CLPMtool - Collaborative Learning Project Management Tool for Moodle

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***Abstract*—Collaboration is an essential element of teaching-learning process. Nevertheless, it does not happen without the presence of coordination mechanisms. Considering that information technology is relevant in supporting group coordination, a software that promotes and assists the coordination of collaboration was developed. The software is based on a coordination framework that permits the definition of flexible collaboration scripts. The students are the authors of their collaboration models. This paper describes a tool (CLPMtool) that was created as a plugin to be attached to Moodle learning management system (LMS). It can favor collaborative learning by organizing group work respecting the particular characteristics of each learning scenario.**

Keywords-collaborative learning; project management; scripts.

I. INTRODUCTION

The promotion of collaboration towards learning is considered an essential educational procedure. According to Johnson et al [1], cooperation, compared with individualistic efforts, tends to result in higher achievement, greater long-term retention of what is learned, more frequent use of critical thinking and meta-cognitive thought, more accurate and creative problem-solving and more willingness to persist in working. For Soller [2], collaborative learning brings benefits to the cognitive process, encouraging students to ask questions, to explain their opinions, articulate their reasoning and reflect on their knowledge. Fischer et al [3] emphasize that collaborative learning prepares students for the challenges of contemporary society.

For Henri et al [4], collaborative learning is not a learning theory, but a journey towards the progressive construction of knowledge. According to Bostrom et al [5], collaborative learning is a strategy that encourages students to work together in order to accomplish shared learning outcomes. Qi et al. [6] consider that collaborative learning refers to methodologies and environments in which learners engage in a common task where each individual depends on and is accountable to each other. Resta et al [7] use the definition that collaborative learning is a process where two or more people learn together.

One can notice common characteristics in the published writings of the authors who were previously quoted. For all of them, collaborative learning is a practice that demands an active participation of the student in his own knowledge building. The apprentice is the main subject of his development because he learns while he is eliciting his ideas as part of a group, listening to other explanations, reformulating rationales, and contributing to others' development. He is not someone to be taught, he is the leading figure of the whole learning process. According to Stahl [8], in collaborative learning, the teacher becomes a facilitator of knowledge building, supporting and directing its construction. Schneider [9] employ expressions like "facilitator", "manager" and "orchestrator" when he is referring to the teacher's role. Resta et al [7] accentuate that the teacher is a facilitator instead of a "sage on stage". Henri et al [4] express this change in the roles of teachers and students by emphasizing that the collaboration journey is characterized by more egalitarian relationships between all learning actors.

Stahl et al [10] sustain that learning happens through interactions among students. They learn by expressing their questions, pursuing lines of inquiry together, teaching each other and seeing how others are learning. Morishima et al. [11] summarize, in a simple formula, the benefits of using a collaborative learning environment through the expressions "learning by teaching" and "learning by observation". Collaborative learning is indeed a process, a pathway, a dynamics of new knowledge construction and validation.

Collaboration depends on coordination. According to Henri et al [4], to coordinate is to effectively manage activities, people and resources for a particular purpose. They affirm that collaboration requires the coordination of the activities of the members of a group, and coordinating the resolution of a problem is to split it into subtasks, to assign responsibilities, and to utilize resources. For Lewis et al. [12], coordination is the act of working together harmoniously, which consists in overcoming conflicts. The organization and management of activities of both large groups and small groups should be facilitated so that learning happens in harmony and efficiently. Kim et al [13] consider that correct coordination work allows group members to have accurate mutual understanding about their tasks and team, and consequently, to successfully achieve their final goal.

Researchers who study such subject attest the need do coordinate collaboration. Collaboration and coordination are inseparable concepts when related to learning. Computer Supported Collaborative Learning (CSCL) literature presents coordination as an imperative element to build harmonious and productive collaboration [14]-[17]. The distribution of learners in a group and the assignment of a task to them do

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not guarantee that learning-effective collaboration will occur [18]. Collaboration is not a trivial activity. It implies interdependence among participating students, and such interdependence necessarily demands coordination of actions [19].

