E-Infrastructures and Technologies for Lifelong Learning:

Next Generation Environments

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Chapter 8
Collaborative Learning Design within Open Source E-Learning Systems:
Lessons Learned from an Empirical Study

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ABSTRACT

This chapter addresses a number of serious 'collaborative learning design' problems faced by adults within the context of e-learning systems and outlines some innovative solutions. Specifically, thirty-three Computer Science students at the Hellenic Open University participated in an experiment aimed at designing collaborative learning courses for Computer Science concepts within MOODLE, a well known open source Learning Management System. The systematic study presented in this chapter argues and specifies that these Prospective Computer Science Professionals (PCSPs) have serious difficulties with the formation of both collaborative learning activities and collaboration procedures, and with realizing them within e-learning settings. The proposed solutions emphasize the design and development of a set of computer-based collaborative patterns reflecting diverse collaboration methods. These patterns are content free and could be used as scaffolding elements for the design of collaborative learning activities for online and blended courses. Specific examples of possible implementation of these patterns within well-known Web-based open source environments that support learning design are also presented.

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INTRODUCTION

E-learning has provided education with many benefits in terms of flexible opportunities to learn anytime and anywhere as well as to communicate and collaborate virtually throughout the world (Harasim, Hiltz, Teles & Turoff, 1995). Recent studies of e-learning have pointed out that involving learners in collaborative learning activities could positively contribute to extending and deepening their learning experiences, test out new ideas, improve learning outcomes and increase learner satisfaction, at the same time decreasing the isolation that can occur in an e-learning setting (Palloff & Pratt, 2004). Furthermore, collaborative learning situations can provide a natural setting for demanding cognitive activities which can also trigger collaborative learning mechanisms such as knowledge articulation as well as sharing and distributing the cognitive load (Dillenbourg, 1999). Within the context of online collaborative learning, students could also be provided with opportunities to be motivated to actively construct their knowledge (Scardamalia, & Bereiter, 1996) and to enhance their diversity and their understanding of the learning concepts in question as well as to acquire a sense of belonging online (Haythornthwaite, Kazmer, Robins, & Shoemaker, 2000).

However, many teachers remain unsure of why, when, and how to integrate collaboration into their teaching practices in general as well as into their online classes (Panitz, 1997; Brufee, 1999). Here, it is also worth mentioning that the abundance of theoretical considerations and models that provide teachers with resources for 'learning design' remains largely unused in their real teaching practices (Fosnot, 1966; Brufee, 1999). At this point, we shall use the term 'learning design' to indicate all the elements of learning activity design, e.g. a learning task to be posed to the students, a set of questions, the group formation, the learning materials to be used by the students, learning assessment, etc. (Koper & Tattersall, 2005).

The essential role of suitably-designed tools to support teachers in their mindful and appropriate 'learning design' has been acknowledged by many researchers (Lloyd & Wilson, 2001; Babiuk, 2005; Kordaki, Papadakis, Hadzilakos, 2007; Kordaki & Daradoumis, 2009). In fact, teachers require more specific support in their learning design practices, such as specific tools and good examples of lesson plans. Thus, teacher encouragement and support for learning design is clearly needed. To this end, the role of learning design patterns has been acknowledged as essential (McAndrew, Goodyear, & Dalziel, 2006). Learning patterns looks to work on Architectural Patterns (Alexander, 1979) as a way to capture knowledge from designers and share them with practitioners.

Especially when it comes to Computer Science (CS) Education, educators have adopted a rather deficient approach to 'learning design', possibly because CS Education is a recently-developed scientific discipline. Yet, learning design should be an essential part of CS teachers' education. A number of studies have investigated CS teachers' opinions on CS curricula and on teaching and learning in CS as well as their real classroom practices (Kalyva, & Kordaki 2006; Kordaki & Kalyva, 2006). In addition, some studies have investigated the role of CS teachers in the formation of collaborative learning activities (Voyatzaki and Avouris, 2005). However, studies investigating Prospective Computer Science Professionals' (PCSPs) attempts to design learning courses incorporating 'computer supported collaborative learning design using some essential, specific and context free collaboration methods' have not yet been reported. Specifically, these methods are referred to: *Brainstorming* (Osborn, 1963), *Student Teams Achievement Divisions* (STAD; Slavin, 1978), Jigsaw (Aronson, Blaney, Sikes, Stephan & Snapp, 1978), *Group Investigation Method* (Sharan & Hertz-Lazarowitz, 1980), *Co-op Co-op* (Kagan, 1985), *Guided Reciprocal*

Peer Questioning (Palincsar, & Brown, 1984; Martin, & Blanc, 1984; King, 1990), *Three Step Interview* (Kagan, 1994), *Paired Annotations* (Millis & Cottell, 1998), *Double entry journal* (Berthoff, 1981).

In this chapter, we investigate PCSPs' attempts to integrate the aforementioned collaboration methods within their approaches to 'learning-design' performed in the context of a specific field study aiming to: (a) address specific problems they face and (b) exploit the results of this study to provide solutions to these problems. These solutions concern the design of appropriate computer tools that can support teachers in their attempts to design and implement online and blended collaborative learning settings. To this end, the design and implementation of specific collaboration patterns within the context of open source Learning Management Systems is proposed.

This chapter is organized as follows: In the next section, the rationale for both the previously-mentioned field study and the design patterns proposed is presented. Then the context of the said field study is reported and, subsequently, its results are depicted and lessons learned are drawn. Next, the design of the proposed collaboration design patterns using the tools provided by LAMS is demonstrated. Such design patterns have not yet been reported. Finally, the proposed solutions are discussed while conclusions and future research plans are also drawn.

2. THE RATIONALE

The idea that collaboration is a basic form of human activity, essential for cultural development, is intensively stressed by many researchers throughout the history of psychology (Vygotsky, 1978; Engestrom, 1987; Bruner, 1996; Lipponen, 2002). Nowadays, in a rapidly changing society, to prepare learners for participation in socially organized activities is also one of the essential requirements (Hakkinen, & Jarvela, 2006). In fact, collaboration is appreciated as a lifelong skill.

In collaborative situations, the participants are mutually involved in shared activities; they must coordinate their efforts if they are to solve problems together. Contrariwise, in cooperative settings the task is split into subtasks and each participant is responsible for solving a portion of the problem at hand. In cooperating settings, learners usually produce separate solutions, whereas in collaborative learning, constructing a shared solution is essential (Liponen, 2002).

Recent studies have indicated that some amount of structuring may help teams achieve effective collaboration (Lehtinen, 2003; Lipponen, 2002). One way to structure collaborative processes employs the so-called computer supported collaboration scripts (Dillenbourg, 2002). Such scripts are intended to facilitate collaborative learning processes and guide learners' activities. A script segments the task into phases, defines roles and places various constraints on the interactions. In scripted collaboration, the participants are supposed to follow directions and undertake shared learning tasks.

