Learning of Software Engineering on Collaborative Virtual Enviroments

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***Abstract*— The collaborative work on virtual environments is one of the greatest outcomes resulting on the development of the information and communication technologies. These advances, that tend to minimize distances, are allowing coordinated work beyond the limits of time and space, also impacting on the educational field. Educational platforms mediated by technology are having a special focus on collaborative work as an instrument for reaching goals, and more importantly, to generate knowledge. However, there are special areas of knowledge that require, apart from the psychology and pedagogy tools, specific ones to be able to complete effectively the process of teaching and learning. Software Engineering (SE) is an area of knowledge which requires specific tools, such as the CASE (Computer Aided Software Engineering). In order to use the Software Engineering in learning and teaching, some tools are needed and these have to have the appropriate characteristics for that aim. In this work, we present a model that specifies and links the concepts of Computer Supported Collaborative Learning, Computer Supported Collaborative Work, and Ubiquitous Learning with the teaching of the Software Engineering, binding them and proposing an integral model with functional content blocks, and an implementation of this model in a software.**

***Keywords*— *Collaborative Work, Collaborative Learning, CASE tools, Software Engineering*.**

I. INTRODUCTION

The constant innovation in Information and Communication Technologies (ICT) has significantly changed social and cultural aspects. The possibility of having access to information at any time and place, and new forms of interactions like chats, forums or blogs, also changes the focus in teaching and learning methodologies [1].

Later on this paper, we will refer to the concept of Computer Supported Collaborative Work (CSCW) and how this gave rise in its integration with teaching and learning environments to new avenues to technology-mediated processes and educational proposals.

On a different note, we know that the theoretical study of Software Engineering (SE) is not enough to understand and solve cooperation problems that arise during the development of a software project. In the case of students, they often focus their efforts on technical problems and assume that the consequent problems of teamwork will not impact the project [2].

But what if we can take into account this omnipresence technology and create new learning tools for the students? When searching for an answer, in the present paper we propose both a learning model and an implementation of such model in a form of tool that contemplates collaborative activities, self-evaluations and, at the same time, that promotes discussion and consensus, all in a virtual environment.

II. TECHNOLOGY ON WORKING AND LEARNING

A. Computer Supported Collaborative Work

Also known as Computer Supported Cooperative Work, this concept is all but new. It started on the late 1960's when Doug Engelbart created the revolutionary computer collaboration system called NLS, which featured most of the functions that today's systems are trying to implement such as real-time shared editing of outlines, shared annotations of documents, and video-conferencing [3].

But we had to wait until the 1980's to hear the term Computer Supported Collaborative Work (CSCW) for the first time, used by two researchers (Irene Greif and Paul Cashman) to describe the topic of an interdisciplinary workshop they were organizing on how to support people in their work arrangements with computers [4]. Nonetheless, the precision of the definition escaped this instance and even today we can encounter alternatives to the characterization of the term. In the present work, we will use the one that is proposed in [5]: "CSCW should be conceived as an endeavor to understand the nature and characteristics of cooperative work with the objective of designing adequate computer-based technologies". This thought focuses on the nature of the collaborative effort and the ground role of the technology as mediator and key component.

B. Computer Supported Collaborative Learning

As stated by Illera in [6], CSCW can be considered the immediate ancestor of the CSLC, rising in the 1990's along with the growing use of technology. We can see this impact as an emerging branch of the learning sciences [7]. And just like the concept of CSCW, CSCL proves to be elusive.

Koschmann defined CSCL as: *"CSCL is a field of study centrally concerned with meaning and the practices of meaning-making in the context of joint activity, and the ways in which these practices are mediated through designed artifacts"* [8], but again, instead of trying definitions it is also valid to consider it as the shared solution of a problem, the learning being the byproduct of this activity, measuring it by acquiring new knowledge or improving the performance in a task [9].

Binding with CSCL, we can encounter other terms, like e-learning, network learning, learning management systems or computer-mediated communications. All of them in the process of resignifying or rediscovering their own meaning, since the Internet takes a central role in our lives.

