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Intelligent Collaborative e-Learning Systems and Applications

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Critical Thinking as a Framework for Structuring Synchronous and Asynchronous Communication within Learning Design-based E-learning Systems

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Abstract. This paper describes a conceptual framework focusing on the role that the development of learners' core cognitive skills and critical thinking plays on the success of synchronous and asynchronous communication within learning design-based e-learning systems. Based on this framework, we propose the design of specific tools which can be used by both teachers and students for structuring synchronous and asynchronous communication. In particular, a Cognitive Skill-based Communication Wizard (CSC-Wizard) is proposed as a supporting tool for helping discussion participants formulate appropriate interventions that express their intentions more clearly and thus facilitate the development of their cognitive skills more adequately. The design of this CSC-Wizard is based on modern social and constructivist views of learning and dialogue modeling. The idea, the rationale, the architecture and the interface associated with the proposed CSC-Wizard is presented through implementing a specific example within LAMS and MOODLE systems; which are widely used web-based, open source environments that support learning design.

1 Introduction

Thinking is essential as a foundation of learning. Philosophy and psychology foster also thinking as a framework of learning. In fact, the end product of education can be envisioned as 'the inquiry mind' [1]. In a nutshell, the centrality of teaching and learning within a framework that emphasize learners' cognitive development

needs no justification, if the goal of education is not just to prepare learners to provide ‘the right answers’ to pass their exams but to create rational, mature thinkers who will be able to acquire and to appropriately use knowledge in analyzing problems, searching for meaning and make thoughtful decisions [2].

E-learning has provided many benefits in education in terms of flexible opportunities to learn anytime and anywhere to communicate and collaborate virtually throughout the world. For teachers, e-learning is seen as having the potential to reach new student markets, facilitating the tracking of student progress and activities as well as providing opportunities for creating innovating learning environments using modern both; theories of learning as well as tools and resources [3]. There is a plethora of e-learning environments and tools to support online learning. These tools include: a) communication, such as chats, forums, bulletin boards, etc. b) content presentation c) learning organization, such as group formation, timetabling, etc. d) learning assessment and e) searching. First generation of e-learning environments such as WebCT, and BlackBoard provided teachers and learners with the opportunity to use all these tools in integration. However, these environments seemed to not obviously support innovative or diverse learning activities. In fact, these are strongly based around information transmission [4].

Contrariwise, the ‘learning design’ based e-learning environments seemed as promising and revolutionary contexts for the design of pedagogically sound e-learning events. ‘Learning design’ has been defined [5] as an application of a pedagogical model for a specific learning objective, target group, and a specific context or knowledge domain. 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. 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) [6]. The key principle in learning design is that it represents the learning activities and the support activities that have to be performed by different persons (learners, teachers) in the context of a unit of learning [7].

The IMS Learning Design (LD) specification aims to represent the design of units of learning in a semantic, formal and machine interpretable way [8]. LD has been related with: a) the use of ontologies and semantic web principles & tools; b) the use of learning design patterns; c) the development of learning design authoring and content management systems, and d) the development of learning design players, including the issues how to use the integrated set of learning design tools in a variety of settings [7]. Despite the fact that the IMS LD specification brings many pedagogical benefits when compared with earlier open specifications for eLearning, it is not easy for teachers to understand and work with it [9]. In fact, in the context of LD -non technologically experts- learning designers and teachers have difficulties because: a) no guidance is provided as to the kinds of pedagogic structures that they can create, b) the authoring using LD is not a simple task and c) the underlying concepts of the LD modeling language are not the same concepts

that a teacher uses to think about in planning educational activities. Thus, the role of teacher - in the context of LD - is reduced to the role of a practitioner who has to use 'learning designs' ready-made by expert learning designers. This role implies the use of traditional behavioristic perspective of learning where learner individual differences are not acknowledged [10].

