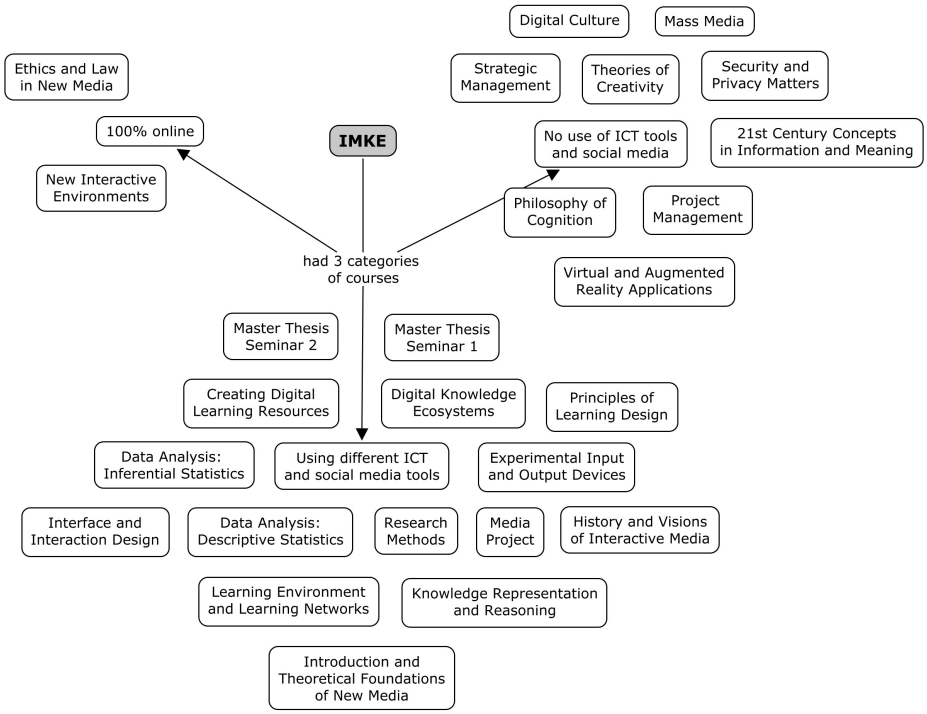

Fig. 1. IMKE's course categories

In blended learning format courses like the Introduction and Theoretical Foundations of New Media (ITFFNM), students had weekly face-to-face meetings and any reading materials as well as assignments were shared in *Dropbox* or published in the course blog. The Media Project (MP), also a blended learning course, had two face-to-face meetings in the beginning and in the end, two intermediary meetings using *FlashMeeting* and all relevant study materials and discussions managed by an environment called *iCampus*, an *Elgg*-based environment.

Finally, in classroom based courses, which did not require any technology for contacting and socializing with colleagues, the students chose independently social media tools to support either their teamwork or individual tasks.

Table 1. e-Learning tools used in some courses

Course	Blogs	Wikis	File sharing	Communication	Aggregators	Face to face
MP				X	X	X
NIE	X	X		X	X	
ELNM	X	X		X		
ITFNM	X		X			X

All-in-all, 17 were one way or the other representing e-learning 2.0 and less than half had the approach of e-learning by having paper based materials or PowerPoint slides as the only ways of presenting study materials. Even in those cases students used Google docs or Skype for collaborative working on their own initiative.

This heterogeneity highlighted flexibility as an advantage of using e-learning 2.0 tools. As most IMKE students work full time, the stress was no longer on how much you are able to do, but on how efficient were you able to be.

Being a full time working student, it is also vital to have the access to course materials or do assignments when there is spare time and therefore this approach helps to manage time more efficiently.

The importance of flexibility was revealed also in the case study of Conole et al. [8] where the students, who had to work, had children, lived from a distance or had high workload, appreciated the access to an integrated set of online-related information and resources.

4 Information access, computational tools and creativity

Overall, studying IMKE was a rather positive experience. As said before, the curriculum promoted the usage of technology to foster openness and flexibility and from a student's perspective, the courses, that left the most positive impression, usually provided only the frame for the course, leaving the content to be created by the students i.e. the students had to be more independent and aware of their wishes and in return, more freedom and responsibility was provided to them. This freedom and independence led to supporting students' creativity.