Hermann et al [20] affirm that coordination is central for the quality of the problem-solving process and its outcome. According to Henri et al [4], collaboration necessitates the coordination of group activities. Malone et al [19] sustain the idea that it is easier to notice the need for coordination when it is absent. Coordination absence may lead to unclear task assignment, lack of time management, redundant work and resources, unshared resources and dissatisfied students [13].

Due to the essential role of coordination in collaborative learning, it is important to develop technological solutions to support it [13][17][21]. Considering the benefits brought by collaborative learning and the fundamental need of coordinating collaboration, we have sought to develop a coordination framework suitable for learning context and a tool that implements this framework. The coordination model was introduced in a previous paper [22]. While that paper described the proposed coordination framework, this one describes the tool that was deployed.

In Section II of this paper, the coordination scheme is discussed, showing the necessity of a collaboration script but proposing self-constructed models. Section III describes the software developed. Conclusions are presented in Section IV.

II. COLLABORATIVE LEARNING COORDINATION

A. Flexible collaboration scripts

Given that coordination plays a key role for the success of the collaborative learning process, it is necessary to promote it. One way to promote it is to create explicit mechanisms that force people to organize their work. Even unconsciously, students and teachers structure the way they interact over collaborative activities. They define long term and short term goals, organize intermediate tasks and determine the necessary resources to achieve their objectives. But if we want to promote coordination, we cannot rely on the initiative of individuals. We need to support coordination of collaboration.

Many researchers advocate the use of collaboration scripts [23][24] as a method of conducting the collaborative process. Coordination is established by a script that rules the activities of the group members. However, the use of default scripts, to some extent, deviates from the idea of true collaboration because it can disrupt the natural process of solving a problem [25]. Heinze et al [26] assume that either an unguided approach to coordination or a very structured one can lead to undesirable effects in a learning community. Schneider [9] reaches the same conclusion when he addresses projects and implementation of pedagogical scenarios. According to him, teachers have to find a balance between student freedom, which is necessary for intellectual development and motivation, and certain guiding principles, which are indispensable to keep collaborative tasks running. According to Dimitriadis et al. [27], there is a growing concern of CSCL researchers on how to design coordination mechanisms and maintain the flexibility of scripting. The effectiveness of using scripts is a highly controversial topic [28]. Haake et al [29] have found no general advantages in the usage of scripts concerning acquisition of knowledge.

One of the greatest challenges regarding the coordination of collaborative learning is to establish a balance between the freedom of students and the power of intervention of teachers. The responsibility of the coordination of activities in collaborative learning is not an exclusive assignment of the teacher. Carell et al [30] affirm that while the definition of the task and its presentation can mainly be carried out by teachers, the plan of the collaboration process has to be developed by the students themselves as opposed to being delivered to them. Even though the primary objective of a collective work is usually given by the teacher, the steps to accomplish this goal are usually defined by the group members. Intermediate tasks are defined, with deadlines and products. Often, the group needs to review the process of knowledge collective construction and decide for new directions. This more refined planning of how collaboration will take place is essential. Without it, the attainment of the ultimate goal is uncertain.

The creation of subtasks permits that students initiate their planning by defining more abstract phases and make successive refinements of these phases, creating, each time, more specific definitions. Collaboration is a cyclic process [31] and this kind of top-down task definition makes explicit this constant renegotiation. Every renegotiation conducts to new tasks. These mechanisms should not be considered as inhibitors to the collaboration process since the preparation of the collaborative work carried out by those who will collaborate facilitates the accomplishment of the intended goal. Those who plan will have a better understanding of what was planned and, as a rule, a stronger commitment to the activity.

Considering that learning is essentially a social process [32], collective planning itself is an opportunity to learn and to develop learning skills. Those who are not capable of planning an activity by them will do it with other's help and will acquire a new knowledge. During task definition, students interact, new concepts may be internalized, and common ground is created facilitating project development.