Another way of structuring collaboration is through the use of collaborative patterns which could be well-integrated within 'learning design' based e-learning environments. In fact, a 'learning design' is defined as the description of the teaching-learning process that takes place in a unit of learning (e.g., a course, a lesson or any other designed learning event such as a specific collaboration structure) (Koper & Tattersall, 2005). An important part of this definition is that pedagogy is conceptually abstracted from context and content, so that excellent pedagogical models can be shared and reused across instructional contexts and subject domains. Specifically, best pedagogical practices can be reflected in the formation of 'design patterns' which are context free and could be shared and reused across instructional contexts and essentially assist online learning. A pattern is seen as something that will not be reused directly

but can assist the informed teacher to build up their own range of tasks, tools or materials that can draw on a collected body of experience (McAndrew, Goodyear, & Dalziel, 2006). The key principle in 'learning design' is that it represents the learning activities that have to be performed by learners and teachers within the context of a unit of learning. In the context of "learning design', the role of collaborative design patterns is to indicate clearly the flow of collaboration activities using specific collaboration methods.

The IMS Learning Design (LD) specification aims to represent the design of units of learning in a semantic, formal and machine-interpretable way (LD, 2003). Various examples of e-learning environments close to the LD specification are mentioned in the literature. COLLAGE is also a system close to IMS-LD specification that is friendly for teachers to use and which supports collaboration using design patterns (Hernández-Leo, Villasclaras-Fernández, Asensio-Pérez, Dimitriadis, Jorrín-Abellán, Ruiz-Requies & Rubia-Avi, 2006). However, despite the fact that the IMS-LD specification offers many pedagogical benefits when compared with earlier open specifications for eLearning, it is not easy for teachers to understand and work with it (Griffiths, & Blat, 2005). To this end, it seems clear that teachers need high level tools to understand learning design and it is likely that tools specialized for a particular pedagogic context will be easier to use (Griffiths, & Blat, 2005). To this end, it is worth noting that the type of editor that classroom teachers usually need should be similar to the authoring environment provided by LAMS. Specifically, LAMS (Dalziel, 2003) is a well known integrated open source e-learning system that effectively supports the idea of 'learning design'.

Open source software is software that has been released under an Open Source Initiative (OSI) certified license. Each of the licenses approved by the OSI meets the conditions of the *Open Source Definition* (http://www.opensource.org/docs/definition.html). That definition includes 10 criteria. Perhaps the most important of these are the free redistribution of the software, access to the source code, and the permission to allow modifications to the software and derived works that may be distributed under the same licensing conditions. Open source is a development method for software that harnesses the power of distributed peer review and transparency of process. The promise of open source is better quality, higher reliability, more flexibility, lower cost, and an end to predatory vendor lock-in (http://www.opensource.org/).

LAMS (Learning Activity Management System; http://www.lamsfoundation.org/) is an open source tool for designing, managing and delivering online collaborative learning activities. In fact, LAMS offers a set of predefined learning activities, shown in a comprehensible way for teachers that can be graphically dragged and dropped in order to establish a flow chart of sequence of activities. When using LAMS, teachers gain access to a highly intuitive visual authoring environment for the creation of sequential learning activities. LAMS is based on the belief that learning does not arise simply from interacting with content but from interacting with teachers and peers. The creation of content-based, self–paced learning objectives for single learners is now well understood in the field of e-learning. However, the creation of sequential learning activities which involve groups of learners interacting within a structured set of collaborative environments - referred to as 'learning design' - is less common; LAMS allows teachers to both create and deliver such sequences. In essence, LAMS provides a practical way to describe multi-learner activity sequences and the tools required to support these. Furthermore, LAMS provides tools that support various activities such as communication, presentation of information, writing and sharing resources as well as posing and answering questions.

Nevertheless, Dalziel (2003) has commented on the absence of tools supporting broader ranges of collaborative tasks and also on missing support

for the concepts of group creation and monitoring. In fact, despite the availability of all tools mentioned above, collaborative activity sequences for the performance of the aforementioned specific collaboration methods within LAMS have not yet reported. One of the contributions of this chapter is to propose specific implementations of a number of essential collaboration methods using the previously mentioned tools of LAMS.

3. THE CONTEXT OF THE EMPIRICAL STUDY

The Method of the Study

This empirical study focuses on the investigation of PCSPs' attempts to integrate specific collaboration methods into their online 'learning design' approaches. Exploiting the results of this study, the design and implementation of a set of web based collaborative patterns reflecting diverse collaboration methods is proposed. These patterns can be used as scaffolding tools to help teachers take into consideration essential collaborative learning methods in their learning design practices. In terms of methodology, this study is a qualitative research educational methodology and can be characterized as a case study (Cohen & Manion, 1989). In terms of the method used, this study is a field study. Qualitative methodologies are usually suggested to illuminate what really happens in under-researched areas such as in PCSPs' collaborative learning design approaches. This methodology was used in order to investigate the PCSPs' collaborative learning design approaches and to form conclusions based on the data coming from the field experiment. Below the method used for this investigation is presented as a sequence of steps regarding the following issues: (a) focus of the study, (b) setting the learning experiment, (c) data resources, (d) data analysis, (e) presentation of results, (d) lessons learned from the said empirical study. In the following section, the description of the aforementioned steps is reported.

Focus of the Study

This study focus on the investigation of PCSPs' attempts to integrate specific collaboration methods into their online 'learning design' approaches. To this end, specific emphasis is put on the investigation of the kind of learning activities –that PCSPs designed during this empirical study- related to all the specific parts an online course consists of, namely; stating the stage, scheduling of the course, integration of learning materials, class organization, learning tasks, communication, collaboration and evaluation.

The Learning Experiment

The learning experiment took place during an elective course entitled 'Informatics and Education' provided to its CS undergraduate students by the School of Science and Technology of the Hellenic Open University. Specifically, thirty-three PCSPs at the Hellenic Open University participated in a learning design experiment aiming at the design of short online courses using MOODLE (Dougiamas & Taylor, 2002). In this experiment, PCSPs were asked to take into account modern constructivist and social views (Jonassen, 1999; Vygotsky, 1978) of learning and a set of specific collaborative methods to accomplish the following task: '*design a short online course for the learning of iteration algorithmic structures by secondary level education students'*. In particular, in the context of this course, PCSPs were asked to design specific lesson plans, integrating appropriate learning materials, collaborative learning activities and collaborative communication structures, as well as questions and teacher interventions that could encourage students' critical thinking.

