The role of context free collaboration design patterns in learning design within LAMS: Lessons learned from an empirical study

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This study presents an experiment aiming the design of short learning courses in the context of LAMS, using a number of specific context-free collaboration design patterns implemented within LAMS. In fact, 25 Prospective Computer Engineers (PCEs) participated in this experiment. The analysis of the data shows that PCEs fully used these context free collaboration patterns - mostly realized in combination - and designed interesting sequences of learning activities. PCEs also used most of the tools provided within LAMS. However, PCEs were presented with difficulties in integrating collaboration strategies with thinking dimensions in terms of communication, decision making, concept formation, problem solving and inquiry based learning.

Keywords: Design patterns, generic sequences of learning activities, LAMS, collaboration

Introduction

Learning design has been defined as the description of the teaching-learning process that takes place in a unit of learning such as, a course, a lesson or any other learning event (Koper and Tattersall, 2005). To this end, the term 'learning design' is used to indicate all the elements of learning activity design, e.g. a learning task to be presented to the students, a set of questions, the group formation, the learning materials to be used by the students, learning assessment, etc. An important part of this definition is that pedagogy is context and content free, in the sense that the best pedagogical models can be shared and reused across diverse subject domains and instructional contexts. Specifically, excellent pedagogical practices can be reflected in the formation of 'design patterns' which are context free and can be shared and reused across instructional contexts and essentially assist online learning (Koper and Tattersall, 2005). In the context of "learning design', the role of context free generic learning design patterns is to clearly indicate the flow of learning activities reflecting specific well known didactical methods.

The concept of design patterns is based on Christopher Alexander's notion of design patterns in architecture (Alexander, 1997). Alexander invented design patterns as a literary form to capture "profound invariants" found in the highest quality spaces. A design pattern for learning is seen as something that will not be reused directly but can nevertheless 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). Design patterns based on sound research can help teachers and educational content developers in the design of potentially effective e-learning settings (Hernandez-Leo, Asensio-Perez & Dimitriadis, 2005). Design patterns have also been adopted to describe best practices in collaborative learning (Dillenmbourg, 2002; Goodyear, Avgeriou, Baggetun, Bartoluzzi, Retalis, Roteltap & Rusman, 2004; Goodyear, 2005). To this end, the role of computer supported collaborative learning has been acknowledged by many researchers

(Dillenmbourg, 1999; Scardamalia & Bereiter, 1996; Lipponen, 2002; Lehtinen, 2003). In the context of "learning design', the role of collaborative design patterns is to clearly indicate the flow of collaboration activities using specific collaboration methods.

A collaborative design pattern can be understood as a way of describing a context free collaborative learning method. Collaborative learning techniques dictate common ways of structuring interactions among participants in different activities, as well as the information they interchange. Context free collaborative design patterns are not theoretical constructs but actually derive from scientifically verified educational practices (Aronson & Thibodeau, 1992; Johnson & Johnson, 1999) rather than from general learning theories. In fact, these design patterns represent collaborative methods that have been extensively tested and applied in a broad range of different educational settings and on which there are many publications on research and practical results (Strijbos, Martens & Jochems, 2004).

LAMS (Dalziel, 2003), is a revolutionary environment that can support learning design –appropriate for the learning of concepts within any subject domain- especially for professionals with no programming experience and knowledge, as are most teachers in the primary and secondary level. In fact, LAMS provides teachers with opportunities for easy and intuitive design of sequences of learning activities (Cameron, 2007). Teachers are also provided with the ability to 'Preview' the sequences of learning activities through the lens of the learners and make suitable adjustments after reflection. (Cameron, 2006). In addition, LAMS provides teachers with possibilities to overview the entire sequence of learning activities on the computer screen and make appropriate revisions (Cameron, 2007). Furthermore, there are also possibilities for improvement of a sequence even while it is running online in real-time. It is also worth noting that, in the context of LAMS, the role of teacher is not reduced to the role of a traditional behavioristic practitioner (Skinner, 1968) who has to use 'learning designs' ready-made by expert learning designers: in fact, LAMS provides teachers with possibilities to transform ready-made sequences of learning activities according to both; their own personal views of learning and their students' individual learning characteristics. Collaboration could also be easily supported by using the possibilities of fine grained grouping and branching. Within LAMS there are also possibilities for adapting a sequence of learning activities according to students' previous knowledge, their preferences and specific learning styles, by using appropriately designed questionnaires in combination with suitable grouping and branching. 'Well working' learning design patterns could be also accessed by the teachers by using the Activity Planner integrated within LAMS. Various generic 'blank' learning sequences representing 'well working' collaboration learning strategies are also available by members of the LAMS community (Kordaki and Siempos, 2009a; http://www.lamscommunity.org/lamscentral/). To this end, the community of learners built around LAMS could play an encouraging role for the teachers and the designers of learning activities by providing them with opportunities to exchange experience and knowledge as well as their own sequences of learning activities.