Contrariwise, modern constructivist and social views of learning [11; 12] emphasize that teaching is closely related with both; design of appropriate activities for each specific group of students as well as appropriate monitoring and intervention by the teacher during the learning process. According to these modern views, learners are in the center of the learning process -that means- that the learning tasks and activities have to be designed taking into account their previous knowledge and idiosyncratic characteristics. To this end, teaching can not become a predefined activity performed by remote experts in learning design but an online modeling, decision making and mediation process performed by the teacher as a basic actor in the design of the learning process whose interventions are also necessary. Among various type of teacher interventions are: proposing appropriate suggestions, asking sound questions, providing constructive feedback, proposing alternative representations and tasks as well as focusing attention, developing a positive attitude towards the tasks, expressing their thinking etc. [13]. Taking all the above into account, it seems clear that teachers need both high level tools to understand LD and easy-to-use tools which are specialized for a particular pedagogic context. It is suggested [14] to represent pedagogical practice in an appropriate form that teachers can easily apply, adopt, adapt, and reuse. At this point, it is also worth noting that a typical teacher needs training for the formation of appropriate learning activities and lesson plans.

Various examples of e-learning environments close to the LD specification are reported such as: RELOAD [15], CopperAuthor [16], COSMOS [17], MOT+ editor [18] and ASK-LDT [19]. However, these are mainly intended for expert designers and not for teachers. In contrast, the learning design languages for teachers in the creation of pedagogically sound learning designs are currently in infancy. For example, learning design languages such as LDVS [20, 21], LDLite [14], 8LEM [22] (Verpoorten et al. 2006) Learning Nuggets [23] usually have no explicit syntax and semantics specified. A learning design authoring tool based on Activity theory has been also reported [24]. In addition, the design of a tool that supports the design of questions to support students' basic cognitive skills has been recently reported [25]. There are also some integrated systems that support the idea of 'learning design' such as; Alfanet [26], LAMS [27] and MOODLE [28]. COLLAGE also is a system close to IMS LD specification that is friendly for teachers to use and supports collaboration using design patters [29]. It is worth noting that, the type of editor that usually classroom teachers need should be similar to the authoring environment provided by LAMS. 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. Nevertheless, it was commented [27] that there is absence of

tools supporting broader ranges of collaborative tasks and also missing support for the concepts of group creation and monitoring. Furthermore, there is an absence of tools that could support teachers' attempts for 'learning design' by explicitly taking into account the development of learners' cognitive skills. In addition, a coherent and integrated framework supporting the design of tools that could support teachers in learning design -especially on the design of tools that support both; synchronous and asynchronous communication- and focus on the development of learners' cognitive structures and critical thinking have not yet been reported.

Taking all the above into account, we have designed an e-communication editor; namely, a Cognitive Skill-based Communication Wizard (CSC-Wizard) to support primary and secondary level education teachers in their attempts at learning design, specifically in intervening in synchronous and asynchronous discussions so that to encourage the development of core thinking skills and critical and creative thinking in learners. This editor was designed taking also into account theoretical considerations arising from modern social and constructivist theories of learning as well as dialogue modelling.

This paper is part of a wider work [30] aiming at the design and the implementation of a system that would be appropriate for teachers so that they can encourage their students to develop their cognitive skills. In the following section of this paper, the rationale of the design of the proposed e-communication editor is presented. Next, the architecture of this editor is described and an example is demonstrated within the context of well known open source e-learning environments that support Learning Design, namely; the LAMS and MOODLE environments. Finally, the advantages of the provision of the proposed e-communication editor are discussed and conclusions are drawn.

2 The rationale

2.1 Thinking dimensions as a framework of 'learning design'

In this section, an attempt has been made to concentrate on essential points of thinking dimensions, presented on the framework formed by [31] and to propose the design of computer-based communication tools that support the development of core thinking skills as well as critical and creative thinking by the learners. The aforementioned framework has been reviewed by numerous researchers, experts, practitioners and scientific organizations and also revised several times so as to be as accurate and helpful as possible. This framework has been proposed to be fully reflected in the design of learning curricula as well as in real teaching practices for the learning of each learning subject. Five dimensions of thinking have been iden-

tified, namely: a) Core thinking skills, b) Thinking processes, c) Critical and creative thinking, d) metacognition and e) the relationship of content-area knowledge to thinking. These dimensions reflect the various domain of thinking but do not form taxonomy. Usually, learners use these dimensions simultaneously -that means- they use core thinking skills and processes to solve a problem of a subject domain in critical and creative ways at the same time monitoring themselves and taking control of their learning. Next, we present a brief description of core thinking skills as well as of critical and creative thinking followed by a proposal of how to best structure discussion. The integration of these thinking dimensions with a dialogue model offers a solid base for the development of our cognitive communication tool that can be used in any an e-learning context.