To successfully address this task, PCSPs were provided with instructions in the form of text-based learning materials regarding: (a) modern social

and constructivist views of learning, (b) specific collaboration methods, including guidelines for the formation of collaborative learning activities, (c) diverse teacher interventions encouraging student engagement in the tasks at hand, (d) diverse types of questions encouraging the development of student critical thinking, (e) specific structures including guidelines for the encouragement of effective collaborative communication activities, and (f) diverse learning activities to be included in specific parts of a lesson plan. PCSPs were asked to take into account all the guidelines included in the said learning materials in order to design their online courses.

As regards the formation of appropriate lesson plans, it was considered critical for them to comprise learning activities related to the following specific parts: (i) student *emotional and cognitive preparation for* the learning of the subject matter in question, including; motivation of students to be actively and passionately engaged in the tasks proposed, clarification of the aims of the course and of each learning activity proposed for students, investigation of students' previous and prerequisite knowledge for the understanding of the concepts in question, (ii) *introduction* of students to the learning of the previously mentioned concepts, (iii) *consolidation* of the said concepts by the students, (iv) *assessment* of the knowledge constructed during the lesson, (v) development of student *metacognitive* skills, and (vi) *extension* of the lesson by providing learning materials and activities for further study.

Regarding the design of collaborative learning activities, PCSPs were provided with learning materials on specific collaboration methods to design collaborative learning tasks and also group/whole class communication. Specifically, these materials concerned the following context free collaboration methods: *Brainstorming* (Osborn, 1963), *Student Teams Achievement Divisions* (STAD; Slavin, 1978), Jigsaw (Aronson, Blaney, Sikes, Stephan & Snapp, 1978), *Group Investigation Method* (Sharan & Hertz-Lazarowitz, 1980), *Co-op Co-op* (Kagan, 1985), *Guided Reciprocal Peer Questioning* (Palincsar, & Brown, 1984; Martin, and Blanc, 1984; King, 1990), *Three Step Interview* (Kagan, 1994), *Paired Annotations* (Millis & Cottell, 1998), *Double entry journal* (Berthoff, 1981). These methods were selected as being representative of the achievement of diverse learning objectives such as: the generation of a large number of ideas for the solution of a problem (*Brainstorming),* motivating students to encourage and help each other, while at the same time accelerating their achievement (*STAD*), emphasizing interpersonal inter-dependence (*Jigsaw*), cultivating student ability to approach problems with different structures (*Group Investigation Method, Co-op, Co-op*), encourage critical thinking (*Guided Reciprocal Peer Questioning)*, enhancing team building and engagement of students in conversation *(Three Step Interview*), developing the ability to concentrate on important terms *(Double entry journal)* as well as promoting cooperative learning through accountability and positive interdependence *(Paired Annotations*).

To avoid repetitions, the said methods will be analytically presented in combination with their implementation within LAMS in a specific section of this chapter (see Implementation within LAMS later on).

Data Resources and Analysis

The data collected consisted of the specific online courses within MOODLE formed by each PCSP as well as their written reports describing/documenting these courses. In the first stage of data analysis, each individual PCSP's approaches to the said task were identified and reported in terms of design of learning activities related to all the specific parts an online course consists of, namely; stating the stage, scheduling of the course, integration of learning materials, class organization, learning tasks, communication, collaboration and evaluation. In the second stage, data was codified using themes that had emerged. Next, the focus was

put on tracking down the PCSP's best practices, as well as drawbacks in their learning designs for short online courses, with an emphasis on the design and implementation of collaborative learning events.

3. RESULTS

Based on the analysis described in the previous sections, the results emerged from this study are reported in the following section. The main points of these results are also briefly reflected in Table 1.

Setting the stage: Most PCSPs (25 PCSPs) used some brief provocative expressions/examples/jokes/figures to motivate their students and draw their attention to the subject matter in question. A few PCSPs (only 2 PCSPs) also designed discussions - using whole class forums - asking each of their students to give an example of their own life that related to the learning concepts in question, so as to stimulate them to actively and passionately participate in the course at hand. Most PCSPs (27 PCSPs) also defined certain cognitive and technical goals of their courses and presented them explicitly in the main page of their courses. Regarding the investigation of students' previous and prerequisite knowledge of the said concepts, a considerable number of PCSPs (20 PCSPs) used specifically designed quizzes while others (2 PCSPs) used the *brainstorming* method utilizing a whole class chat room. However, it should not be ignored that some PCSPs (6 PCSPs) failed to initiate any action to prepare their students emotionally and cognitively to actively and effectively participate in the learning of the subject matter through the said online courses. It was probably due to the fact that, usually, in Computer Science departments emphasis is given in the presentation of the subject itself with less attention on the development of an appropriate emotional climate for its understanding.

Scheduling of the online courses: All PCSPs designed their online courses to last two weeks at minimum. The first week was usually devoted to the introduction of the learning of the primary aspects of the concepts in question while the second week was usually dedicated to consolidation and extension of these concepts, as well as to evaluation procedures. To this end, PCSPs used most of the blocks provided by MOODLE such as Calendar, Latest News, Upcoming Events, Participants, Grades and Activities.

The typical flow of learning events that most PCSPs (30 PCSPs) suggested for their students was as follows: (a) completing quizzes to express their previous knowledge related to the subject matter in question, (b) participation in groups, (c) reading the learning materials provided, (d) fulfilling the learning tasks at hand during the 'introduction' part of the course, (e) completing quizzes to assess the knowledge acquired during this part of the course, (f) fulfilling the learning tasks at hand during the 'consolidation' part of the course and (g) completing quizzes to assess the knowledge acquired during the said part of the course or the knowledge they acquired during the whole course.

Integration of learning materials: Here, as well, all PCSPs integrated various learning materials to help their students acquire some knowledge about the subject matter in question as well as background issues. These learning materials were in the form of text documents, Power Point presentations, links on the Web, Glossaries and online Encyclopedias, appropriate educational software and, finally, online tutorials about MOODLE. Most of these materials provided information and solved examples to help the students grasp the learning concepts in focus. However, it is important to note that some PCSPs integrated so many learning materials – and usually failing to emphasize the most important aspects of the subject matter in question – that they could become boring for the students to navigate and read.