The other positive factor was the introduction of various possibilities in the form of making the students explore independently or use in their assignments different applications and/or learning environments. Therefore once again, the students chose their own way to solutions, while exploring and experimenting different applications and environments through which the development of their creative side was supported. This kind of approach was also more beneficial in the sense of inducing the students to be more creative in general as already used solutions were adapted to different situations and the students couldn't "cruise their way" with a single approach without exploring alternatives.

The interactive communication via Skype or FlashMeeting provided the students with higher range of flexibility for participating in course meetings. Also when the courses had blog as their central body, the students got relevant information quickly. For example there were courses, where the course blog acted as the main body, providing all information needed (administrative issues, course related assignments, feedback of the conducted tasks, study materials) online and therefore were accessible whenever the students needed. It is known, that uniting your school activities with personal and work routine, is quite challenging, especially if you need to participate in face-to-face meetings. Interactive communication lost the restriction of physical space and most probably increased the general participation level. The need for physical meetings was also small for courses using course blogs, as there were contact session

at the beginning and end of the course, but general communication was done via commenting each other's assignments and posting feedbacks.

If there was something to be changed, then I would suggest limiting the variation of different tools in the sense of them being compulsory. Not all students are impressionable when it comes to using new tools/environments, especially if the student does not belong into the Net Generation [9]. When the students have chosen IMKE program, they need to take into account the wide range of possibilities they'll be introduced to, but the fact that master level students are older and more conscious, makes them more standoffish toward enforced solutions. There should be kept the possibility that student can choose his/her own tool together with the agreement of the teacher, which by the end can lead to the students exploring even more in the field of opportunities provided by Social media.

5 Closing remarks

As it happens with the Interactive Media and Knowledge Environments master program at Tallinn University, the technology facilitated application of creativity to using a stock of knowledge to promote novel problem solving has, in many cases, lead to innovation, as proposed by Yusuf [10].

The combinatorial power of IMKE's e-learning 2.0 learning environment is nothing new and has been present in many other learning settings, but it seems to be much more apparent and useful in open and flexible learning environments such as the one herein described, as curricular structures fades into the background and the activity tends to focus on creatively dealing with each learning challenge.

Also, the idea that this kind of learning environments is permeable to context may challenge the traditional conception of course materials and students' digital portfolio as context adaptation is now much easier to achieve.

Most course materials and portfolio are usually designed for a specific purpose. However it appears that e-learning 2.0 facilitates breaking this principle due to its inherent context permeability. Thus, it might be helpful to think of an e-learning 2.0 environment, which is not limited to helping us in solving a particular task, but it has a broader purpose of helping us to creatively adapt to our environment as a whole. This is due to the fact that e-learning 2.0 environments, given their context-permeability, can be more easily integrated into distinct contexts thus facilitating creative approaches to address each inherent challenge.

Creativity is then encouraged, as the context for both course materials and portfolio does not need to be preset, facilitating opportunistic usage. Further and has highlighted but the first person account provided in the previous sections, e-learning 2.0 settings enable both teachers and learners to act on their environment thus increasing the possibility of successfully adapting to it.

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A Student's Perception Related to the Implementation of Virtual Courses

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Abstract. This paper illustrates the point of view of the students regarding virtual courses in education, but in particular reflections are made, based on the experience gained by the students in the *Designing TEL* course, organized in the frame of CoCreat project. Thus, it was noticed that a very important role in the development of virtual courses was played by using Wiki and Moodle platforms. Despite some difficulties encountered when implementing virtual courses using those platforms, the *Designing TEL* Course can be considered a successful one.

Keywords: virtual course, Wiki, Moodle, cooperation, internet, access to information

Introduction

In the past 20 years, the Internet has produced a large impact on the social sector, communication, information, and its immediate effect was observed on science and education. This environment, yet contradictory, had the fastest growing among other services through all sectors of the economy and helping the global flow of information. Its success is seen by the speed of conquest of the population: in only 5 years of development, it won an audience of 50 million users, something hard to achieve in its time for other features of humankind. (Fig. 1). [1]

Indeed, the popularity of the Internet is due to technological developments, but also because the Internet may include other facilities such as TV, radio, telephone, that makes it superior to other services.