a) Core thinking skills: These skills are used in metacognitive reflection as well as in thinking processes which are performed in the acquisition and performance of knowledge of each content area by the learners. Needless to say, these core skills are also implied in critical and creative thinking. Core thinking skills (TSi, i=1,...21) have been classified into eight categories (Ci, i=1,…8) and are briefly presented bellow:

C1. *Focusing skills*. Two skills are included: TS1) 'Defining problems' that means clarifying situations that are puzzling in some way, and TS2) 'Setting goals'. These skills can be used at any time during a task to clarify/ verify and also redefine one's efforts.

C2. *Information gathering skills*. Skills included: TS3) 'Observing' involving obtaining information using learners' one or more senses, and TS4) 'Formulating questions' implying the focus on important information and searching for clarification of essential issues through inquiry.

C3. *Remembering skills*. Here, fall the skills of: TS5) 'Encoding', that is the process of linking pieces of information to be stored in long-term memory, and TS6) 'Recalling' that implies the use of effective strategies to store information for easy retrieval.

C4. *Organizing skills*. Here are included the skills of: TS7) 'Comparing' that means finding similarities and differences between or among entities, TS8) 'Classifying' that is grouping entities into categories based on some of their attitudes, TS9) 'Ordering' that implies the establishment of a criterion and the use of it to put entities in order or hierarchy, and TS10) 'Representing' that means put information in such forms (visual, verbal, symbolic), so that relationships of its critical elements be demonstrated in a meaningful way.

C5. *Analyzing skills.* Skills included in this category: TS11) 'Identifying attributes and components' that implies the analysis and recognition of the parts that constitute an entity, TS12) 'Identifying relationships and patterns' that means articulation of interrelationships among entities and recognition of the repetition of a pattern, TS13) 'Identifying main ideas' that is finding the main message or line in reasoning, and TS14) 'Identifying errors' involving the ability of detection of er-

rors in logic and calculation procedures. These skills are crucial in the development of critical thinking.
C6. *Generating skills*. Here, fall skills such as: TS15) 'Inferring' implying the ability to go beyond available information to identify what maybe true based on learners' previous knowledge and reasoning, TS16) 'Predicting' that is the skill of anticipation of the progress and outcomes of a situation, TS17) 'Elaborating' that is improving understanding by adding relevant information and explanations.
C7. *Integrating skills*. Two skills included in this category: TS18) 'Summarizing' that means the learners' ability for condensing, selecting and synthesizing a cohesive statement from the data analyzed, and TS19) 'Restructuring' that is the ability of restructuring existing knowledge by incorporating new information.
C8. *Evaluating skills*. Here as well, fall the skills of: TS20) 'Establishing criteria' that implies the ability of establishing standards for judging about the value or logic of statements from both; philosophical and psychological points of view, and TS21) 'Verifying' that means confirmation or proving a statement by using the criteria of evaluation established using the previously mentioned skill.

Mapping core thinking skills to 'learning design'. Considering the core skills mentioned in this section, our framework proposes a specific vocabulary for critical thinking consisting of a number of appropriate key-words (see Section 3). These key-words can be used as labels in the construction of structured forums and chats, in the formation of relative questions, and in design patterns of learning tasks. To support teachers and students to successfully use these tools, our framework provides good practices of use of this vocabulary in designing good communication as well as appropriate questions and examples.