Class organization: The majority of PCSPs (26 PCSPs) organized their students in two ways; as a whole group and as small groups, mainly

Table 1. PCSPs' attempts to form small collaborative online courses within MOODLE

PCSPs' attempts to form small collaborative online courses within MOODLE	Number of PCSPs
Setting the stage	
Use of specific expressions to engage students in the course	25
Design of whole class discussions to engage students in the course	2
Formation of cognitive and technical goals	27
Investigation of students' previous and prerequisite knowledge using: • Quizzes • Whole-class Brainstorming	20 2
Scheduling of the online courses	
Design of a 2-week course	33
Use most of the blocks provided by MOODLE: Calendar, Latest News, Upcoming Events, Participants, Grades and Activities	33
Integration of learning materials	
Use of: text documents, Power Point presentations, links on the Web, Glossaries and online Encyclopedias	33
Use of: educational software and online tutorials about MOODLE	6
Class organization	
Whole class setting	33
Formation of 3-student, heterogeneous groups	33
Group formation by the teacher	31
Design of quizzes to assess student knowledge in order to classify them into heterogeneous groups	17
Learning tasks given	
During the introductory and consolidation parts of the course	33
During the evaluation part as well as after the end of the course	8
Non collaborative tasks	32
Collaborative tasks	1
Tasks that stem from the students' world	33
Communication	
Use of: whole class and group chat rooms and forums for synchronous and asynchronous communication	26
Use of e-mail	17
Establishment of specific communication guidelines for chat rooms/ forums	6
Use of the *Guided Reciprocal Peer Questioning* method to structure communication in forums	3
Use of specific pre-defined questions to structure communication in forums/chat-rooms	4
Establishment of specific days and hours for the chats integrated in PCSPs courses	23
Design of non ending forums as well as loose and unstructured communication procedures to take place within forums and chat-rooms	24
Collaboration	
Use of the *STAD* collaboration method (with non collaborative tasks)	23
Design of rewarding procedures	17
Evaluation	
Design of the evaluation of students' achievement using quizzes	33
Design of specific procedures for course evaluation	6

consisting of three students. The allocation of students into groups was mainly viewed as a teacher task by the majority of PCSPs (31 PCSPs), and group formation was mainly based on students' heterogeneity in terms of their achievement. At this point, it is worth noting that half the PCSPs used specifically designed quizzes to assess their students' knowledge in order to classify them into heterogeneous groups.

Learning tasks: All PCSPs designed learning tasks to be performed by their students during the introductory and consolidation parts of the course. Some PCSPs (8 PCSPs) also designed tasks to be faced by their students during the evaluation part of the course– as well as after the end of the course - for the extension and further consolidation of their knowledge. It is worth noting that all of these tasks were taken from the students' world, so that they would be actively and passionately involved in constructing their solution structures. However, the majority of these tasks (all except one) were simple enough not to require collaboration among team members for them to be successfully realized. Some PCSPs assigned such tasks to an entire group and others to each individual student.

Communication: The majority of PCSPs (26 PCSPs) used both whole class and group chat rooms for synchronous communication, as well as both whole class and group forums for asynchronous communication. The e-mail facility was also used to inform students about their allocation in groups. Whole class forums were mainly used for welcoming the students onto a specific course, for the assessment of the course by the participants and for the recognition of students' good work. Whole class chat rooms were mainly used for the investigation of students' previous knowledge (brainstorming), for meta-cognitive assessment of students' progress at the end of the course and for the expression of students' difficulties with the learning of the concepts in question. Group forums and group chat rooms were mainly used to provide students with opportunities to exchange ideas about the difficulties they encountered facing the learning tasks given. Due to the fact that these tasks were not mainly designed to be realized by a group, but could be easily performed by an individual student, students' contributions within group forums and group chat rooms took the form of expression of students' difficulties in successfully performing these tasks.

However, few PCSPs (6 PCSPs) established specific communication guidelines within chat rooms and forums, while some (3 PCSPs) used the *Guided Reciprocal Peer Questioning* method to structure communication in forums. Few PCSPs (4 PCSPs) also formed specific pre-defined questions to structure the communication in forums and chat-rooms. A considerable number of PCSPs (23 PCSPs), however, established specific days and hours for the chats they integrated in their learning designs, although most PCSPs (24 PCSPs) designed non ending forums as well as loose and unstructured communication procedures to take place within forums and chat-rooms.

Collaboration: The favorite collaboration structure used by a considerable number of PCSPs (23 PCSPs) was the STAD structure. This structure emphasizes heterogeneous grouping, individual and group assessment as well as recognition of the students who performed the best work. However, the tasks designed were not appropriate to be realized by teams. In addition, some PCSPs (17 PCSPs), designed rewarding procedures whereas others did not.

Evaluation: All PCSPs designed evaluation procedures for the investigation of students' achievement while few PCSPs (6 PCSPs) designed additional procedures for the investigation of the effectiveness of their courses. As regards the evaluation of students' achievement, all PCSPs designed quizzes including multiple-choice and true-false questions. These quizzes were assigned to be performed by the students after each part of the course (introductory and consolidation parts) and, in some cases, also at the end of the whole course. In addition, for the evaluation of students'

achievement, their performance in facing the tasks posed during both of the said parts of the course was taken into account. In fact, the total grade of each student in most cases was the sum of his/her grades gained from the quizzes and the tasks posed during the course, while in a few cases the students' grade emerging from their participation in the communications realized within forums and chats was also added. Regarding the grading of the learning tasks, it is worth noting that when a task was assigned to each individual student, in some cases, she/he gained a specific grade from her/his performance, while in other cases the median of individual grades gained by a group was viewed as the grade of each student participating in it. When a task was assigned to a group, the grade gained by this group was assigned as a grade to each individual student belonging to this group.

4. LESSONS LEARNED FROM THE EMPIRICAL STUDY

At first glance, the results emerging from this study show that the design of student-centered collaborative online courses was a tricky task for the PCSPs who participated in this experiment. Specifically, PCSPs had emphasized emotional preparation of their students to motivate them to be actively involved in their own learning. However, this motivation was designed according to teacher hypotheses about students' interests and mainly took the form of an action (usually a statement) performed by the teacher. Only a few PCSPs designed collaborative communication activities around a question so as to enforce student-centered motivation in terms of encouragement to express their personal opinions and experiences of the subject matter in focus.

As regards cognitive preparation, most PCSPs used quizzes to diagnose students' previous and prerequisite knowledge in order to allocate them into groups. Needless to say, quizzes are useful in informing the teacher about students' knowledge. However, most important is the structuring of the teaching procedure, so as to allow students to become aware of their knowledge, including misconceptions and difficulties. In addition, if students are allowed to share and negotiate their knowledge with their fellow students, they can enrich and clarify their approaches to the subject matter in focus.

Class organization was also mainly left in teachers' hands. In fact, no attempts were designed by PCSPs to guide their students to form groups according their own preferences. On the other hand, group work was completely left up to the students. Specifically, students were provided with forums and chat rooms to interact as both a whole class and in small groups. However, no structure for this interaction was suggested. In fact, the concept of sharing ideas and negotiation of meanings was not satisfactorily addressed by PCSPs throughout the online courses they designed. In addition, students were asked to face learning tasks by collaborating with their teammates, but these tasks were not designed to support collaboration.

To this end, the collaboration structures designed by PCSPs were mainly used in a non collaborative way. In particular, despite the fact that a considerable number of PCSPs used the STAD cooperation structure, its configuration was only partly used. Specifically, the organization of students into groups and the recognition of the best work in front of the students were emphasized, leaving out the organization of their contribution to form solutions to the tasks given. Evaluation procedures were also aimed at each individual student. In particular, the feedback – in terms of grades and suggestions - was designed to be received by each student, rather than from their classmates.

