

# Fostering Collaborative Work between Educators in Higher Education

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**Abstract**—This paper presents the architecture that supports the collaborative model ACEM (Advanced Collaborative Educational Model) to assist educators in the collaborative design of learning activities, supported by a high-level graphical tool. ACEM embraces the research areas of Computer Supported Cooperative Work (CSCW) and Learning Design (LD). Some facilities are considered in order to implement the online interactions between educators, namely a shared whiteboard and a conversation room. A workflow descriptive model of the educators' teamwork is also introduced.

**Keywords**- collaborative design of learning activities, learning design, educators' online teamwork, executive activities, knowledge sharing, high-level graphical tool.

## I. INTRODUCTION

One of the most crucial and recurrent educators' tasks is the preparation of both educational content and learning activities. Every school year, this process is performed with the necessary adjustments. To complicate a little more, three other issues can be introduced. Firstly, in higher educational institutions it is very common to have multiple formats of classes (e.g. lecture, practical, laboratorial and tutorial classes) associated to one discipline, contributing, in this way, to a more complex and careful planning. Secondly, it is the educators' team's stability assigned to a discipline. An educator that has just entered in an earlier formed team needs to be involved in teaching-learning tasks and participate in them as well. Thirdly, the delivering process of educational content is still very conventional, that is, normally, learning management systems are used to deliver the educational material but its reuse is not a very valuable concern in the educators' community [1].

In many organizations, the collaborative work has been readjusted to new demands of our era (e.g. [2] [3] [4]). However, in the educational sector, this practice between educators has a long way to go. There are several reasons that can be pointed out. Firstly, the educators have, in general, some difficulties in sharing knowledge and pedagogical experience. Secondly, the reuse of content material is not yet a common practice. Finally, educators who are excited about new digital technologies are often seen as not pedagogically effective [5]. Caution, time restrictions and curriculum content [6] are some usual justifications for this professional behavior.

To facilitate the coordination of educators' work in respect to the preparation of learning activities as well as their reuse, we introduce the ACEM model to assist educators in the collaborative design of those activities. This environment considers two important facilities, namely a shared whiteboard and a conversation room. The first one aims at providing a design area where a plan of learning activities can be conceived. The online conversation facility, in turn, provides a means of exchanging knowledge and educators' points of view while developing a learning design.

To accomplish the mentioned goals, knowledge from two important research fields is embraced, namely Computer Supported Cooperative Work (CSCW) and Learning Design (LD).

The motivation inherent to this project stems from the scarcity of high-level graphical tools to enhance teamwork between educators in order to get them more involved in the collaborative design of learning activities. This way, we intend to conceive appropriate mechanisms to foster coordination, discussion, sharing knowledge and reuse of such activities. This field has aroused a lot of interest in the e-Learning community since last decade but there is still a lot of work to be done in that issue. Besides, other aspects of graphical tools have recently been earning great importance, namely sharing, collaboration, and diversity of pedagogical methods.

The remainder of the paper is organized as follows. In section 2, we introduce the underlined main concepts of CSCW and LD research fields. The ACEM features and functionalities are presented in section 3 along with its general architecture. The conclusions and future work are presented in section 4.

## II. RESEARCH VISION: FROM COMPUTER SUPPORTED COOPERATIVE WORK TO COLLABORATIVE LEARNING

### A. Computer Supported Cooperative Work

The research field of computer supported cooperative work (CSCW) emerged in the 1980s joining researchers from different fields of science, namely computer science, information science and social science. There is no single definition concerning CSCW term, however its general purpose is about the study how people work, and the technology's role in the work environment [7] as well. As an example of a

CSCW description we introduce the following: "CSCW is concerned with understanding social interaction and the design, development, and evaluation of technical systems supporting social interaction in teams and communities – or in other words it is about researching the use of computer-based technology for supporting collaboration"[8]. Two research domains are very linked to the CSCW field, on one hand, the technology and computer hardware and software domain and on the other hand, group work and social phenomena domain [8].

The CSCW field deals with a series of questions related to the inherent problems it in general introduces, namely: "What characterizes cooperative work?; How can we model cooperative work?; Which computer facilities should be provided?; And what are the basic characteristics of useful platforms for CSCW-systems?". The answers are not simple rather very complex depending on the problem we are faced with (see [9] for a good overview).

In a more physical point of view, CSCW technologies can be described by means of a matrix (2\*2) crossing two measures of dispersion: time dispersion (synchronous vs. asynchronous communication) and geographic dispersion (distributed actors vs. non-distributed actors). Concerning synchronous communication, several facilities can be embraced, for example: shared whiteboards, video conferencing systems, collaborative writing systems, chat rooms. As asynchronous communication' examples the e-mail and forum services are very common.