c) Critical and creative thinking. Both concepts are referred to the quality of thinking. Critical thinking has been defined as "reasonable, reflective thinking that is focused on deciding what to believe or do" ([32], p. 54). Important dispositions and abilities of critical thinking have been reported [33]. Creativity can be thought as 'the ability to form new combinations of ideas to fulfill a need' ([34], p. 324). Creativity has been related with: intense desire and preparation, internal locus of evaluation, reframing of ideas and working at the edge rather than the center of one's capacity.
Core cognitive skills that participate in critical thinking have been also reported [35] such as: TS22) Separation between facts and opinions. This skill implies the learner's ability to separate their own personal opinions which are arbitrary and some times biased from some facts that can be confirmed using specific data. TS23) Implementation-Improvement. This skill implies the learner's ability to transfer the knowledge constructed -in previous stages- in similar/analogous cases. Making also improvements of the solution constructed. TS24) Knowledge organization. This skill means that the learner is capable to form some diagrammatic visual hierarchical organization of the knowledge constructed during the data analysis and data transcendence stages of the experiment at hand. TS25) Empathy.

This means the learner's ability to make sense of the other people's feelings and emotions of the situation at hand. So he/she can take a distance from a situation and accept the individual differences referred to it. TS26) Reflection. Reflection has been described as the mental process of looking back over the completed experience and performance to asses, analyze, and make connections to convert experience into learning and to lead to new understandings and appreciations [36] (Boud, Keough & Walker, 1985). Few people are able to convert personal experience to transferable learning, principles and models through the experience alone.

Mapping critical and creating thinking to 'learning design'. Our framework uses the previously mentioned dispositions and abilities of critical thinking in the design of learning activity design-patterns as well as of structured communications in forums and chat rooms. Motivating tasks and tools that support monitoring and self-evaluation can also be designed to enhance critical and creative thinking. In this paper we show how the vocabulary of critical thinking can be used to facilitate participants' intervention in forums and chat rooms.

2.2 The role and importance of structured communication within e-learning systems

This section examines how learning and knowledge building can be facilitated by supporting the development of learners' core cognitive skills and critical thinking in the context of well-structured synchronous and asynchronous discussions in a virtual learning environment. To this end, a conceptual sociolinguistic framework is defined for modeling dialogue and understanding how learning evolves and how knowledge is constructed during the discussion process. One important issue to consider is the types of interaction that occur in a discussion, the intentions which are manifested and finally the knowledge produced. This approach aims at identifying the various types of interaction produced and examining how an interaction type is related to the learning that results from it. As a result, this framework allows the study of how knowledge is transformed and becomes common to all discussion members.

In particular, this section examines how the building and distribution of knowledge is manifested in the context of teacher-student and student-student interaction and how it can be studied in a virtual learning environment. This involves the definition of appropriate learning situations that encourage the development of core thinking skills as well as critical and creative thinking by the learners, and the distinction of two levels of participant interaction; the discourse and the action level.

At the discourse level, the essential element is the interaction among peers (participants need to interact with each other to plan an activity, distribute tasks, explain, clarify, give information and opinions, elicit information, evaluate and con-

tribute to the resolution of problematic issues, and so on). At the action level, task objects (e.g., documents, graphics) are created and manipulated. This approach focuses more at the analysis of the discourse level by seeing discourse as a medium and means through which the building and distribution of cognition is effected.

The framework proposed in this paper to support this model is based on an integration of several models and methods: the Negotiation Linguistic Exchange Model [37]; a model of Discourse Contributions [38]; and, the types of learning actions underlying a participant turn [39]. The structure of a long interaction is constructed cooperatively by using the exchange as the basic unit for communicating knowledge. Following [37], three general exchange structure categories are considered: give-information exchange, elicit-information exchange and raise-an-issue exchange, which consist of different types of moves (interventions) [40] and describe a generic discourse goal. More specifically, the goal of the actor who initiates the give-information exchange is to inform his/her partners about a certain situation with the aim to change the partners' mental states. Informing includes moves that explain, give an opinion, describe or remind a situation in different ways. The actor goal of the second exchange is to elicit the partners' state of mind (knowledge, beliefs, attitude, desire or abilities) of a situation which the actor is not aware or certain about. The actor goal of the third exchange is to raise an issue (a problem or question) to be resolved by the participants, which causes to explore their state of mind (knowledge, beliefs, etc.).