As to the learning materials incorporated into the PCSPs' courses, we can say that, in technical terms, various and diverse materials were used. However, in terms of quality, many of these materials can be characterized as 'chatty', and some of them were not necessary.

Based on the results emerging from this study, we can conclude that the design of collaborative online courses is not an easy task. Knowledge of the subject matter is not enough for the formation of appropriate collaborative online learning courses. The information that can be selected from the Internet to be integrated into these courses may be abundant, but this does not mean it is of acceptable quality. Moreover, also placing individualistic tasks within the frame of a collaborative structure does not mean that collaboration will be encouraged. Furthermore, grouping students into small teams and presenting them with team forums and team chats, in isolation from the design of specific structures that encourage sharing and negotiation of meanings, does not necessarily produce the benefits of collaboration. In our view, it seems that PCSPs rely mostly on their own previous experience of schooling that did not encourage collaboration. In fact, it appears that teachers tend to reproduce this experience, despite the fact that they read a lot about collaboration methods during this undergraduate course. However, one course appears to be not enough to familiarize PCSPs with such big issues as collaboration, learning-design and e-learning in general, especially when these are referred to the framework of modern theories of learning.

To this end, it could be claimed that teachers needed more support in the design of collaborative online courses. Some ways of support could be to emphasize: (a) the use of online environments that explicitly and intuitively support learning design, such as LAMS, (b) the provision of essential content-free collaboration patterns, within the frame of the said online environments, (c) the provision of good examples of online courses that incorporate collaborative methods, (d) teachers' involvement in teams aiming at the design of collaborative online courses and (e) the participation of teachers as learners in teams, within the context of such courses. As LAMS is designed to collaborate fully with MOODLE, the features of both environments can also be exploited by teachers for the design of online collaborative courses. To this end, in the next section of the chapter, the implementation of the previously mentioned content-free collaboration methods –in the form of design patterns- within the LAMS framework is reported.

5. IMPLEMENTATION OF ESSENTIAL CONTENT-FREE COLLABORATION METHODS WITHIN LAMS

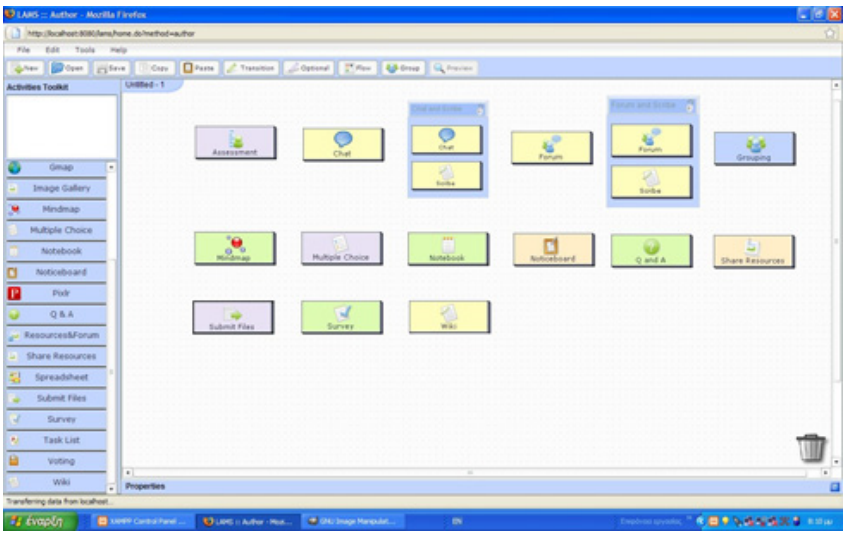
The said content-free collaboration methods were implemented within LAMS using some of its essential tools (http://wiki.lamsfoundation.org/display/lamsdocs/Home). These tools are demonstrated in its interface (Figure 1) and briefly presented below:

- The *Assessment tool* that allows sequence authors to create a series of questions with a high degree of flexibility in total weighting
- The *Chat Activity* runs a live (synchronous) discussion for learners
- The *Chat and Scribe Activity* combines a *Chat* Activity with a *Scribe Activity* for collating the chat group's views on questions posed by the teacher
- The *Forum Activity* provides an asynchronous discussion environment for learners, with discussion threads initially created by the teacher
- The *Forum and Scribe Activity* combines a *Forum* Activity with a *Scribe Activity* for collating Forum Postings into a written report
- The *Mindmap activity* allows teachers and learners to create, edit and view mindmaps in the LAMS environment. Mindmaps allow for the organising of concepts and ideas, and exploring how these interact
- The *Multiple Choice* activity allows teachers to create simple automated assessment

questions, including multiple choice and true/false questions
- The *Notebook Activity* is a tool for learners to record their thoughts during a sequence of activities
- The *Noticeboard Activity* provides a simple way of providing learners with information and content. The activity can display text, images, links and other HTML content.
- The *Question and Answer Activity* allows teachers to pose a question or questions to learners individually, and after they have entered their response, to see the responses of all their peers presented on a single answer screen
- The *Share Resources tool* allows teachers to add content into a sequence, such as URL hyperlinks, zipped websites, individual files and even complete learning objects
- The *Submit Files Activity* allows learners to submit one or more files to the LAMS server for review by a teacher
- The *Survey Tool* presents learners with a number of questions and collects their responses. However, unlike Multiple Choice, there are no right or wrong answers
- The *Wiki Tool* allows authors to create content pages that can link to each other and, optionally, allow learners to make collaborative edits to the content provided.

In the next section of this chapter, the set of collaborative methods referred to in the previous section are briefly presented in combination with their implementation as collaborative design patterns using the previously mentioned tools of LAMS. Specifically, each method is presented in terms of: (a) a short introduction and general information (b) its' goals (c) description of its processes in terms of appropriate steps to be performed (d) its diagrammatic implementation as a design pattern within LAMS. The presentation of these patterns is referred to the context of synchronous collaboration. However, these patterns could be used also for asynchronous collaboration by substituting the function of "Chat and Scribe" by the "Forum and Scribe" function.

Figure 1. Tools for learning design presented on the interface of LAMS



5.1. Brainstorming

Brainstorming (Osborn, 1963) is a group management technique designed to promote the generation of a large number of ideas for the solution of a problem. The main goal of the technique is to encourage group members to adopt a more liberal approach in the expression of personal opinions.

Goals: 1) to facilitate quick generation of ideas, 2) to encourage creativity and indirect thinking, 3) to get all the team involved, 4) to underline the importance of collaborative study.

Process: 1) Generation of ideas and writing up, 2) Commenting on ideas, 3) Asking for criteria for idea categorisation and 4) Presentation of the main ideas.