In this way we find a deconstructive approach useful, setting aside definitions, identifying the components of this new genre of learning [10]:

a) Contents: the e-learning systems as training tools, not just mere containers of digital information, but constructed accordingly to pedagogically defined models and patterns.

b) Technology: the e-learning systems based on software applications, mainly on web environments.

c) Services: the e-learning systems and services that help the final users (teachers and students) and provides communications and evaluations management.

C. Ubiquituos Learning

Like we mentioned before, the omnipresence of Internet in all its forms is having a position of importance in our society. The immediate access of information allow the educational fields to find an excellent mean to elevate themselves from geographical and temporal boundaries, which leads to a mobile learning (m-learning) also known as ubiquitous learning or u-learning. This framework proposes an environment that allows students to learn, anytime, anywhere [11], to the extent to be embedded in daily real life.

A characterization of ubiquitous learning comprehends:

Permanency: Learners never lose their work unless it is purposefully deleted.

Accessibility: Learners have access to their documents, data, or videos whenever the learners need to use it.

Immediacy: Learners can get any information immediately, allowing them to solve problems quickly or recording questions and look for answers later.

Interactivity: Learners can interact with experts, teachers, or peers efficiently and effectively. The experts are more reachable and the knowledge becomes more available.

Context-awareness: The environment can adapt to the learner's real situation to provide adequate information since the learning could be embedded in our daily life [12].

III. Ubiquitous-CSCL

One step further, and we get to the term Ubiquitous-CSCL [13][14].

Collazos in [15] proposes a learning model, which is constituted primarily by the best practices of two forms of learning: (1) localized learning (u-learning) that uses training activities supported by technology, accessible anywhere and available in different channels at the same time; and (2) CSCL,

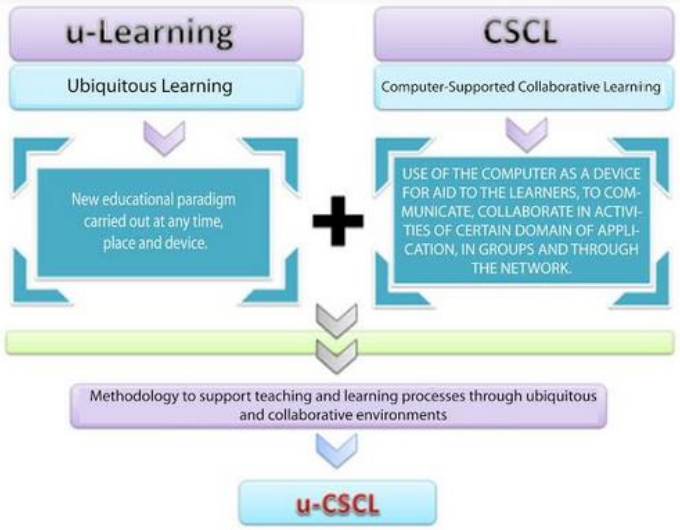

Fig. 1. U-CSCL Model

which is collaborative learning supported by computational tools, focused on educational environments [16].

The u-CSCL model includes five main components: 1. Teachers, 2. Students, 3. Study Materials (subject-matter, collaborative activities). 4. Technology Platform, 5. Access Services [17].

IV. Case tools and Teaching of Software engineering

Computer-aided software engineering (CASE) is the name of a broad range of software tools used to design and implement applications.

There are a significant number of studies about the evolution of CASE modeling tools with UML support. These types of tools are widely employed because the UML standard are being increasingly used, particularly during the analysis and design of software in engineering activities [17]. They are progressively focused on the concept of collaboration as a tool to improve development processes, integrated in web-based environments. In contrast, current modeling tools lack utilities intended for the teaching of Software Engineering [18].

Considering that software engineering requires more and more group participation, and as systems become more and more complex, this implies greater organization and management to achieve better results. In academic environments, it is necessary to use CASE modeling tools, which allow to support at least one standard modeling language that helps to simplify both the communication and the documentation of the system under study. Nowadays, current modeling tools lack utilities for the teaching of software engineering [19].

