Learning design: a conceptual frame work emphasizing critical thinking

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Abstract: This work presents a conceptual framework for 'learning design'-based e-learning systems focusing on the role of the development of learners' cognitive skills and critical thinking. To this end, an attempt has been made to map basic dimensions of thinking to 'learning design' through the proposal of an innovative environment which includes various features such as: i) a set of design-patterns for the design of appropriate learning activities, ii) communication tools aiming for the development of these thinking dimensions as well as for the formation of appropriate teacher-interventions, iii) regulation tools to be used by the learners to take control of their learning, iv) monitoring tools supporting appropriate teacher interventions encouraging critical thinking, v) teacher scaffolding elements in terms of providing a teacher education curricula based on thinking skills, and vi) meaningful online help for teachers providing explanations and examples regarding the pedagogical and technical use of the tools proposed.

Introduction

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, then the centrality of teaching and learning within a framework that emphasize learners cognitive development needs no justification (Anderson, 1983). In a nutshell, thinking as a foundation of learning is essential.

E-learning has provided many benefits in education in terms of: a) flexible opportunities to learn anytime and anywhere as well as to communicate and collaborate virtually throughout the world and b) facilitating the tracking of student progress and activities as well as providing opportunities for creating innovating learning environments using both modern theories of learning as well as tools and resources (Conole and Fill, 2005). However, first generation of e-learning environments such as WebCT, and BlackBoard, seemed to be strongly based around information transmission (Britain and Liber. 2004).

Contrariwise, the 'learning design' based e-learning environments seemed as promising contexts for the design of pedagogically sound e-learning events. In fact, 'learning design' has been defined (Koper. and Tattersall, 2005). as an application of a pedagogical model for a specific learning objective, target group, and knowledge domain. An important part of this definition is that pedagogy is abstract and not depended upon both; context and content. Specifically, best pedagogical practices can be reflected in the formation of 'design patterns' which 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 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 in the context of a unit of learning.

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). 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 and non-technologically experts to understand and become actively involved with it (Griffiths & Blat, 2005). 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 experts learning designers. In fact, this practice implies the traditional behavioristic framework of learning where learner individual differences are not acknowledged.

Contrariwise, modern constructivist and social views of learning (Jonassen, 1999) 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. To this end, teaching can not become a pre-defined activity -performed by remote experts in learning design- but an online modeling, decision making, intervention and mediation process performed by the teacher as a basic actor in the design of the learning process. However, this kind of teaching is difficult for typical teachers to grasp, so they need appropriate education, help and supporting tools. Needless to say that, in order to integrate, this innovative view of teaching with learning design-based e-learning environments, teachers need high level tools to understand LD and possibly tools that are specialized for particular learning approaches. Finally, when such tools are accompanied with appropriate educational help and good examples, they will be most useful for teachers.

Various examples of e-learning environments close to the LD specification are mentioned in the literature such as: RELOAD (RELOAD, 2005), CopperAuthor (OUNL, 2005), COSMOS (Miao et al., 2005), MOT+ editor (Paquette et al., 2005) and ASK-LDT (Karampiperis & Sampson, 2005). 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 (Agostinho, et. Al. 2008, Bennett, et al. 2005), LDLite (Oliver and Littlejohn, 2006), 8LEM (Verpoorten et al. 2006) Learning Nuggets (Bailey, Zalfan, Davis, Fill and Conole, 2006) usually have no explicit syntax and semantics specified. A learning design authoring tool based on Activity theory has been also reported (Miao, van der Klink, Boon, Sloep, and Koper, 2008). In addition, the design of a tool that supports the design of questions to support students' basic cognitive skills has been recently reported (Kordaki, Papadakis, and Hadzilacos, 2007). In addition, various learning design languages which can be easily used by the teachers have been reported, which however, have no explicit syntax and semantics specified There are also well known integrated systems that support the idea of 'learning design' such as; LAMS (Dalziel, 2003) and MOODLE (Dougiamas & Taylor, 2002). COLLAGE also is a system close to IMS LD specification that is friendly for teachers to use and supports collaboration using design patterns (Hernández-Leo, Villasclaras-Fernández, Asensio-Pérez, Dimitriadis, Jorrín-Abellán, Ruiz-Requies and Rubia-Avi, 2006). Nevertheless, there is an absence of tools that could support teachers' attempts for 'learning design' by taking into account the development of learners' cognitive skills.