A diagrammatic representation of this method –as a design pattern within LAMS- is presented in Figure 2.

5.2. Student – Teams – Achievement - Divisions (STAD)

STAD (Slavin, 1978) is considered to be one of the basic approaches to introduce learners to cooperative learning. The use of this method is thought of as an effective and efficient way to teach well defined educational subjects. The teams are heterogeneous, made up of learners of diverse academic achievement, race, and nationality. The reward of the best teams motivates better students to encourage the other members of team in order to achieve the mutual goal.

Goals: 1) to motivate students to encourage and help each other, 2) to accelerate student achievement, 3) to facilitate gains in self esteem, liking of class, 4) to improve behaviour.

Process: 1) Personal assessment, 2) Assignment presentations, 3) Team collaboration, 4) Collaborative writing of reports, 5) Team assessment, 6) Praise for best reports.

A diagrammatic representation of this method –as a design pattern within LAMS- is presented in Figure 3.

5.3. Jigsaw

The *Jigsaw* method (Aronson, E., Blaney, N., Sikes, J., Stephan, G., & Snapp, M. 1978) is a cooperative learning strategy which enhances the process of listening; commitment to the team; interdependence and team work. Each member of the team has to excel in a well defined subpart of the educational material undertaking the role of expert. The experts form a different group discussing the nuances of the subject and later they return to their teams to teach their colleagues. The ideal size of teams is 4 to 6 members.

Goals: 1) to build interpersonal and interactive skills, 2) to ensure that learning revolves around interaction with peers, 3) to hold students accountable among their peers, 4) to encourage active student participation in the learning process.

Figure 2. Implementation of Brainstorming as a design pattern within LAMS

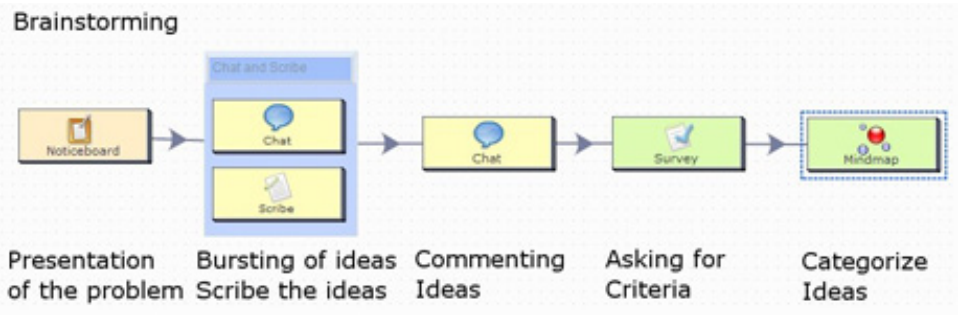
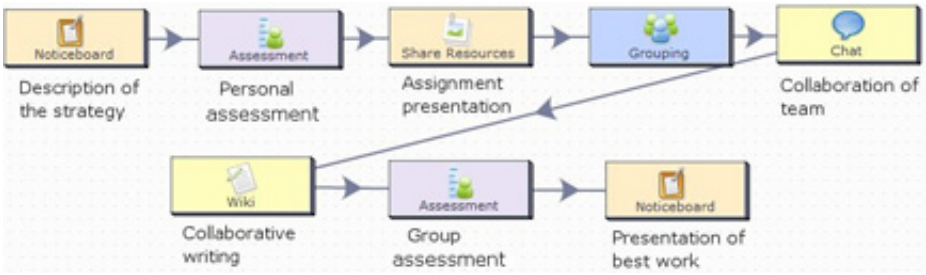


Figure 3. Implementation of STAD as a design pattern within LAMS



Process: 1) Divide the problem into sub-problems, 2) Assign roles and material to each student, 3) Form group of experts, 4) Experts study the material and plan how to teach their colleagues, 5) Create heterogeneous groups, 6) Experts teach in their groups, 7) Assess students.

A diagrammatic representation of this method –as a design pattern within LAMS- is presented in Figure 4.

5.4. Group Investigation Method

This method was proposed by Sharan and Hertz-Lazarowitz, (1980). It is based on the four main elements of learning process: 1) Investigation, 2) Interaction, 3) Interpretation, 4) Intrinsic motivation. During the operation of this method, groups work on similar problems using versatile approaches. The whole process leads to the active construction of knowledge.

Goals: 1) to organise the class, 2) to design activities promoting versatile approaches, 3) to promote plural discussion on learning material, 4) to enrich teacher-student interaction.

Process: 1) Teacher sets the problems to be studied, 2) Teacher shares educational materials, 3) Groups analyse the given problem in sub-problems, 4) Each member of the group studies a specific sub-problem, 5) Teacher provides additional material, 6) Discussion and drawing of conclusions, 7) Collaborative writing of reports, 8) Assessment and enhancement of reports in discussion with teacher, 8) Presentation of the main ideas, 9) Final interaction between students, 10) Assessment.

Figure 4. Implementation of Jigsaw as a design pattern within LAMS

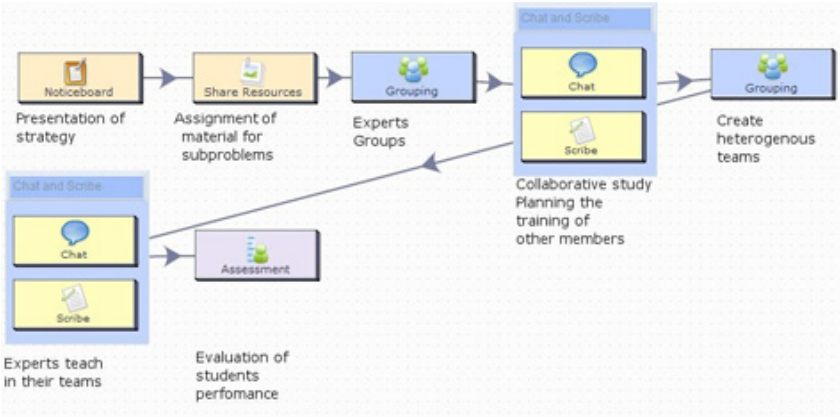
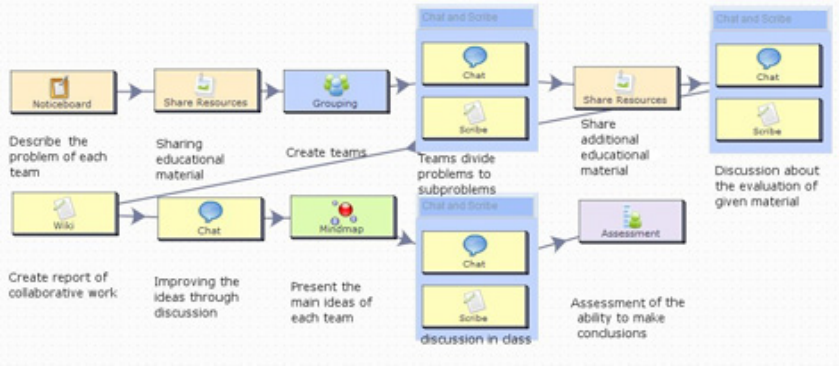


Figure 5. Implementation of the Group Investigation method as a design pattern within LAMS



A diagrammatic representation of this method –as a design pattern within LAMS- is presented in Figure 5.