Concerning the type of formalization and implementation different approaches can be found in this field. It can vary from a more formal construction of a system (Distributed Artificial Intelligence scope) to a more informal approach (Cooperative-Supported Collaborative Work (CSCW) scope). These mainstreams have different requirements and goals, which should be considered carefully.

### *B. Learning Design and Collaborative learning*

Learning design can be described [10]: "as the application of learning design knowledge when developing a concrete unit of learning (UOL), e.g. a course, a lesson, a curriculum, a learning event". The meaning of learning design knowledge is transmitted by a series of prescriptive rules with the following format: "if situation, then method". The left-hand side of the rule is the learning situation which accommodates the situational factors. The main objectives of these factors are twofold- firstly, they may represent the requirements that any new learning design method has to meet – secondly, they can be seen as descriptors of the situation in which an existing learning design method has been applied. The term situation factors is justified by the assumption that one method may behave best in one situation whereas one other method may behave best in a different one. Learning outcomes and learning conditions are the two subclasses of situational factors. The former is related to the level of effectiveness, efficiency, attractiveness and accessibility of the learning design method. The latter is related to the characteristics of some elements, such as the learning objective (knowledge, skill, attitude, competence), the learners (pre-knowledge, motivation, situational circumstances), the setting (individual and/or group work, work at school and/or work and/or home) and the media

(bandwidth, synchronous/asynchronous, linear/interactive, media types) [10].

Concerning the aforementioned learning design method, it describes basically a teaching-learning process. This process has several components, namely metadata, roles, plays, acts, environment, role-parts, sequence of activities and conditions. This conception may be compared to a script of a film or a theatrical play. The comparison is self-explanatory.

It is worth stressing that the term learning design is used to describe a learning experience supported by tasks to which students should be engaged to. For example, students may be formed into groups and required to discuss the relations between two given topics; they may be asked to gather some information about a theme and then write a report.

The collaborative learning design, in turn, emerges from the learning design field attracting much interest from the research community since the last decade. This specific field has potential to promote high level collaborative environments in educational settings [11]. The main features that drive these environments are the learners-centered approach and the support by learning theories, namely the constructivist branch, which claims that the learner should have an active role in his/her knowledge construction. Consequently, the diversity and nature of learning design have evolved accordingly [12] [13]. On the other side, the technological innovations in different fields of science are fostering the development of dedicated frameworks to assist learners in the development of their skills and knowledge. CSCL (Computer-Supported Collaborative Learning) systems make part of that group of frameworks serving as a great platform to deal with different models for knowledge creation, accumulation and sharing [14].

In this research domain, other relevant concept is learning activity. There is no single definition concerning this concept. We introduced the following definition as a good example to frame this issue: learning activity is "a specific interaction of learner(s) with other(s) using specific tools and resources, orientated towards specific outcomes" [15].

Four components are associated to learning activity:

- **Learner(s):** This component combines identities (preferences, needs, motivations), competences (skills, knowledge, abilities) and roles (approaches and modes of participation).
- **Learning Environment:** The focus is tools, resources and services.
- **Learning outcomes:** It comprises new knowledge, academic and social skills, and abilities.
- **Other(s):** Other people involved and the specific role they play in the interaction, e.g. support, mediate, challenge, tutor and guide.

The range of pedagogical approaches to the learning design process should be of a large spectrum using different perspectives on learning. The Associative, the Constructivist (individual and/or social focus) and Situative perspectives are considered a helpful support to create and sequence learning activities [16]. The learning outcomes to be achieved underpin

the pedagogical decisions that educators should reflect carefully.

Concerning the tools for supporting educators in the design of learning activities, several examples can be mentioned, namely RELOAD[17], CopperAuthor[18], CoSMoS[19], MOT+[20], ASK-LDT[21], COLLAGE[22] and LAMS[23]). Briefly, the first three set of tools are general purpose systems more oriented to LD experts than teachers. MOT+ and ASK-LDT tools provide a graphical representation approach and their audience is also practitioners in LD. With regard to COLLAGE[24] and LAMS, they are graphic-based high-level tools more oriented to help teachers developing collaborative learning scenarios. In general, the reuse and sharing of learning activities are two of the most important features underlined to those tools.

One core feature we intend to introduce in this type of tools concerns the possibility of a group of educators to design learning activities supported by synchronous and asynchronous facilities. The main goal is to promote an online and interactive environment in order to assist educators in the preparation, discussion and design of all details of such activities, being these steps embraced in what we call being a project.