Although officially, the Internet conquest by education began in recent years due to obstacles arising in teaching classical education, unofficially Internet influenced our education since its inception. Popularize it, indirectly, made a source of information, documentation, communication and misinformation, loss of leisure time and addiction. [2]

adfa, p. 1, 2011.
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To use the Internet for teaching purposes, everybody should be aware of all the problems that may arise during the implementation, adoption as supporting material. After the elimination of all factors that could decrease the quality of learning, in the future, total assimilation of the classic courses by the virtual courses, it is possible.

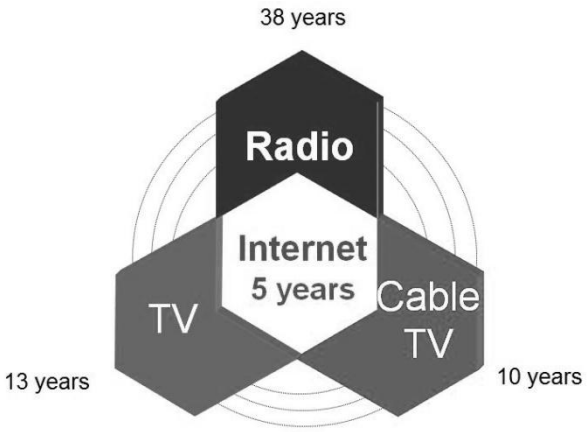

Fig. 1. Time to reach a large audience of 50 million users

Increasing in scale, the Internet has caught also the education field. There are various reasons why it was the Internet that was used for teaching in this environment:

- Increased number of students;
- Decreased quality of learning ;
- Increased costs of teaching.

One of the solutions designed in some UK universities was to create online platforms (e.g. Wiki) by certain courses, to facilitate the teaching practice and attracting the attention of students for learning.

The effect was not exactly the desired one, because the student's position towards virtual classroom presentation was not the favorable one. Student behavior can be easily explained, statistically speaking. Most would choose to learn through online platforms (e.g. Wiki) due to the mess of course, lack of time, lack of interest. [3]

However, there are studies showing that Wiki platforms can be a suitable environment for students. In international educational projects, it was noted that learning is possible through wiki platforms, but only in cases where students are involved in solving collaborative goals. [4]

Methodology

In the frame of CoCreat project, starting with February 2012, till May 2012, it was organized the *Designing TEL* course. In this context, students tried to be familiarized with the key concepts, theories, and approaches of *Technology-Enhanced Learning*.

There were created 12 mixed groups of 6-7 students from different countries. Monitoring the group's activity was done by a tutor. Generally, a tutor led two groups of students simultaneously. For communication, between groups and tutors, it was chosen the English language. The main tasks that students had to perform were: the creation of a teaching script, a technical script and the design of a virtual course.

2.1 Pedagogical Script

By carrying out this task, it was aimed to find out the student's opinion on the structure of a virtual course. Through collaborative work, students have developed a teaching script with the following structure:

- Name and scope of the course
- Learning theory
- General description of the course
- Description of the target group
- Pedagogical model
- Tutoring and teacher's behavior
- Evaluation

Depending on convenience, students have created the teaching script on platforms like Moodle, Wordpress and Google Docs.

2.2 Technical Script

By running this script, the students have mentioned the resources they need to achieve a virtual course according to the teaching script. Technical script structure was as follows:

- Basic idea of technical implementation of the web course
- Structure of the web environment
- Communication
- Learning materials
- Testing the web environment

Most students believed that the best platforms are the „wiki" type. And that's why, 7 groups of 12 used this type of platforms. Free access to the virtual course was important for 9 of 12 groups.

The virtual course proposed a communication module, an essential aspect for the students' work.

2.3 Making the Virtual Course

As it was mentioned, 7 groups of 12 have made their virtual courses on wiki platforms. Moodle platform has been chosen by 3 groups, and the blog-type platform by 2

groups. All groups emphasized the easy way of navigation within the course and used a friendly and attractive interface.