According to [37], there is a move that constitutes the "obligatory move" of the exchange, since it either carries or indicates completion of the discourse goal for which the exchange is initiated. The obligatory move of each of the above exchanges is: the first move of the give-information exchange, the second move of the elicit-information exchange and the third move of the raise-an-issue exchange.

According to [38], each move is seen as a contribution to discourse. This means that in a cooperative conversation, contributions are regarded as collective acts performed by the participants working together, resulting in units of conversation - typically turns (moves/interventions) - that aim to make a success of the discourse they compose. Yet, not all moves contribute in the same way toward the successful completion of the exchange.

Some moves have a pure contributing function toward the realization of the obligatory move of the exchange. This is the case of the first move of the elicit-information exchange, as well as of the first and the second moves of the raise-an-issue exchange. In fact, without the presence of those moves, the obligatory move cannot be realized; thus, those moves really contribute toward the realization of the obligatory move. Consequently, it is stated that successful realization of the obligatory move conveys evidence of (initial) success of the exchange [38].

In contrast, the other moves have a rather supporting function (provide evidence of support) toward the definite completion of the obligatory move and consequently of the exchange. This is the case of the follow-up moves of the three exchanges. Supporting moves are optional, so they may not be realized. In such a

case, they convey an implicit support toward the obligatory move, that is, toward the definitive completion of the exchange.

Based on the work of [39], [41], and [42], partners are involved in a process of realizing a number of learning actions which lead to the completion of the exchange goal. Each move type captures and controls the evolution of the learning action performed by a participant by setting the expectations of the type of learning actions which has to be realized next by the other participants so that the goal set by the initial move be accomplished.

Completion of an exchange expresses the mutual beliefs of all participants about the accomplishment of its discourse goal. Moreover, it implies the achievement of a certain degree of knowledge building and distribution among the different participants. This degree can be deduced and measured by exploring the core thinking skills as well as the critical and creative thinking skills proposed by this model. As explained in next sections, for each participant the model can measure the way he/she contributes toward the development of a specific thinking skill by looking at the types of moves (interventions) that the participants create. The model can also deduce the users' participation behavior (focusing, organizing, analyzing, evaluating, etc.), as well as the effectiveness and impact that each move has in the discourse and in the achievement of the current discourse goal.

In general, the three types of exchanges represent standard discourse structures for handling information and suggest a certain type of knowledge building, as a result of giving and eliciting information or working out a solution on an issue set up. These discursive structures enable the participants to take turns, share information, exchange views, monitor the work done and plan ahead. Most importantly, they provide a means to represent and operationalize the cognitive product at individual level, that is, the way the reasoning process is distributed over the participants as it is shared in a collaborative discourse.

Consequently, interaction analysis takes into account both the way the interaction is structured and the types of contributions which are explicitly defined and expressed. The analysis of these interactions yields very useful conclusions on aspects such as individual and group working, dynamics, performance and success, which allows the tutor to obtain a global account of the progress of the individual and group work and thus to identify possible conflicts and monitor the whole learning process much better.

A further innovation of this model is that it allows participants to end up an exchange which took several moves to conclude by "replaying" the main contributing move of the exchange. For instance, in a set-up-an-issue exchange, a solution move may not be sufficiently complete and thus has to be further elaborated, corrected or extended. To that end, another participant has the option to provide an amplify-solution move which completes the initial solution. In general, a "replay" move can be used to resume all the changes produced from the initial appearance of an exchange goal to be achieved to its final conclusion and acceptance by all participants. This can be useful both to reinforce the fact that the goal of the exchange has been completed successfully and to explicitly indicate the progress

achieved in the participants' process of knowledge building (especially as regards the participant who provided the main contributing move of the exchange).

Finally, the system requires the participant to commit certain action to indicate s/he is following a conversation, such as improve, support, assent or reflect upon a contribution. The aim is both to provide reliable indicators to measure the participants' critical and creative thinking skills and to promote the discussion's dynamics by increasing the users' interaction with the system.

Next, we show how the ideas presented in this model are further codified and implemented into a specific proposal of a Cognitive Skill-based Communication Wizard.