If the use of scripts can be an obstacle for collaboration to prosper, it is reasonable to consider the use of a computer system to support a coordination schema that produces multiple collaboration arrangements not restricted to a particular model. Students should be able to structure collaborative process with a high level of autonomy. They should be able to dynamically build their own collaboration model. The teacher, on the other hand, should be authorized to intervene in those situations that he diagnoses as prejudicial for learning. A tool whose purpose is to facilitate the coordination of collaborative learning must make students the leading actors of the process, promoting the emergence of a reflexive, critical, argumentative and autonomous thought on reality. At the same time, it must create conditions for the teacher to monitor the process and

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to realize the best moment for imperative course corrections, aiming collaborative learning.

B. Proposed framework

As students need to organize how they will collaborate to learn [4][14]-[19], one could carefully observe coordination mechanisms used in corporate groupware as an alternative to support collaborative learning. Project Management Tools, found in corporative groupwares, may help to make learning management systems more efficient on issues related to the coordination of collaboration due to the fact that they pay special attention to coordination aspects of collaboration, such as problem organization, task assignment, deadline setting and activity progress tracking.

Schmitt et al [22] proposed a coordination framework. The main characteristic of that framework is to allow students and teachers to create collaboration scripts (or models) tailored to specific learning scenarios. It has two basic assumptions: students have an active participation in the organization of collaborative learning and project management tools can be used to support the coordination of collaboration in educational contexts. Through project definition and task organization, students and teachers coordinate collaboration and create a script that is more adequate for achieving specific goals.

III. CLPMTOOL

A. Reasons to deploy a Moodle plugin

Currently, learning management systems are used both in distance learning programs and in on-site classes. In the first case, they are essential means to managing courses, allowing communication among students and teachers, deploying of learning objects (texts, hypertexts, videos, simulations, games, exercises), and organizing courses (registration of students, participation assessment, grades publication). In the second case, they are used as a support tool for the on-site activities, allowing communication at any time, and publishing of learning resources that lead to the consolidation and deepening of what is learned in the classroom. Thus, learning management systems are, increasingly, becoming well know environments to students and teachers.

Stahl [33] asserts that CSCL artifacts must be built, among other things, to support and structure collaboration. Although there are free project management tools that can be used by any community, the dissociation between the learning management system and any tool used to coordinate the collaboration can hamper the learning process. A first case study [22], which used Egroupware [34] as project manager software, revealed that the use of two different environments brings difficulties for students, especially with regard to the process of learning to use a new user interface. This same case study indicated that the intended coordination framework does not occur spontaneously. It is necessary, therefore, that the tool implements components that cause the organization of collaboration, that is, it must provide ways to make it clear to students and teachers the coordination phases that exist to execute collaborative activities.

The reasons given above led to the decision of building a project management tool integrated to a virtual learning environment. We opted for the implementation of a Moodle module since the institutions which researchers belong to use this software. It was also taken into consideration that a large community, present in several countries, could benefit from such module since Moodle is used in more than 83,000 sites, in at least 236 countries.

B. Plugin description

CLPMtool was developed based on the defined coordination framework. The tool consists of five modules (Figure 1):

a) Project Control Module - allows the definition of activities to be undertaken by groups of students.

b) Task Control Module Tasks - allows students and teachers to define and track tasks that comprise the activity.

c) Gant Chart Control Module - presents a graphical view of the development of the activity.

d) Forum Control Module - organizes group asynchronous discussion.

e) Chat Control Module - organizes group synchronous discussion.