Results and discussions

As Internet is still not seen as a serious area of study due to the fact that it offers many possibilities, but it is often mistakenly associated only with recreation, which can go in waste of time (games, social media, video, music). [2]

The *Designing TEL* course - embraced by students from Romania, Finland and Estonia - has tried to implement a virtual course, where teams formed with different ethnic composition for facilitating intercultural communication were coordinated by international tutors who established tasks for the team members.

Because of the experience gained during this project, students have understood certain aspects of how to implement a virtual course. To attract the interest of students, some issues in this area need to be made clear:

- Free access to information;
- Quality of information;
- Virtual course layout;
- Students cooperation in addressing objectives
- Communication means

3.1 Free access to information

If we talk about a course at a class level , a group of students, from school, university, then it should be noted that a course that can be easily accessed from anywhere without restrictions is preferably to one which is hidden behind some limitations. There can be obstacles such as accessing information by paying money, restriction by IP, password-based login, loading pages with too many ads. These hinder access to information leads to loss of interest from the student. [5]

This has its explanation in classical practice: a website with many restrictions and too many commercial purposes has a less number of visitors compared with a non-commercial or less commercial one.

Let's consider the most important aspect - the financial one or the payment for information. Indeed with the growth of the Internet, there have been many scientific bases with quality content but which ask for money for the information provided. There is nothing illegal and surely they have a pretty big impact on scientific and technological development. But, in terms of education in the society as a whole, these bases have a much less important role compare to some database information such as Wikipedia. [6] Of course, it is not a basis as professional like SpringerLink or Science Direct, but because it provides free access, makes it more accessible to a larger circle of people.

This is observable through traffic from Google on two online platforms. Although the scientific basis www.sciencedirect.com has the number of pages indexed in

Google, less than about 10 times to wikipedia.org, the number of visitors is less than about 2000 times. These data refer only to traffic from Google.com and do not take into account the number of visitors who access these two databases directly without using any search engine. (Fig. 2).

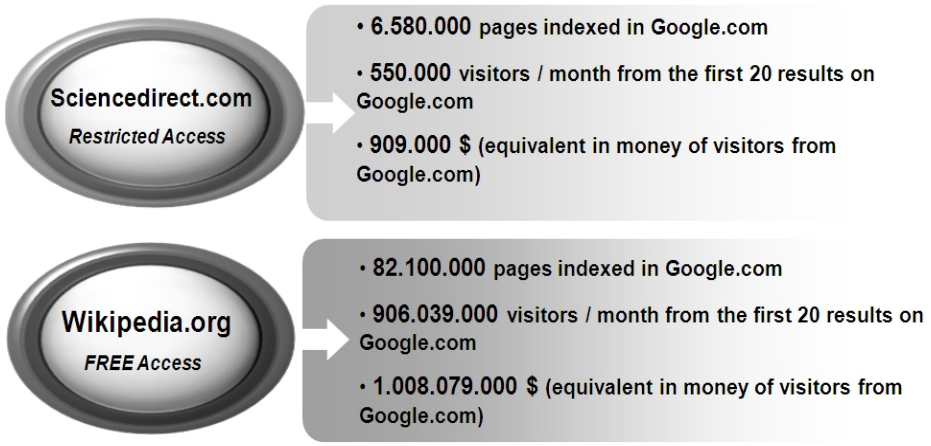

Fig. 2. The difference in traffic between a knowledge base with certain restrictions and an open access one (Data from Semrush.com for April 2012)

The importance of open access virtual courses is very high; such an investment is not only for students of a university but for the entire community. [7]

For all groups it was important that the course should be accessed from anywhere. 9 groups of 12 said that access to information should be freely without restrictions. Only changing or adding information is based on a login.

3.2 Quality of information

It is still a serious problem related to Internet. Classical libraries acquire information, in general quality information, from different areas, while the Internet has accumulated some of this information, but also a lot of unnecessary and confusing ones. Information on the Internet often is confusing, difficult to access due to various obstacles (banners, advertising, poor website structure) (Fig. 3). [8]

There is another aspect of the problem rather of the virtual course structure. It cannot be made as a book, only with text, images and classic diagrams. It is a need to have other components such as animations, video, mobile charts and so on.

If we exaggerate with the latter, we face again a lower quality of virtual course.

Although students have done just some examples of virtual courses, the quality of these courses is very important, and that it is easily understood from the materials they used. The quality of the information increases the confidence level of the virtual courses.