Finally, the features of such collaborative work environments may vary considerably and some important decisions need to be considered. The type and sequence of steps a group of educators are allowed to perform, the type of support, the level of adaption, flexibility and personalization one intend to implement are some examples of important issues to reflect on.

### III. THE MODEL DESCRIPTION

#### A. The context

The educational settings we frame this work are the Higher Education Institutions. It is very common in these institutions to have multiple formats of classes (e.g. lecture, practical, laboratorial and tutorial classes) associated to one discipline. Those different classes force, in general, to allocate several educators to the same discipline which depends on several issues, namely the number of students enrolled as well as the number of students allowed for each type of class. The complexity of coordination of the educators' teamwork concerning the design and deployment of all learning activities can therefore vary considerably. Several constraints should be taken into consideration in order to plan the design of learning activities among different classes and to coordinate properly teaching activities, namely:

- The type of classes;
- The number of educators allocated to one discipline;
- The pedagogical methods and techniques to be carried out;
- The expectation of reusing both the contents and learning activities.

Traditionally, this type of educators' tasks is engaged in the beginning of an academic semester and some face-to-face meetings are carried out from time to time to discuss teaching

issues. From our experience, we know that the educators' tasks go beyond the preparation of lessons, doing some work in the coordination of projects, invited talks, participation at conferences, paperwork, among others, and consequently face-to-face meetings are sometimes very complicated to schedule.

To face with the above constraints, collaborative work between educators supported by computers with synchronous and asynchronous facilities may be a good complement to the traditional approach of learning activities design. The proposed model of collaboration aims to tackle the mentioned constraints as will be explained in the following sections.

#### B. Strengthening teamwork

Teamwork between educators has already a long way, however, the use of high-level graphical tools to foster collaborative design, teamwork coordination, interactive discussions, and sharing and reusing of all type of educational content are not so well developed.

The proposed ACEM model aims at responding to these concerns. This model will be supported by a high-level graphical tool where a specialized shared whiteboard has a core role in order to facilitate the collaborative design of the learning activities. A chat facility is also an important feature we consider in the teamwork environment.

A list of sub-goals is now presented:

- The development of an educational system more specifically a high-level collaborative graphical tool. This authoring environment owns several facilities, namely a specialized shared whiteboard to assist teachers in their learning design tasks.
- The conception and maintenance of a digital repository to keep educational resources (Educational Resources Repository – ERR), namely learning activities, multimedia items (e.g. texts, graphics, images, videos).
- The conception and maintenance of a digital repository to keep learning activities templates. These templates should follow good teaching-learning techniques that teachers may reuse to develop their own designs.
- The construction of a searching mechanism to allow educators to seek learning activities as well as educational resources based on a multi-criteria process. To accomplish this goal, tags and domain ontologies will be considered in order to achieve a more efficient recovery of learning designs. The tags are written by educators. This information aims to reflect educators' experience in the teaching-learning process.
- The creation of a tool to translate the learning activity design to an intermediate language. From this point, other tool is envisioned to produce the translation of the learning activity written in that intermediate language to an e-learning specification.

Some features of this graphical tool need to be accomplished, namely the design of learning activities should be intuitive, adaptive, easy to develop and supported by good teaching-learning practices. Furthermore, the automatic

translation of the learning design conceived by the group of the teachers will be codified to an intermediate modeling language, to be defined, focused on specifications but at the same time, maintaining some independence. An additional tool will be devised in order to create the final translation of the learning activity design based on the output of the intermediate language phase. Concerning this issue, the well-known IMS-LD specification and the SCORM (Sharable Content Object Reference Model) reference model are both highlighted.

To facilitate the searching and maintenance procedures of a repository of learning activities and resources, tagging collaboration and ontologies are considered. The former allows a practical human contribution based on the experiences of the teachers. The latter consists of a very important framework to represent entities and their relationships, and consequently, useful to produce new knowledge to help in this trend.

An overview of ACEM is presented in Figure 1.

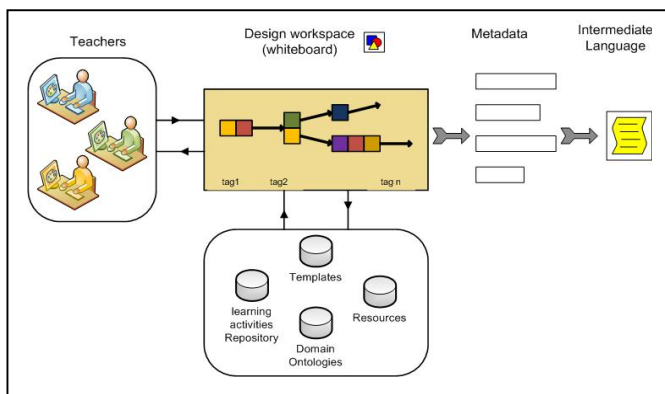


Figure 1. An overview of ACEM model

As mentioned before, our model is sustained in a set of ideas that we believe they are relevant for a collaborative learning environment oriented to teamwork between educators.