The system uses features that are already present in Moodle. The modules that control project, tasks and Gantt charts use Moodle libraries that administer users and groups of the virtual learning environment. Thus, the management of users and groups is carried out by teachers the same way as they do in any Moodle block. The modules that control forums and chats use what is already available inside the environment, integrating everything and organizing groups of students

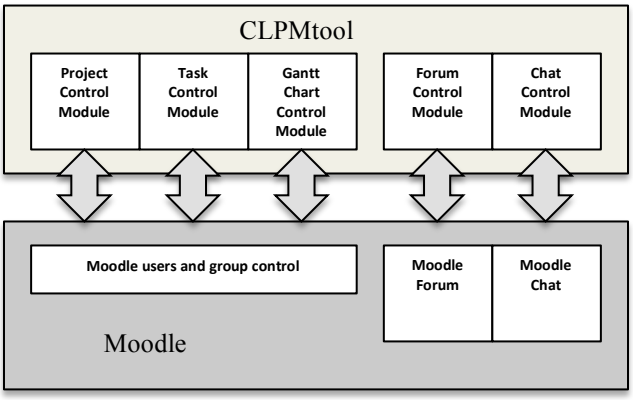

Figure 1 - CLPMtool modules

The plugin is used as any Moodle block. Teachers only have to enable it inside a course and perform an initial setup. This initial setup includes the following actions:

a) Inside the course / outside the block

a. Groups creation

b. Forum creation

c. Chat creation

b) Inside CLPMtool
   a. Initial activity definition
   b. Project deadline definition
   c. Forum and chat association.

Once the block is set, it can be used to assist in the coordination of collaboration. The coordination is accomplished in three phases:

a) identification by the teacher of a basic activity (really important for the student groups to define their projects);
b) definition by the groups of the projects that will be executed;
c) creation and control of task execution.

As proposed in the coordination framework [22], initially, the teacher defines an activity to be developed by the students. The students, in turn, build a collaboration plan in order to achieve the intended objectives. Although the teacher should not be the protagonist of actions, one cannot ignore his responsibility in identifying the skills and the abilities that must be acquired by the students, as well as the means to foster collaboration.

The plugin requires the definition of the activity to occur when the block is initially configured. This definition is a short textual instruction, accompanied by the start and end dates of the activity. It is up to the teacher to create a clear description of his intentions. That description must prompt students to build a collaboration plan. An unclear definition from the teacher may cause groups to make proposals dissociated from learning objectives. A very narrow definition will withdraw from the students the opportunity to establish how the collaboration will occur. In that case the chances to produce among the groups the emergence of argumentative writing, critical thinking, articulation of thought and autonomy will be reduced.

Students will be able to access the block and create their projects as soon as the plugin is setup by the teacher. The plugin is part of an environment already known and used by all students. Once the activity is created, each student will have access to the project of his own group. The plugin integrates in the same environment already known and used by students, the management of the project itself and the communication tools - forum and chat (Figure 2).

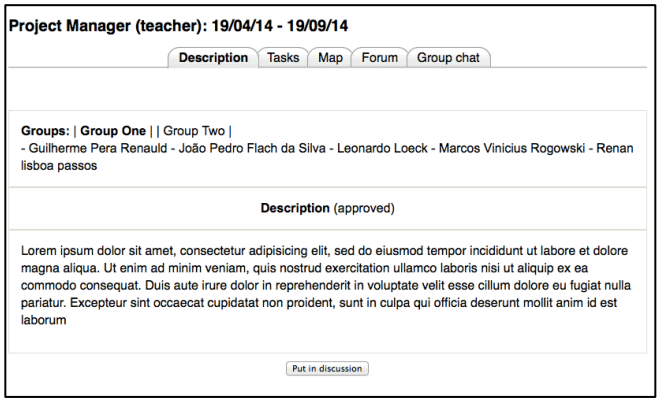

Figure 2 - CLPMtool project definition screen

That strategy seeks to establish a balance between an autonomous attitude of the students and an appropriate mediation of the teacher. The proposed project is a collective construction of students assembled under the mentoring of the teacher.

After defining a project, students detail how the objectives will be achieved. This is accomplished by defining tasks. Figure 3 shows CLPMtool screen that allows the definition of a task. Just like in a corporate project manager, deadlines and responsibilities are set, and the user can register and observe each task progress.

Students build a collaboration model best suited for achieving the intended goals through the proposed tasks. The plugin forces them to be authors of the collaboration script and they perceive themselves as coordinators of the whole activity.