V. UBIQUITOUS CASE- CL MODEL

Taking all the previous concepts of CSCW, CSCL, u-CSCL and CASE tools as we can see in Fig. 2, and considering the teaching of Software Engineering (SE) as a multidisciplinary work involving pedagogy, psychology, informatics, and Information and Communication Technology (ICT), we propose an integrative model, called Ubiquitous-CASE Collaborative Learning (uCASE-CL) [20].

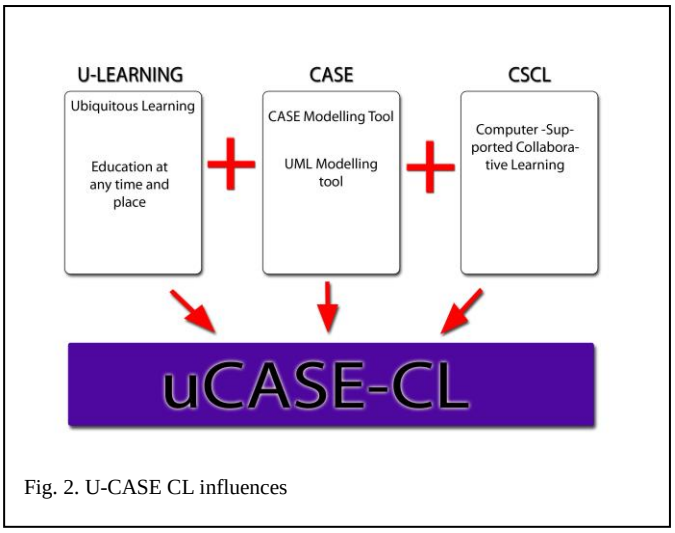

Fig. 2. U-CASE CL influences

In addition to the five components mentioned by Coto previously in [14], there is a need in the case of SE's for specific tools and assessment activities. Then, this model (Fig. 3) comprehends the following components: 1). U-CASE-CL 2) Technology platforms. 3) Access Services. 4) Collaborative Technology Platform. 5) Roles (Teachers and Student). 6) Subject-matter contents 7) Learning Objects. 8) CASE Modelling tool. 9) Evaluation 10) Collaborative Activities and 10) Guide to define collaborative activities.

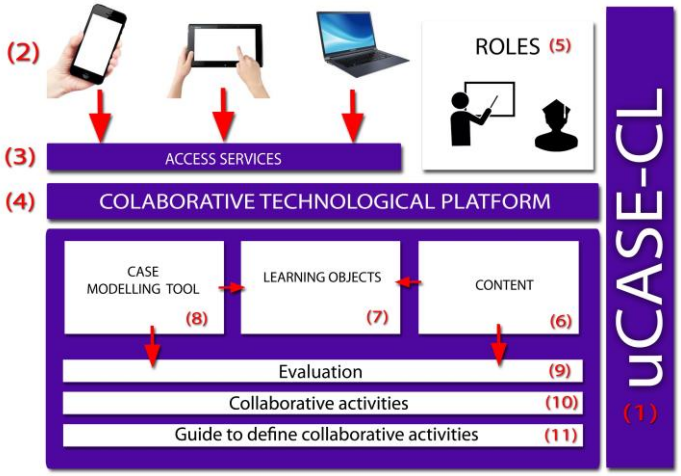

Fig. 3. U-CASE CL model

In the upper layer, ubiquitous access is represented by different types of platforms (2). Access Services (3) represents the technological paradigm, related with the ICT's, on which ubiquitous teaching is supported. The Collaborative Technology Platform (4) is a level of abstraction that encapsulates the technology that provides the collaborative services, where teachers and students are supported to carry out the collaborative activities.

The CASE tool (8) and the subject-matter contents (6) represent the foundational elements of the teaching environment. Together they constitute the learning objects (7).

Both CASE and learning content tools must also have evaluation tools. In the model, the evaluation is linked to the UML modeling, so it is important to define Evaluation Activities (9), such as collaborative evaluation, self-evaluation and automatic evaluation.

Finally, there is a level of abstraction that represents the group of Collaborative Activities (10), this corresponds to the psychological part of the CSCL model, since is here that we work with all the collaborative activities, using predefined instructions (11). This abstraction represents and supports the psychology of social activities, in this case between teachers and students (5).