5.5. Co-Op, Co-Op Method

This method was proposed by Kagan (1985). It belongs to the category of methods focusing on the development of group consciousness inside class (class building techniques). The learner undertakes the responsibility to control what and how he learns. There is a little interaction among the teams.

Goals: Similar to the previous structure. The main aim is to cultivate the ability of students to approach problems with different structures.

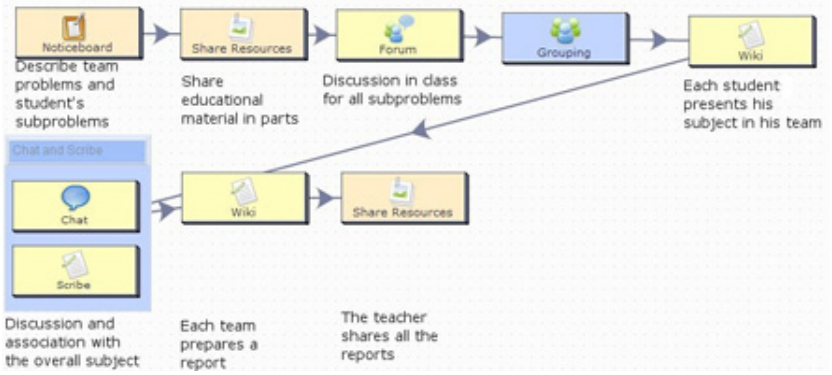
Process: 1) Division of the problem into team sub-problems, and later into student sub-problems, 2) Sharing of the educational material, 3) Each student prepares his subject, discussing it in class in order to collect more info, 4) Creation of groups, 5) Each student presents their report to their group, 6) Discussion of the connection of the sub-subject to the whole, 7) Preparation of the team report, 8) Presentation in class of group reports.

A diagrammatic representation of this method –as a design pattern within LAMS- is presented in Figure 6.

5.6. Guided Reciprocal Peer Questioning

The method of *Guided Reciprocal Questioning* guides learners how to assess their understanding when studying (Palincsar, and Brown, 1984; Martin & Blanc, 1984. This method is based on

Figure 6. Implementation of Co-op, Co–op as a design pattern within LAMS



questions influenced by the well known Bloom taxonomy. Specifically, this method allows learners to identify the question patterns of their teacher, and to recognize more easily the important ideas to be learned.

Goals: 1) to encourage critical thinking, 2) to make the student understand what information is important, 3) to help in the introduction of previously unknown material, 4) to stimulate discussion on specific subject.

Process: 1) Present the problem, 2) Study the material for 10-15 minutes, 3) Teacher shares a set of semi-completed questions, 4) Each student prepares the answers to questions and submits them to the teacher, 5) Discussion on the subject, 6) Assessment based on the given questions.

A diagrammatic representation of this method –as a design pattern within LAMS- is presented in Figure 7.

5.7. Three Step Interview

The *Three Step Interview* (Kagan, 1994) can be used as a tool to support the better comprehension of ideas through discussion with peers. Each learner listens to others' opinions, enriching their cognition about the specific topic. Even the weaker learners with little prior knowledge will gain a better understanding of the subject because of the participation in the interviews.

Goals: 1) team building, 2) reinforcement of the comprehension of information based on lectures or textbooks, 3) students engagement in conversation.

Process: 1) Sharing of material, 2) Assignment of the roles of the interviewer and interviewee, 3) Formation of a team, 4) Timed discussion and inversion of roles, 5) Formation of groups with 4 members, 6) Discussion between pairs.

A diagrammatic representation of this method –as a design pattern within LAMS- is presented in Figure 8.

5.8. Paired Annotations

Millis and Cottel (1998) suggest this method as capable of improving the ability of learners to comprehend faster. The main idea is the formation of student pairs who try to identify key ideas. The frequent alternation of the pairs may help the further development of metacognitive skills.

Goals: 1) to enable students to identify key points, 2) to develop literature review skills, 3) to encourage students to make connections between

Figure 7. Implementation of the method of Guided Reciprocal Questioning as a design pattern within LAMS

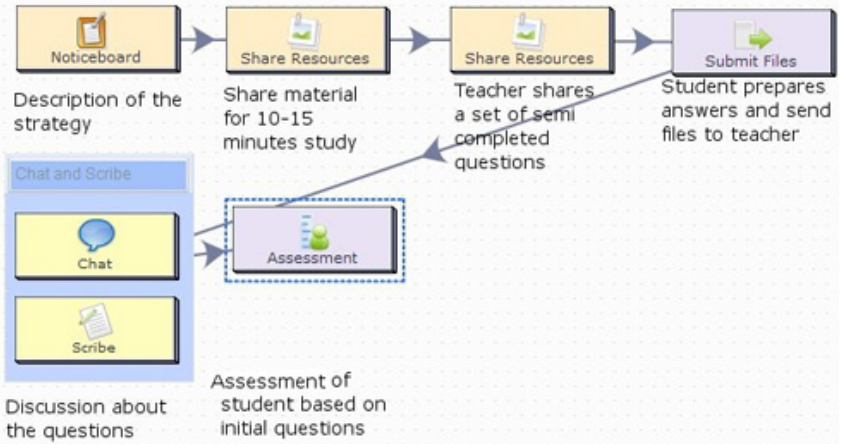
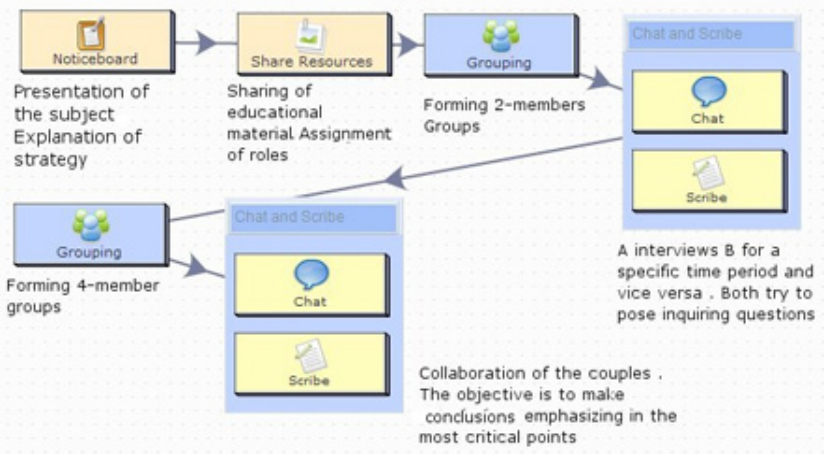


Figure 8. Implementation of the method of Three Step Interview as a design pattern within LAMS



new and existing bodies of knowledge, 4) to promote cooperative learning through accountability and positive interdependence.