### C. Overall workflow

There are several issues that teachers might think about when preparing learning activities, such as learning outcomes, teaching-learning techniques, contents, remedial procedures and multimedia elements. These educators' activities we named executive activities and may be proposed "on fly" as they are working on the graphical tool. Other issue is the allocation of these executive activities to each educator that belongs to the team. When allocated, the educator will be responsible for its execution. The allocation process will be explained later in this section.

Briefly, the overall workflow embraces five main phases:

- The initialization of a project by means of a high-level graphical tool where the collaborative design of the learning activities will be executed.
- The collaborative design of the learning activities itself.
- The proposal by the educators of the executive activities.

- The allocation of the executive activities to educators that belong to the project. In this case, a specific algorithm for this purpose will perform that task.
- Finally, the validation of the project, and consequently the creation of the final product, i.e. a unit of project (UoP) which is the name we have assigned to the final set of learning activities.

The initialization phase comprises several validations as illustrated in Figure 2. Firstly, the educator must be logged in order to start a project. The educator responsible (IE) for the initialization of a project (IE) needs to enter some relevant information, such as a description of the project, objectives and the identification of educators that will participate interactively in the project as well as their privileges. Other educators are allowed to participate in the project during the collaborative design phase but as guests only. A project can also be opened instead of being initialized. Two main reasons underpin this functionality. One reason is the continuation of a project that it is not yet finished. The second reason concerns the reuse of the learning activities designed in other project.

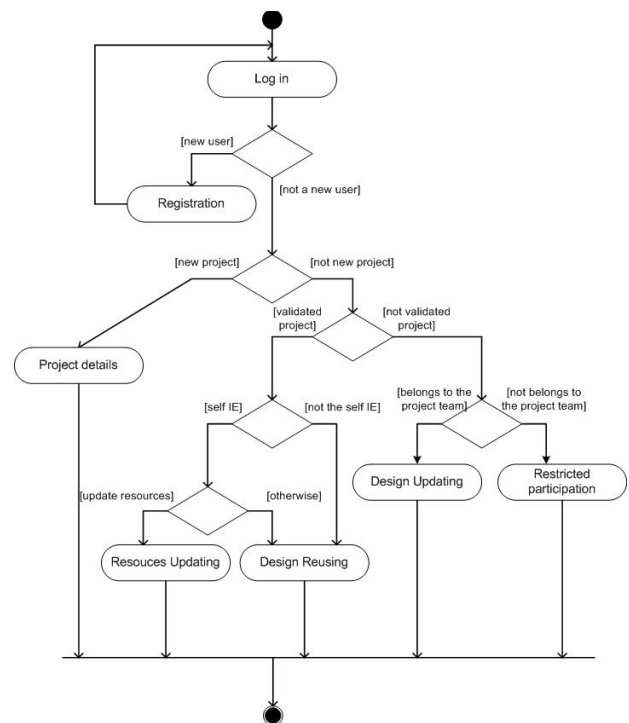


Figure 2. "Initialization of a project" activity diagram

The privileges associated to an educator that initializes a project are: to assign privileges to other educators in the project; to participate in the design of the UoP; to participate in online discussion; to propose executive activities "on fly"; to negotiate with other educators/participants the assignment of executive activities; to add and eliminate executive activities from the project; to check the status of executive activities; to validate and close the project; and to reopen a project already closed.

Concerning the privileges for other educators that were added to the project by the IE, it is IE's responsibility to decide about "who can do what", and therefore to assign the privileges accordingly. The participants who will join later on in the project they are allowed to participate in the online discussion only.

In the collaborative design phase all educators that are logged in the graphical tool may interact, discuss perspectives, suggest learning activities and flows, design in the shared whiteboard those activities, among other related tasks. To facilitate the use of teaching-learning techniques, educators may use some available templates (e.g. brainstorming, inquiry-based learning, assessment templates) provided for the graphical environment. From these templates, the collaborative design can then take place more easily. Nevertheless, educators may opt for designing from scratch (i.e. void template).

As mentioned earlier, the learning activities are defined "on fly", i.e. during the development of the project. These activities are maintained in a database and can be reused in other projects as well. The characterization of each activity involves multiple attributes, such as description, objectives, roles and support tools.