VI. UAI CASE

UAI Case (Fig. 4.) is an implementation of the uCASE-CL model, allows to exploit to the maximum the benefits of the collaboration applied to the teaching of SE for the creations of software models and their integration with the face-to-face traditional academic environment, in order to support teaching, monitoring and evaluation within this specific area of knowledge [21].

This project enhances the work of curricular integration developed in the Facultad de Tecnología Informática of the Universidad Abierta Interamericana (UAI). By this tool, students will be able to acquire and use the concepts of modeling and software engineering in a collaborative project that will evolve, iteratively and incrementally, from the first years of the academic cycle [22].

We identify three dimensions of project:

A. Technological Dimension

The technological dimension is given by the specification of the deployment model of the solution raised in UAI Case. In this model, we specify the technology required to achieve a ubiquitous collaborative environment that meets the requirements set out in the uCASE-CL specification. The implementation of all aspects related to this dimension was done in virtual servers financed by IBM in the framework of an academic agreement between the company and the UAI, in which they granted credit to use their infrastructure called Softlayer [23] which is renewed every six months based on the progress of the project.

B. *Pedagogical dimension*

In this dimension, we propose the training activities and those of the SE teaching model, in relation to the collaborative processes that define them. In addition to collaborative activities such as a chat channel, a to-do list or an internal messaging, we consider the following as recurring and important activities:

1) Free collaborative UML modeling.

This activity is done in the modeling tool, in a project shared among a group of students. The goal is to make a UML model among all participants in a freeway, that is, all participants can interact deliberately but without any coordination. In this process, the freedom of each user to participate in the modeling with the information of who is participating and which component is selected by each is highlighted.

2) Coordinated UML modeling.

It corresponds to the realization of a UML model based on the coordination of the work group.

3) Collaborative evaluation of UML models.

An evaluation technique based on the collaboration between teachers and students using a forum as a collaborative communication tool [24].

4) Collaborative self-evaluation of working groups using rubrics.

Team self-evaluation based on the use of rubrics [25].

C. *Psychological Dimension*

In order to develop the collaborative activities involved in the teaching and learning processes mentioned, we use a specification technique proposed by Rodríguez in [26], focuses on the diagnosis of the task, evaluation of the activities that compose it, decomposition of each one to reduce the complexity and finally validation of the design to evaluate its effectiveness.

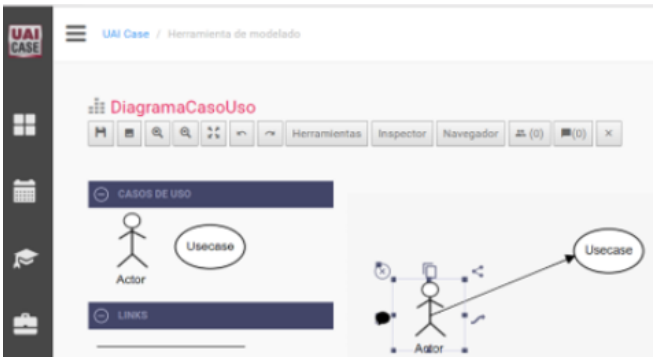

Fig. 4. Screenshot of UAI CASE

VII. CONCLUSIONS

Nowadays, there is a tendency to replace face-to-face courses with a mixed or blended learning environments.

This requires, without any doubt, a change in teaching paradigms, as there is a substantial change in the roles of the teacher and the student. This change occurs in a context modified by the disruption of ICT and the possibility of exploiting the concept of collaborative work in virtual teaching and learning environments.

Other points to consider are those related to the evaluation and monitoring of work, particularly, in the areas of knowledge proposed by SI. For this reason, we consider it is important that the integration of a collaborative academic environment with a specific tool requires formal aspects, and for this reason we present the uCASE-CL model, where we describe a conceptual model to support it. When formalizing, this model may be applicable to different areas of knowledge, such as the teaching of the UML modeling process or, for example, during the teaching of databases, code creation, or any other area where the use of these tools is required.

An implementation of the model, UAI Case [21], still in prototyping phase, will try to give students a collaborative environment to develop a shared project. We look forward to keep developing it.

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