Despite the advantages of learning design and the plethora of theoretical considerations and models that provide teachers with various relevant resources, these remain largely unused in real teaching practices (Fosnot, 1966; McNaught, 2003; Kordaki, Papadakis, & Hadzilacos, 2007). As far as collaboration is concerned, it also seems that 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 (Brufee, 1999). To this end, many researchers acknowledge the significant role of appropriate tools to support teachers in their mindful and appropriate 'learning design' (Lloyd & Wilson, 2001; Babiuk, 2005; Kordaki, Papadakis, Hadzilakos, 2007a; Kordaki and Daradoumis, 2009). In fact, teachers require more specific support in their learning design practices, such as specific tools and good examples of lesson plans. To this end, the role of learning design patterns has been acknowledged as essential (McAndrew, Goodyear, Dalziel, 2006).

Regarding Computer Science (CS) Education, typical teachers in the secondary level seemed to adopt a rather deficient approach to 'learning design'. As a result, these teachers faced difficulties in the formation of appropriate questions and learning activities that would enhance their students' cognitive skills (Kordaki, Papadakis and Hadzilakos, 2007a; 2007b). Furthermore, prospective CS teachers are challenged with difficulties in the design of collaborative learning activities, despite the fact that they are provided with theoretical materials to be informed about basic context free collaborative structures (Kordaki, Siempos, Daradoumis, to appear). Taking into account the results of the aforementioned studies and the fact that learning design should be an essential part of CS teachers' education, a number of context free collaborative design patterns (17 patterns) have been constructed within the context of tools of LAMS (Kordaki &

Siempos, 2009b). In this study, an attempt has been made to investigate the role of these collaborative context free design patterns on the attempts realized by Prospective Computer Engineers (PCEs) for learning design within LAMS. Studies investigating PCEs' attempts to design learning courses incorporating computer supported collaborative learning design using context free collaboration patterns have not yet been reported.

In this paper, we investigate PCEs' attempts to: (a) integrate the aforementioned ready-made collaboration context-free design patterns within their approaches to 'learning-design' performed within LAMS, in the context of a specific field study (b) explore specific problems they face in this integration and (c) exploit the results of this study to provide some solutions to these problems.

This paper is organized as follows: In the next section, the context of the said field study is reported and, then, subsequently, its results are depicted while lessons learned are drawn. Based on these lessons, specific solutions are proposed while future research plans are also outlined.

Context of the study

This empirical study focuses on the investigation of PCEs' attempts to integrate specific context free generic collaboration design patterns into their online 'learning design' approaches within LAMS. In terms of methodology, this study is based on qualitative educational research and can be characterized as a case study (Cohen & Manion, 1989). Qualitative methodologies are usually suggested to illuminate what really happens in under-researched areas such as in PCEs' collaborative learning design approaches. In terms of the method used, this study is a field study. This particular methodology was used in order to investigate the PCEs' collaborative learning design approaches within LAMS using specific generic collaborative design patterns and to form conclusions based on the data coming from the field experiment about the effectiveness of these patterns. The method used for this investigation is presented below as a sequence of steps regarding the following issues: (a) focus of the study, (b) setting of the learning experiment, (c) data resources, and (d) data analysis. In the following section, the description of the aforementioned steps is described.

This study focuses on the investigation of PCEs' attempts to integrate specific collaboration context-free design patterns into their online 'learning design' approaches within LAMS. To this end, specific emphasis is put on the investigation of the kind of learning activities designed by PCEs during this empirical study, namely; integration of learning materials, class organization, learning tasks, communication, collaboration and evaluation of student learning as well as tools of LAMS used.