3 The proposed architecture for a Cognitive Skill-based Communication Wizard

Communication is usually supported within e-learning environments synchronously and asynchronously by using the features of chat rooms and forums correspondingly. Learners and teachers can take advantage of these features, in terms of allowing diverse communications, especially from their own space and time. Despite these advantages, these features usually are very generic and are not enriched in such a way as to provide specific support for the user (teacher/student) to design their interventions within communication settings so that to encourage learners' cognitive skills. To this end, our proposed CSC-Wizard aims to act as a scaffolding tool for the design of communication interventions that support the development of critical thinking and core thinking skills in learners. In fact, nine different groups of Communication labels (CL) dedicated for the design of twenty six types of participant communication-interventions are proposed. These CLs have the form of appropriate 'words' which can be selected by the user (teacher/student) to form appropriate interventions in forums and chat rooms. Each type of CL is assigned to each different core thinking skill mentioned in the previous section of the paper. For example, labels CLTS5 are dedicated to the development of the thinking skill TS5, and so on. In fact, for each thinking skill, at least two carefully designed labels have been designed for use by the users. The architecture of the CSC-Wizard is presented in Table 1, including the aforementioned basic thinking skills (column, 1) while the proposed Communication Labels (CLTSij, i=1…26, j=1, 2) for the formation of each type of specific user-intervention are also presented in this Table (column, 2).

Table 1. Examples of Communication-Labels that could be used for appropriate intervention to develop basic cognitive skills in learners

List of Basic Core Thinking Skills	**Communication Labels (CLTSij, i=1…26, j=1, 2)**
C1. *Focusing skills*	
TS1: 'Defining problems'	CLTS01: Identify/State a problem
TS2: 'Setting goals'.	CLTS02: Set/Propose a goal
C2. *Information gathering skills*	
TS3: 'Observing'	CLTS03: Observe, Focus
TS4: 'Formulating questions'	CLTS04: Form a question, Request
C3. Remembering skills	
TS5: 'Encoding'	CLTS05: Encode, Codify, Check
TS6: 'Recalling'	CLTS06: Recall, Retrieve, Define
C4. Organizing skills	
TS7: 'Comparing'	CLTS07: Compare, Contrast
TS8: 'Classifying'	CLTS08: Classify, Categorize, Qualify
TS9: 'Ordering'	CLTS09: Order, Arrange
TS10: 'Representing'	CLTS10: Represent visually, Represent symbolically
C5. *Analyzing skills*	
TS11: 'Identifying attributes & components'	CLTS11: Identify attributes/ components
TS12: 'Identifying relationships & patterns'	CLTS12: Identify relationships/ patterns
TS13: 'Identifying main ideas'	CLTS13: Identify main ideas, Suggest main issues
TS14: 'Identifying errors'	CLTS14: Correct, Rectify
C6. *Generating skills*	
TS15: 'Inferring'	CLTS15: Infer, Deduce, Reason
TS16: 'Predicting'	CLTS16: Predict, Estimate, Provide
TS17: 'Elaborating'	CETS17: Elaborate, Process
C7. *Integrating skills*	
TS18: 'Summarizing'	CLTS18: Summarize, Conclude, Moderate
TS19: 'Restructuring'	CLTS19: Restructure, Modify, Replay
C8. *Evaluating skills*	
TS20: 'Establishing criteria'	CLTS20: Establish criteria/metrics
TS21: 'Verifying'	CLTS21: Verify, Ascertain
C9. Critical and creative thinking	
TS22: Separation between facts and opinions	CLTS22: Differentiate facts/opinions
TS23: Implementation-Improvement	CLTS23: Implement, Improve
TS24: Knowledge organization.	CLTS24: Organize, Structure
TS25: Empathy	CLTS25: Support, Understand
TS26: Reflection	CLTS26: Reflect, Think over, Acknowledge

4 Implementing an example of the proposed CSC-Wizard within learning design based e-learning systems

LAMS (Learning Activity Management System; http://www.lamsfoundation.org/) is an open source tool for designing, managing and delivering online collaborative learning activities. When using LAMS, teachers gain access to a highly intuitive visual authoring environment for the creation of sequential learning activities. These activities may be individual tasks, small group work or whole class activities. LAMS is based on the belief that learning does not arise simply from interacting with content but from interacting with teachers and peers. LAMS allows teachers to both create and deliver sequential learning activities which involve groups of learners interacting within a structured set of collaborative environments - referred to as 'learning design'.