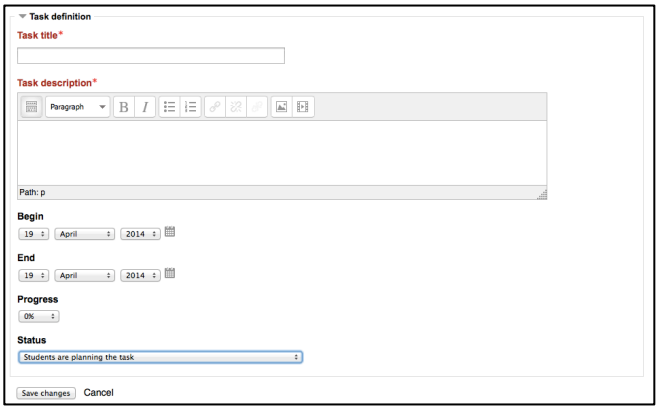

Figure 3 - CLPMtool task definition screen

In addition to the commitment of all involved - students and teachers - collaborative learning requires that group members have a common understanding of the objectives and the planned pathway to accomplish them. Macmillan et al [35] state that for a team to act harmoniously in order to achieve a common goal, this team should have shared information on the situation and on the other group members. In the process of knowledge construction, it is essential that all students become aware of the activities developed by their colleagues [36]. There must be a mental model shared by group members for collaboration to occur [13]. In this context, it is important that students and teachers are able to realize the defined collaboration script and to monitor the fulfillment of activities through time. It is possible to visualize the main plan of actions by clicking over the tab named "Tasks" (Figure 4). From this interface, users may

a) view the collaboration model that was built;
b) track the progress of the tasks;
c) identify each task status;
d) modify each task;

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e) edit tasks;
f) create new tasks.

CLPMtool makes it possible to define multiple collaboration models by implementing the proposed coordination framework. Aiming to promote collaborative learning, the software has mechanisms that drive user actions. For the actions of students and teachers to comply with the coordination schema, it is essential that students signal their propositions and teachers their reviews. In the case of project definition, signaling is done by changing the project state: "Students planning the project" or "project set". The current state is shown to the users with the textual definition. The assessment of the proposed project occurs during the planning process or after the students warn the teacher by some communication tool.

Managing a task is more complex. Because of that, we decided to implement a more explicit signaling mechanism, which would be more independent from the communication tools (forum and chat). It includes planning, tracking and assessment of tasks. Table 1 shows the many states that are signaled in order to define, execute and evaluate a task.

Depending on the context, students may perform different actions on the task. CLPMtool allows students to change the status of the task according to the defined coordination framework. For example, a planning task may be delivered by any student of the group to the teacher in order to be assessed. This will make the state and the associated icon to change to "Teacher assessing planning task." The same is valid for a running task that may have a change in its progress status or may be delivered to the teacher for evaluation. On the other hand, the group cannot change a task that is being evaluated by the teacher

It is also possible to follow the evolution of collaborative work through a Gantt chart. This type of chart, as well as the screen that summarizes task states (Figure 4), is fundamental for the group members to acquire the same understanding of what is being held. The coordination of collaboration requires a common understanding about the objectives to be achieved and the responsibilities of the group and of each of its members. Collaboration harmony, also obtained by proper coordination, depends on the understanding of all participants of the proposed dynamic and its progress in time. Graphical views always contribute to the realization of what is aimed and how far the target is.

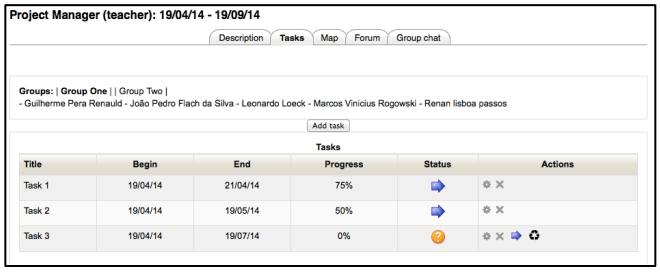

Figure 4 - CLPMtool task tracking screen

Table 1- Sates and icons used in CLPMtool to signal task status.