The learning experiment took place -in Fall 2009- during an elective course entitled 'Educational Technology and Didactics of Informatics II' provided to the undergraduate students of the department of Computer Engineering and Informatics of the Polytechnic School of the University of Patras, Greece. Specifically, twenty-five PCEs participated in an experiment aiming at the design of short online courses within LAMS considering learning design issues. These PCEs had not any previous experience in learning design. In this experiment, PCEs were asked to take into account modern constructivist and social views (Jonassen, 1999; Vygotsky, 1978) of learning and a set of specific collaborative patterns to accomplish the following task: 'design a short online course for the learning of any subject of Computer Sc*ience by secondary level education students*'. In the context of this course, PCEs were also asked to design specific lesson plans by integrating appropriate learning materials, collaborative learning activities and communication as well as questions and teacher interventions that could encourage students' critical thinking.

To successfully address this task, PCEs were provided with instructions in the form of text-based learning materials regarding: (a) modern social and constructivist views on learning, (b) diverse teacher interventions encouraging student engagement in the tasks at hand, (c) diverse types of questions encouraging the development of critical thinking in students, and (d) diverse learning activities to be included in specific parts of a lesson plan. PCEs were asked to take into account all the guidelines included in the aforementioned learning materials in order to design their online courses. PCEs were also provided with specific generic context free collaboration design patterns as ready made sequences of learning activities (Kordaki and Siempos 2009a; http://www.lamscommunity.org/lamscentral/) constructed using the tools of LAMS. Some of these patterns were appropriate to be used for the design of collaborative learning tasks while other

patterns were appropriate for structuring collaborative communication activities during group/whole class communication.

Specifically, these generic collaborative design patterns concerned the following context free collaboration methods: *Brainstorming* (Osborn, 1963), *Roundtable* (Kagan, 1994), *Team Expectations* (Felder & Brent, 2000), *Uncommon Commonalities* (Kagan, 1994), *Student Teams Achievement Divisions* (STAD; Slavin, 1978), *Jigsaw* (Aronson, Blaney, Sikes, Stephan & Snapp, 1978), *JigsawII* (Slavin, 1990), *Group Investigation Method* (Sharan and Hertz-Lazarowitz, 1980), *Co-op Co-op* (Kagan, 1985), *Guided Reciprocal Peer Questioning* (Palincsar, and Brown, 1984; Martin, and Blanc, 1984; King, 1990), *Think-Pair-Share* (Lyman, 1981), *Three Step Interview* (Kagan, 1994), *Numbered Heads Together* (Kagan, 1992;1994), *Paired Annotations* (Millis and Cottell, 1998), *Double entry journal* (Berthoff, 1981), *Focused Listing* (Angelo and Cross, 1993; Johnson, and Johnson, 1999) and *One minute papers* (Angelo and Cross, 1993). These collaboration design patterns have been uploaded within LAMS at:

These methods were selected as being representative of the achievement of diverse learning objectives such as: generating a large number of ideas for the solution of a problem (Brainstorming and Roundtable), motivating students to encourage and help each other, while at the same time accelerating their achievement (STAD), promoting cooperative learning through accountability and positive interdependence (Jigsaw and JigsawII that is an integration of STAD and Jigsaw), involving the whole group in the consideration of a question or problem, while at the same time increasing individual accountability (Numbered Heads Together), cultivating student ability to approach problems with different structures (Group Investigation Method, Co-op, Co-op), encourage critical thinking (Guided Reciprocal Peer Questioning and Think-Pair-Share), enhancing team building and engagement of students in conversation (Three Step Interview, Team Expectations and Uncommon Commonalities), developing the ability to concentrate on important terms (Double entry journal and Focused Listing), promoting cooperative learning through accountability and positive interdependence (Paired Annotations), developing student metacognitive skills as well as quick and easy assessment of the knowledge constructed during a lesson (One minute papers). From the aforementioned collaboration structures, some could be used for structuring a collaborative task (eg. STAD, Jigsaw, JigsawII, Group Investigation Method, Co-op, Co-op, Numbered Heads Together, Double entry journal, Focused Listing and Paired Annotations) while the rest could be used for structuring communication.

As regards the formation of appropriate lesson plans, it was considered critical for PCEs 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 aformentioned 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.