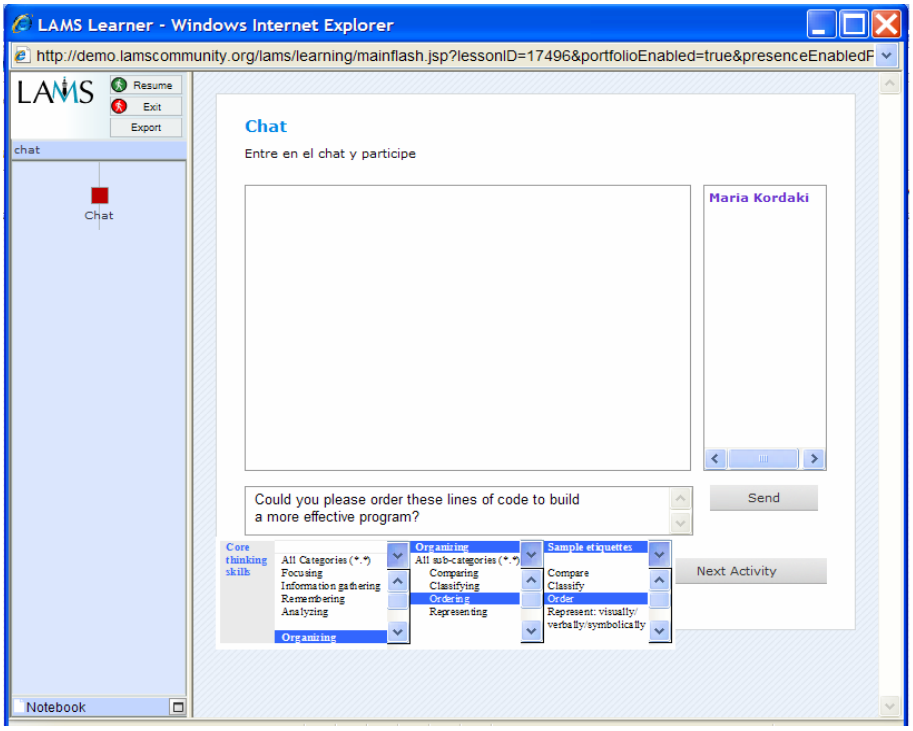

Fig. 1. Integration of the CSC-Wizard within a LAMS chat room

In essence, LAMS provides a practical way to describe multi-learner activity sequences and the tools required to support these. In fact, LAMS provides tools that support various activities such as presentation of information, writing and sharing resources, posing and answering questions as well as communication.

MOODLE is also a similar Course Management System (http://moodle.org/). Despite this fact, the tools that support synchronous and asynchronous communication in both systems are very generic. Consequently, we suggest the integration of the proposed CSC-Wizard within the forum and chat room tools provided by LAMS and MOODLE (see Figures 1 and 2 for the CSC-Wizard integration within a LAMS chat and a MOODLE forum). As is shown in Figures 1 and 2, when the CSC-Wizard is integrated into the forum and chat room, participants are provided with the opportunity to construct the nine categories of interventions described in the previous section. They can select a specific intervention category, e.g. the intervention that supports 'Organizing' core thinking skills. Subsequently, this skill is presented with all its sub-skill types which are included in this category; namely 'Comparing', 'Classifying', 'Ordering' and 'Representing', (see the second pull down menu in Figures 1 and 2). At this point, a participant can select a specific type of Communication Label (e.g. 'order') that expresses the intention s/he wants to convey, and then proceeds to formulate an appropriate intervention that matches the label e.g., "Could you please order these lines of code to build a more effective program?" (see the third pull down menu and the question produced in Figure 1).