Process: 1) Sharing of the educational material, 2) Grouping in pairs, 3) Discussion about key points, 4) Grouping in teams of 4 members, 5) Further discussion within the bigger groups about the key points, 6) Collaborative writing of summary of the learning material.

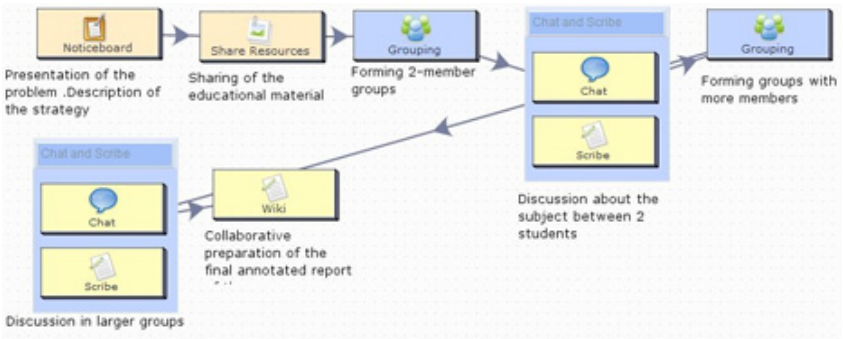
A diagrammatic representation of this method –as a design pattern within LAMS- is presented in Figure 9.

5.9. Double Entry Journal

This method (Berthoff, 1981), belongs to the category of reflective techniques. The learner has to play two different roles: a) The role of researcher, who collects information and builds knowledge, and b) the role of reviewer, who compares his findings with the established wisdom. All these roles are realized in an environment of collaborative learning.

Goals: 1) to help students focus on key points, 2) to provide an alternative method of study, 3) to help students becoming more involved with the material they study, 4) to improve students' comprehension and vocabulary.

Figure 9. Implementation of Paired Annotations as a design pattern within LAMS



Process: 1) Sharing of educational material, 2) Grouping in teams, 3) Discussion about the given subject and research for additional material, 4) Sharing of more specialised material, 5) Teams compare their findings with the new material, 6) Conclusions are discussed in class, 7) Presentation of the main ideas and conclusions.

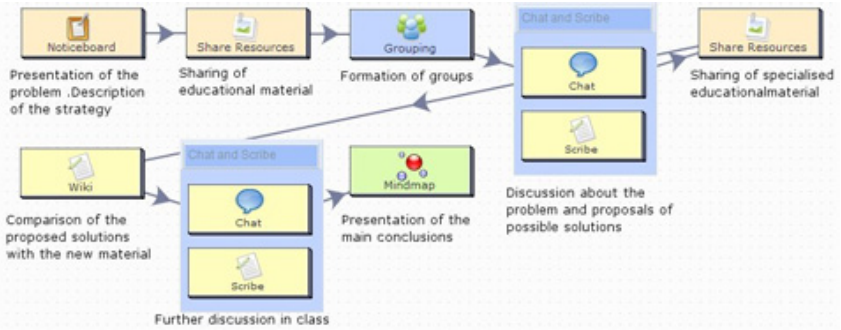
A diagrammatic representation of this method –as a design pattern within LAMS- is presented in Figure 10.

6. CONCLUSION

This chapter addressed some serious problems faced by adult students – Prospective Computer Professionals at the Hellenic Open University - in collaborative learning design and indicated a number of innovative solutions. Specifically, thirty-three PCSPs participated in an experiment aiming to design short collaborative online courses - taking advantage of the tools provided by MOODLE - for the learning of iteration structures. PCSPs participated in this experiment in the context of a one-year, specific course, entitled 'Informatics in Education', on the design and use of Computer Technology for teaching and learning. The analysis of the data shows that the design of such courses is a prickly task, especially for adults with limited experience of learning design. In fact, the courses designed by these PCSPs used various facilities provided by MOODLE but these tools were mainly used to support individualistic, non-collaborative learning. Despite the fact, that PCSPs allocated their students within groups and provided each of them with forums and chat-rooms, the interaction within these communication devices was left loose/non structured and subsequently non-productive. The learning tasks designed were also very simple, so they could be performed by individual students. Furthermore, when a collaboration structure was used, some essential parts of it were ignored. These parts related to the lack of design negotiation of meanings and mutual understanding as well as lack of design specific contributions of each individual student to complete the tasks at hand. The evaluation procedures implemented were also oriented towards each individual student, thus not permitting student-learning from their classmates' learning diversity, including their mistakes. On the whole, the students' interdependence, through their contribution to the tasks at hand and also in communication procedures, clearly did not emphasize negotiation of meanings and mutual understanding of the concepts in question. PCSPs also integrated various learning materials into their courses, in some cases unnecessarily.

Taking into account the results of this study, and in our attempt to help novices and teachers in their approaches towards successful collaborative learning design, we designed and implemented a

Figure 10. Implementation of Double Entry Journal as a design pattern within LAMS



number of collaborative design patterns within LAMS, reflecting essential collaboration methods, namely: Brainstorming, Student Teams Achievement Divisions, Jigsaw, Group Investigation, Co-op Co-op, Guided Reciprocal Peer Questioning, Three Step Interview, Annotations, and Double entry journal.

Based on the results of this field study, we also plan to provide novices and teachers with extra support in their attempts to design collaborative online courses, namely: a) good examples of online courses incorporating the previously mentioned collaborative structures, b) engagement of teachers in teams aiming to design collaborative online collaborative courses, c) training teachers for collaborative online learning design by encouraging them to participate as learners in teams within the context of such courses. Finally, the use with real teachers of the previously-mentioned collaboration patterns - as implemented within LAMS - is in our future plans. In this way, the effectiveness of these patterns in the form of this specific implementation could be explored.

7. FUTURE RESEARCH DIRECTIONS

We end this chapter with a brief note on the implication of this study towards future research directions in learning design, computer science education and teacher education. Our study clearly suggests that CS teachers need support in their everyday teaching practices. To this end, more research is needed to: (a) investigate the most significant teaching weaknesses –especially for CS teachers- through specific field studies (b) form appropriate design patterns for teachers taking into account their needs (c) form and evaluate sequences of learning activities appropriate for the learning of Computer Science concepts in all levels of education at the same time taking into account the students' diversity and (d) investigate ways of teacher education to encourage teachers in general and CS teachers in particular, to implement essential learning designs and sequences of collaborative learning activities.

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