Data resources and analysis: The data collected consisted of the specific online sequences of learning activities within LAMS formed by each PCE as well as their written reports describing/documenting these activities. In the first stage of data analysis, each individual PCE's approaches to the assigned 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, general planning of the course, integration of learning materials, class organization, learning tasks, communication, collaboration and evaluation. In the second stage, the data was codified using the themes that had emerged. Next, the focus was put on tracking down the best practices used by the PCE's, as well as the drawbacks in their learning designs for short online courses, with an emphasis on the design and implementation of collaborative learning events.

Results

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

Setting the stage: All PCEs (25 PCEs) used –through the use of a notice board- some brief provocative graphics/animations/expressions/examples/jokes/figures to motivate their students and draw their attention to the subject matter in question. A few PCEs (only 2 PCEs) also designed discussions - using whole class forums – and asked each of their students to give an example of their own life that was somehowrelated to the learning concepts in question, inorder to stimulate them to actively and passionately participate in the course at hand. Most PCEs (22 PCEs) also defined certain cognitive and technical goals for their courses and presented them explicitly through a notice board to their students. Regarding the investigation of students' previous and prerequisite knowledge of the concepts in question, a considerable number of PCEs (20 PCEs) used specifically designed questionnaires while others (2 PCEs) used the brainstorming method utilizing a whole class chat room.

General planning of the course: All PCEs designed their online courses aiming to incorporate various activities within them. The first activities were usually devoted to the introduction of the learning of the primary aspects of the concepts in question, while the later activities were usually dedicated to the consolidation and the extension of these concepts, as well as to evaluation procedures. To this end, PCEs used most of the tools provided by LAMS such as: noticeboard, chat rooms and forums, grouping and branching, wikis, submit files, etc.

Table 1. PCEs' attempts to form small collaborative online courses within LAMS

PCEs' attempts to form small collaborative online courses within LAMS	Number of PCEs
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	22
Investigation of students' previous and prerequisite knowledge using: • Questionnaires • Whole-class Brainstorming	 20 2
Scheduling of the online courses	
Design of a multiple activity course	25
Use most of the tools provided by LAMS: noticeboard, chat rooms and forums, grouping and branching, wikis, submit files	25
Integration of learning materials	
Use of: interactive learning materials, text documents, Power Point presentations, links on the Web, Glossaries and online Encyclopedias	25
Use of: educational software	6
Class organization	
Whole class setting	25
Formation of 4-student, heterogeneous groups	25
Group formation by the teacher	18
Design of questionnaires to assess student knowledge in order to classify them into heterogeneous groups	14
Learning tasks given	
Collaborative cohesive tasks	25
Tasks that stem from the students' world	25
During diverse parts of the course	25
During the evaluation part as well as after the end of the course	8
Communication	
Use of: whole class and group chat rooms and forums for synchronous and asynchronous communication	25
Use of the '*Brainstorming*' and '*Roundtable*' design patterns to structure communication in chats	17

Establishment of specific communication guidelines for chat rooms/ forums	4
Use of the '*Guided Reciprocal Peer Questioning'* design pattern to structure communication in forums	3
Use of specific pre-defined questions to structure communication in forums/chat-rooms	3
Establishment of specific days and hours for the chats integrated in PCEs courses	20
Design of loose and unstructured communication procedures to take place within forums and chat-rooms	20
Collaboration	
Use of the provided collaborative design patterns within LAMS	25
Use of combinations of collaborative design patterns within LAMS	21
Use of *Jigsaw* collaboration design pattern within LAMS	7
Use of *JigsawII* collaboration design pattern within LAMS	7
Use of the *STAD* collaboration method design pattern within LAMS	11
Design of rewarding procedures	21
Evaluation	
Design of the evaluation of students' achievement using online questionnaires	25
Use of the *"One minute papers'* design pattern within LAMS	24

The typical flow of learning events that most PCEs (20 PCEs) suggested for their students was as follows: (a) provision of information about the course and its main goals (b) completing questionnaires to express their previous knowledge related to the subject matter in question, (c) participation in groups, (d) reading the learning materials provided, (e) fulfilling the learning tasks at hand during all the parts of the course, (f) preparation of group-reports, (g) presentation of the group work in the whole class, and (g) completing questionnaires to assess the knowledge acquired during each part of the course and the knowledge they acquired during the whole course.