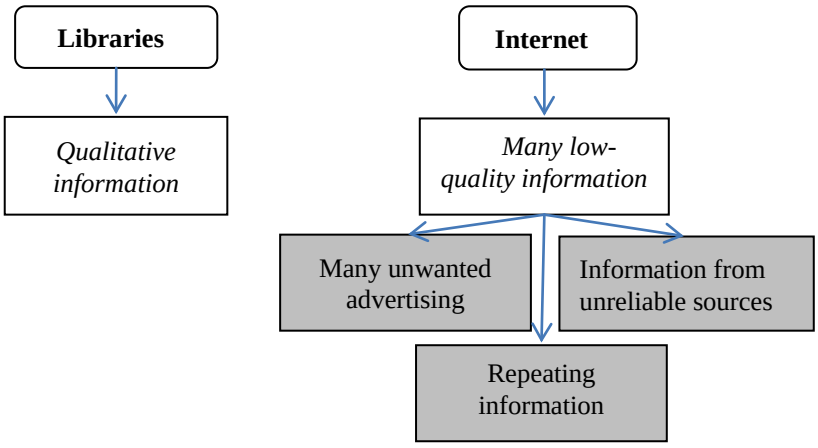

Fig. 3. Key features of the two sources of information: Libraries and the Internet

3.3 The aspect of the virtual course

The competition of the websites on the Internet has led to very attractive designs with which the new courses that have just been implemented via internet cannot compete yet. Often they appear mundane because the author or authors still remained with the concepts of classical teaching that does not have the same effect. Aesthetic virtual course has a great impact on student attention and aesthetic effect rate + quality information leads to better feed-back.

The simplicity and the elegance of the wiki platforms are the strongest points in implementing the virtual courses. Students, generally, are not attracted to complicated interfaces because of the difficulty in navigation.

3.4 Cooperation between students to achieve the objectives

Cooperation between students makes them more interested in the quality of learning. Organization into groups - where each member has something to do -, makes them move faster than when they are working individually. There is a stimulating focus of the students on the course because of their friendly cooperation. Quality increases because cooperative learning is possible depending of what the teacher taught them through interaction with colleagues. The best environment would be a Wiki platform that students are able to operate. Platform may be restricted for the privacy of students and only after the objectives are completed it can appear online to everyone.

3.5 Communication Means

It is a matter to which attention should be paid. Implementing a virtual course in the UK, noted that students do not leave comments to these courses which normally is a classic course. This phobia was explained by the fact that students did not feel in their

environment. Some students did not want to be the first to comment, others waiting to comment on someone else or they don't have time to do it and so leaving some unresolved targets. [3]

Creating special channels of communication between students and also between students and teacher could solve this problem. Circle shrinks to a family one and so the student finds it easier to communicate. Of great success was the Moodle platform used in the *Designing TEL* course, but also a common environment in several universities in Romania, Finland and Estonia. It had a positive effect on communication between students and in achieving objectives. Similar results were obtained in a project between two universities in Italy and Egypt. [4]

For communication, students prefer asynchronous mode. The fact that they can leave messages or comments at any time makes them more interested in the virtual course. However, the synchronous mode of communication is welcomed as well, especially among students.

Cooperation and communication helped the objectives to be made simpler.

Conclusions

It is not so easy to change from traditional teaching to virtual courses, but it's time to make this transition. But it is impossible to do this so suddenly, because this is difficult for parts, students and teachers, to formulate a new type of teaching. Gradually, however, education will become more accessible to all people or at least that's how it should be, and the Internet environment will be the key in promoting it.

By reaching the target points mentioned in this paper, it will be easier to organize students in the learning process. Transition must be slow for teachers and students to have time to adjust. Teachers must change their teaching methods by connecting to information technology, and students must indicate how it is easier to assimilate information.

In the *Designing TEL* course, through students' practice, it was understood that a successful virtual course must have a structure similar to a wiki platform, which can be accessed without restrictions. The quality and the appearance of the information presentation it is also very important. The presence of a communication module facilitated cooperative work for students in groups. All criteria observed on this project represent a very important stage for virtual courses' implementation. The students' perspective on this project will help teachers to create more interesting and explicit courses for them.

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