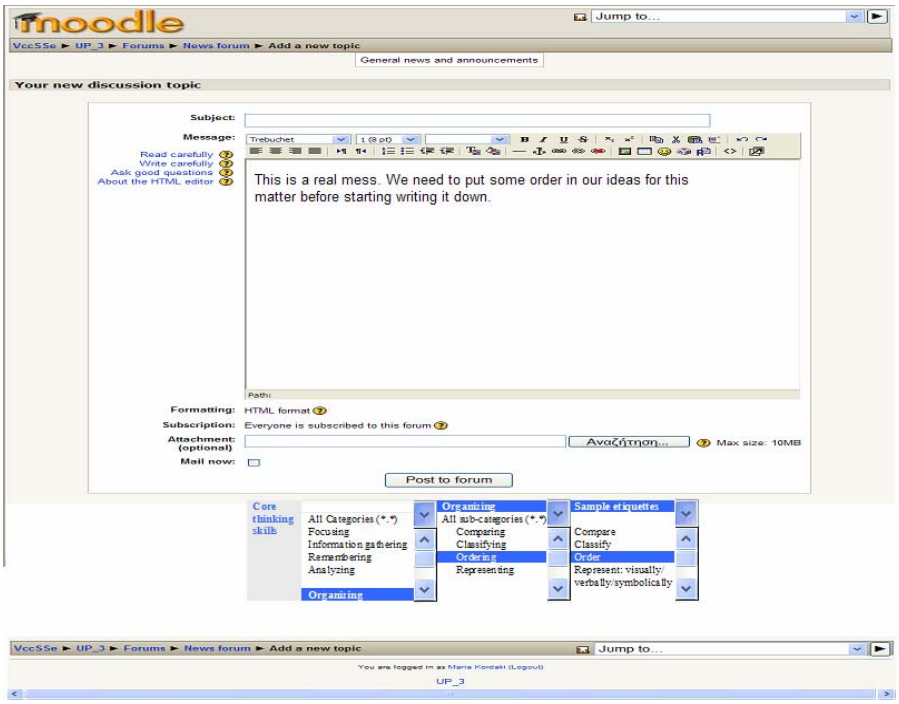

Fig. 2. Integration of the CSC-Wizard within a MOODLE forum

4 Summary and future research plans

This paper has presented the idea and the architecture of an e-communication editor - the Cognitive Skill-based Communication Wizard, or CSC-Wizard - dedicated to supporting teachers and students in the realization of effective synchronous and asynchronous communication by forming such interventions that encourage the development of core thinking skills as well as creative and critical thinking in learners. The design of this editor has taken into account social and constructivist theories of learning as well as a sociolinguistic dialogue model. In fact, the CSC-Wizard consisted of twenty six – core, critical and creative thinking skills – labels that can be used to construct an equal number of types of communication interventions. These labels were designed to support the following core, critical and creative thinking skills: a) *Focusing*, including the specific cognitive skills of: Defining problems and Setting goals, b) *Information gathering*, including the skills of: Observing and Formulating questions, c) *Remembering,* including the skills of: Encoding and Recalling, d) *Organizing*, including the skills of: Comparing, Classifying, Ordering, and Representing, e) *Analyzing*, including the skills of identifying: attributes & components, relationships & patterns, main ideas as well as errors, f) *Generating*, including the skills of: Inferring, Predicting and Elaborating, g) *Integrating*, including the skills of: Summarizing and Restructuring, h) *Evaluating*, including the skills of: Establishing criteria and Verifying, and i) *Critical & creative thinking* including the skills of: Separation between facts and opinions, Implementation-Improvement, Knowledge organization, Empathy and Reflection.

Each type of these labels is dedicated to support the development of a core thinking skill. Integration of the proposed CSC-Wizard within the Forum and Chat rooms provided by MOODLE and LAMS is also presented. However, it is worth noting that the architecture of the proposed CSC-Wizard can be integrated into any e-learning environment that supports learning design. By using the CSC-Wizard, users have the opportunity to design communication interventions, not by chance but in a focused way, aiming towards the development of core, critical and creative thinking skills in learners. Having a solid theoretical base, the potential features of the proposed CSC-Wizard can find wide application in field studies which are deemed appropriate to test its impact on constructing real learning design by teachers.

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