Integration of learning materials: Here, as well, all PCEs integrated various attractive, colourful and interactive learning materials in their sequences of learning activities -using the 'notice board' tool- to help their students acquire knowledge about the subject matter in question and about background issues as well. These learning materials were presented in various forms such as: text documents, Power Point presentations, videos, animations, links on the Web, Glossaries and online Encyclopedias as well as appropriate educational software. 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 most PCEs integrated so many learning materials –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. In addition, PCEs did not provide learners with any strategy for studying these materials in order to comprehend them and gain appropriate knowledge and develop their critical thinking.

Class organization: All PCEs organized their students in two ways; as a whole group and as small groups, mainly consisting of four students through the use of the grouping tool in combination with the branching tool. The allocation of students into groups was mainly viewed as a teacher task by the majority of PCEs (18 PCEs), and group formation was mainly based on students' heterogeneity in terms of their achievement in a pre-test. At this point, it is worth noting that more than half of the PCEs (14 PCEs), used specifically designed questionnaires to assess their students' knowledge in order to classify them into heterogeneous groups. The rest PCEs (7 PCEs), designed grouping in terms of students' preferences.

Learning task design: All PCEs designed collaborative learning tasks –in the form of collaborative projects- to be performed by their students for the introduction and consolidation of the concepts in question. These projects included research in literature as well as gathering data from real life situations, processing of these diverse kind of data, production of conclusions and preparation of reports and presentations in the whole class. Some PCEs (8 PCEs) also designed tasks to be faced by their students during the evaluation part of the course– as well as offline, after the end of the course - for 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, PCEs failed to form well organized inquiry based projects that would have the capability to involve students in all phases of a typical inquiry. In addition, problem based projects were also incompletely formed. Appropriate strategies for

concept formation were also not considered. On the whole PCEs failed to successfully integrate in their task design activities that could encourage students' essential thinking dimensions such as: concept formation, problem solving and inquiry based learning.

Communication design: All PCEs used both whole class and group chat rooms for synchronous communication, as well as both whole class and group forums for asynchronous communication. Whole class forums were mainly used for welcoming the students into a specific course, for making some agreements and for the recognition of the students' good work. Whole class chat rooms were mainly used for the investigation of students' previous knowledge (through brainstorming) as well as for meta-cognitive thinking and assessment of students' progress at the end of the course (through one minute papers). Group forums and group chat rooms were also used to provide students with opportunities to exchange ideas about the difficulties they encountered whilst facing the learning tasks given.

However, few PCEs (4 PCEs) established specific communication guidelines within chat rooms and forums, while some (3 PCEs) used the 'Guided Reciprocal Peer Questioning' method to structure communication in forums. Only a few of the PCEs (3 PCEs) formed specific pre-defined questions to structure the communication in forums and chat-rooms. A considerable number of PCEs (20 PCEs), also established, specific days and hours, for the realization of the chat sessions which they integrated into their learning designs. However, most PCEs (20 PCEs) designed loose and unstructured communication procedures to take place within forums and chat-rooms. In addition, teacher diverse types of interventions, meant to encourage the development of students' cognitive structures through communication were totally missing. Finally, specific decision making strategies were not considered when a decision was necessary.

Collaboration design: All PCEs used the context free collaboration design patterns to design sequences of learning activities. Most of these PCEs (21 PCEs) used these design patterns in combination: eg. the 'Brainstorming' pattern for generating ideas, the 'Jigsaw' design pattern for structuring a collaborative project including a sequence of tasks, and the 'one minute papers' design pattern to encourage metacognitive thinking at the end of the sequence of learning activities. The favourite collaboration design patterns used by a considerable number of PCEs were: the Jigsaw design pattern (used by 7 PCEs), the STAD collaborative pattern (used by 11 PCEs) and the JigsawII design pattern (used by 7 PCEs). As expressed by the PCEs, the STAD pattern was deemed as appropriate because it '*emphasizes heterogeneous grouping, individual and group assessment as well as recognition of the students who performed the best work*'. PCEs also liked Jigsaw because '*it helps to share a big task among the students*' and Jigsaw II as it "*combines good structuring of the collaborative performance of a big task with recognition of the best work*'. It is worth noting that most PCEs (21 PCEs), designed rewarding procedures for the students who produced the best work.