The third phase is related to the proposal of the executive activities that should occur online. This proposal emerge from the educators' points of view and it may embrace a variety of different assignments, such as the preparation of a multiple choice test, a video, an image, a text, among others. These type of assignments aims to support learners' activities.

The allocation of those executive activities to the participants in the project is the next phase. It aims at involving educators in cooperative work in order to get all educational material prepared to learners. The automatic allocation mechanism takes into account the following information: the proponent of the executive activity, skills, interests and teaching experience of the participants/educators. The allocation procedure can take several iterations. The first iteration is performed automatically. An algorithm will be conceived for that purpose. If all participants agree with this first plan, the allocation process is closed. Otherwise, the educators need to negotiate the assignment of the executive activities until an agreement is reached. The graphical tool will provide a chat facility to support online discussions between educators. We assume that assignments can only be allocated to educators that are online in order to prevent disagreements at another stage.

As each participant finishes her/his executive activities, (s)he must sign it in the graphical tool environment. The executive activities that are finished can be visible to all educators that belong to the project.

Finally, the validation phase is the IE responsibility who should verify whether the executive activities are finished. After this step, the learning activities design can be translated to a final language in order to be exported to a proper learning management system. We are considering the UoP being translated to a language based in the IMS LD specification.

#### D. General architecture

Three main modules form the basis of ACEM architecture as depicted in figure 3.

The user model (UM) keeps information related to the educators' profiles. Those profiles encompass both personal data (e.g. educator' name, date of birth, nationality, educational qualifications, preferences and interests) and teaching related data (e.g. institution, research areas and teaching experience).

In relation to the pedagogical model (PM), there is a hierarchical representation of the following concepts: teaching-learning techniques (e.g. brainstorming, inquiry-based learning and assessment) and learning activities to be accomplished by the students. We consider useful the use of templates to represent the teaching-learning techniques in order to facilitate the design of learning activities to be conceived by a group of educators.

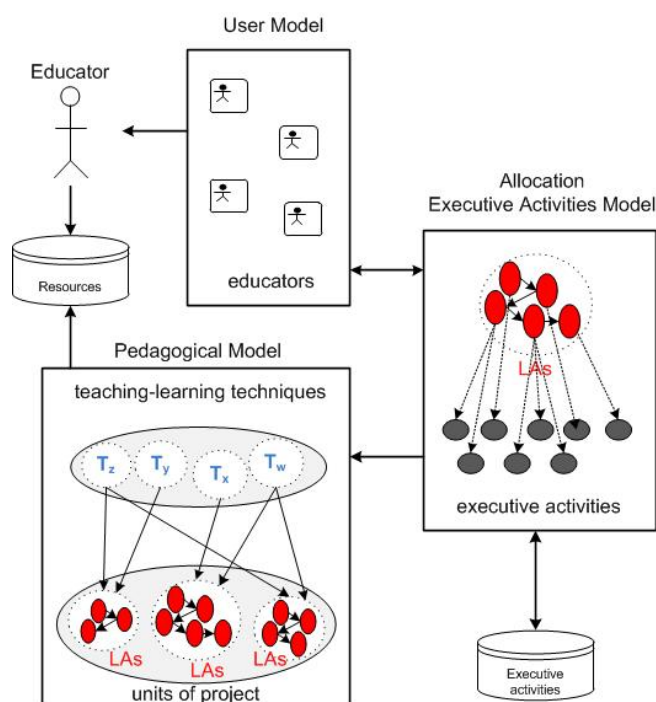


Figure 3. General architecture of ACEM

Finally, the allocation executive activities model (AEAM) is responsible for putting in practice the "divide to conquer" practice, i.e. it will allocate the set of executive activities that were assigned earlier to each educator participating in the project. As mentioned before, this procedure is based on several data, namely the proponent of the executive activity, skills, interests and teaching experience of participants. The allocation process may have several iterations, however the first one is performed automatically whereas the following ones, if exist, are carried out in online mode by the educators until they reach an agreement. The extract knowledge of the final agreement will be used to update the educator's profile.



#### IV. CONCLUSION AND FUTURE WORK

In this paper we present a collaborative model for the interactive design of learning activities. To facilitate the coordination of a group of educators' work as well as the reusing of this type of activities, we introduce the ACEM model to assist educators in that task. The output of the interactive design is named unit of project and it joins the learning activities themselves conceived by the educators in an interactive approach. A high-level graphical tool is being developed to support all the necessary workflow. This environment considers two important facilities, namely a shared whiteboard and a conversation room. The main goal is to promote an online and interactive environment in order to assist educators in the preparation, discussion and design of all details of such activities. The main features of ACEM were introduced along with the underlined workflow and the general architecture.

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