CLPMtool actions	Icon	Framework status
Students planning a task		Students planning a task
Students ask the teacher if the task is well planned		Teacher evaluating task planning
Teacher accepted task planning and students are executing it		Students executing the task
Teacher did not accept task planning and students are correcting it		Students planning a task
Students considered the task finished and the teacher is evaluating it		Teacher evaluating task execution
Teacher considered the task finished		The end
Teacher did not considered the task finished and students must redo it		Students executing the task

Finally, the plugin allows students to communicate with each other through a forum board or a chat room in the same interface. Communication via the existing tools in Moodle facilitates users exchange of messages. Besides that, the integration into the same workspace indicates to students and teachers the need to communicate in order to define and execute the collaboration model.

C. *Plugin coordination mechanisms*

CLPMtool permits students, with the assistance of teachers, to coordinate their collaborative activities. The various actions of users on the system correspond to the following coordination procedures:

1) Project description visualization

The visualization of project description is a coordination activity since they perform those actions during planning and execution phases in order to maintain a common understanding of the project.

2) Project description editing

Editing the project description indicates a stage in the process of building the collaboration model. The greater the group autonomy, the lower the participation of teachers in this action.

3) Project status update

Updating the project status marks the moment when the teacher believes that the proposal meets the learning objectives. It may also set the need for students to return to discuss their proposals. It is a coordination activity as it corresponds to an explicit indication of project status change.

4) Task creation

By adding tasks to the project, students detail the collaborative model that will be used in achieving the main goal. The greater the group autonomy, the lower the participation of teachers in this action.

5) Task editing

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When students edit tasks they are articulating and bethinking their proposals. It corresponds to an interaction with the intention of collectively constructing the collaboration model.

6) Task list view

When consulting the list of tasks, students and teachers are trying to better understand what was planned or being planned and how the project is progressing.

7) Task status update

Updating the status of a task corresponds to an explicit communication about progress in achieving the intended objectives.

8) Task removal

When a task is deleted, the teacher is mediating the coordination process and is proposing a change in the collaboration model.

9) Gantt chart visualization

When consulting the project Gantt chart, students and teachers are, once again, trying to better understand what was planned or being planned and how the project is progressing.

10) Forum and chat usage

When using the forum and chat tools, students and teachers are communicating to build a model of collaboration or to carry out the model created.

IV CONCLUSIONS

In order to evaluate CLPMtool, a case study was carried on. Three groups of students used the tool in a PHP course. The logs related to coordination activities produced by the software were analysed and the students were interviewed. All students found the tool useful to improve organization, control and communication in collaborative learning. Data related to task list view, and even Gantt Map view, indicated that students' actions did not limit to produce the requested planning like in the first experiment. Students used CLPMtool to get situated and to control the execution of collaborative process. Logs also revealed the distinct collaboration schemas produced by the coordination model. Those results were presented in [22].

This work, like many CSCL researches, investigates how computational tools can support collaborative learning. Coordination is a constitutive element of the collaboration process intended to produce learning, deserving attention from the community that researches how technology can support collaborative learning. This paper presented software that was developed with the aim of favoring the coordination of collaboration. CLPMtool is a project manager for the collaborative learning in that it combines elements found in corporate groupware (definition of projects and tasks) and features required in the educational context (integration with a virtual learning environment, mechanisms to facilitate the roles of students and teachers, records of users' activities for later analysis). This software was created with the premise that students are active constructors of their collaboration script.

We intend to continue this study in order to propose and develop models and artifacts that better support collaborative learning. Considering that when using project managers, collaboration is organized as projects and tasks, it is important to investigate how the task level of detailing may influence the collaborative activity. One question that still demands investigation is which explicit coordination mechanisms may further favor collaboration. It is also necessary to incorporate the artifacts produced during the collaboration process into the coordination tool. At last, we believe that agile project methodologies can contribute to enhance the coordination framework since there are some similarities between agile projects and projects as an instrument to promote collaborative learning.

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