Evaluation design: All PCEs designed evaluation procedures for the investigation of students' achievement. Specifically, all PCEs designed questionnaires including all types of questions provided by LAMS: open response, multiple-choice and true-false questions. These questionnaires were assigned to be performed by the students after the end of the whole course. In addition, for the evaluation of students' achievement, their performance in facing essential tasks posed during the course was taken into account. In fact, the total grade of each student in most cases was the sum of the grades gained from their answers to the aforementioned questionnaires as well as from the quality of the work performed during the whole collaborative activity, while in a few cases the grade assigned to them from their participation in the communications within forums and chats was also added. 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.

Lessons learned from the empirical study

At first glance, the results emerging from this study show that the provided context free collaborative design patterns were thoroughly used by PCEs to design their online sequences of learning activities within LAMS. Specifically, PCEs 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. Only a few PCEs designed collaborative communication activities around a question seeking to enforce student-centered motivation in terms of encouragement of expression of individual opinions and experiences of the subject matter in focus. As regards cognitive preparation, most PCEs used

online questionnaires to diagnose students' previous and prerequisite knowledge in order to allocate them into groups. Needless to say, questionnaires 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 are given the opportunity to enrich and clarify their approaches to the subject matter in focus.

As to the learning materials incorporated into the PCEs' 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. In addition, no specific guidelines for studying these materials were provided to the students.

Class organization was also mainly left in teachers' hands. Some attempts were also designed by PCEs to guide their students to form groups according to 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 PCEs throughout the online courses they designed.

As a result, the collaboration activities designed by PCEs were mainly in the form of project work utilizing the context free design patterns provided. This fact clearly indicates that these design patterns helped PCEs to successfully perform collaborative learning design within LAMS, comparing to the results of another study (Kordaki, Siempos and Daradoumis, 2009), where prospective computer professionals failed to design actual collaborative tasks –despite the fact that they were provided with text-based relative information about the same collaborative methods. It is worth mentioning that these design patterns were used in their full configuration and in most times these patterns were used in combination. In this way more complicated design patterns were formed by PCEs. The most favourite collaboration design patterns were those emphasizing the structuring of the collaborative work as well as the recognition of the best work in front of the students. However, the learning tasks designed were incomplete in terms of encouragement of students' cognitive thinking: in fact, problem solving, concept formation and investigation tasks were incompletely designed because no specific design patterns were proposed to these PCEs. Assessment procedures were also designed for the evaluation of both; each individual student and each group.

Based on the results emerging from this study, it can be concluded that the design of collaborative online courses can become a reality by non experts in didactics, when specific context free collaborative design patterns are available. However, the advantages of collaborative learning go hand-in-hand with the design of the encouragement of thinking dimensions in students, such as: concept formation, decision making, problem solving and inquiry based learning. To this end, the availability of design patterns that can support the development of the aforementioned thinking skills in students is considered as a necessary provision for the teachers. In addition, the provision of information that can be selected from the Internet to be integrated into collaborative courses may be abundant, but this does not mean it is of acceptable quality and that students can comprehend it without the help of specific comprehension patterns. 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 and decision making towards the development of students' critical thinking skills, does not necessarily produce the benefits of collaboration. In fact, it appears that non experts need more help to participate in synchronous and asynchronous communication in a way that supports their cognitive structures. On the whole, it seems that the provided collaborative design patterns are useful and necessary in the learning design by non experts; however, more attention should be paid in the provision of specific learning patterns and communication techniques that promote critical thinking.

To this end, it could be claimed that teachers needed more support in the design of collaborative online courses which will effectively enhance students' critical thinking skills. Some ways of support -within LAMS- could be to emphasize: (a) the provision of support in the design of communication activities in chat and forums that encourage critical thinking, (b) the provision of essential content-free design patterns to encourage critical thinking, such as problem based, decision making, concept formation and inquiry based learning, (c) the provision of good examples of online courses that incorporate strategies for collaboration and

critical thinking, (d) teachers' involvement in teams aiming at the design of collaborative and encouraging critical thinking online courses and (e) the participation of teachers as learners in teams, within the context of such courses.

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