This paper is part of a wider work (Daradoumis and Kordaki, 2009a; 2009b) 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 structures. In this paper, a coherent and integrated framework regarding critical thinking is presented. An attempt has been also made to map core thinking dimensions within the 'learning design' context through the proposal of specific tools.

Mapping thinking dimensions within the 'learning design' context

The basic thinking dimensions presented in this section are based on the framework formed by Marzano, Brandt, Hughes, Jones, Presseisen, Rankin and Suhor, (1988) that 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 identified, 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. In the following section, a brief description of these dimensions is presented followed by proposals of how it is possible to treat them in terms of tools within the e-learning context.

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 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 errors 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. These key-words can be used as labels in the construction of structured forums and chat rooms, in the formation of relative questions, and in design patterns of learning tasks. Examples of the use of this vocabulary in designing good communication as well as appropriate questions and examples could be also provided.

Thinking processes

Concept formation. A concept consists of several information about one or more entities – objects, events, ideas or processes- organized by a person, so that, s/he is able to discriminate the particular entity or class of entities and also to relate to other entities and classes of entities (Klausmeier, 1985; p. 276). Various concept formation levels have been proposed such as; concrete and identity level, beginning classificatory level, and mature classificatory and formal level.

Principle formation. Principles are generalizations describing relationships between or among concepts in a discipline. Principles have been classified as: cause and effect, correlational, probability and axiomatic (Klausmeier, 1985).

Comprehension. Comprehension is the subjective process of extracting new information from various sources, interpreting and integrating it with what is already known to generate new meaning. Such sources would be; observing a phenomenon, reading, listening something, looking at a sign, participating in an activity etc. Various strategies have been proposed to achieve comprehension.

Problem solving. The ability to solve problems is essential in human development. In fact any goal directed behavior can be classified as problem solving (Anderson, 1983). Problems could fall in two broad categories: well defined and ill-defined. Despite the fact that, some general problem solving processes are lists of unordered strategies, various heuristics and specific strategies have been proposed to treat problem solving (Bransford and Stein, 1984; Frederiksen, 1984).

Decision making. This process is closely related to problem solving and it is also an activity that we all engage in, many times each day. In fact, the decision maker has to invent or choose the best among alternatives, taking into account essential criteria (Wales, Nardi and Stager, 1986). To this end, a 12-step decision making process has been proposed involving four operations: state the goal, generate ideas, prepare a plan and take action.

Scientific inquiry. This is a major thinking process that includes problem solving and decision making but its purposes emphasize explaining and predicting. Many different conceptualizations of scientific inquiry share common characteristics such as; describing phenomena, formulating and testing hypotheses. General models for the process of scientific inquiry have been also reported (Marzano, Brandt, Hughes, Jones, Presseisen, Rankin and Suhor, 1988).

Composition. This is a process towards the development of a product. Composition models have been proposed emphasizing: planning, translating and monitoring (Flower and Hanes, 1981).

Oral discourse. This process is central in the process of meaning making. Basic abilities for effective discourse have been reported and a number of tools are also available to the teacher to supervise conversation.

Mapping thinking processes to 'learning design'. By exploiting the various constructs proposed for the development of thinking processes, our framework proposes diverse design patterns for specific learning activities. Specifically, design patterns can be formed by taking into account the proposed: a) levels of concept formation, b) the classification of principles, c) strategies to achieve comprehension, d) problem solving processes, e) decision making processes, f) models of scientific inquiry, g) composition models and h) tools for oral discourse.

It is worth noting, that the core thinking skills reported in the previous section constitute the integral components of the thinking processes mentioned above. Since these general patterns of skills are characteristic descriptions of most thinking processes, it could be helpful to design units of learning emphasizing the use of these skills.

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" (Ennis, 1985, p. 54). Important dispositions and abilities of critical thinking have been also reported (Ennis, 1987). Creativity can be thought as 'the ability to form new combinations of ideas to fulfill a need' (Harpem, 1984; 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 thinking skills that participate in critical thinking have been also reported (Matsagouras, E 1997) 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. 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 activity-design patterns as well as of structured communications in forums and chat rooms. In addition the vocabulary of critical thinking can be used to facilitate teacher intervention. Motivating tasks and tools that support monitoring and self-evaluation can also be designed to enhance critical and creative thinking.

Metacognition

This term refers to 'one's knowledge concerning one's own cognitive processes and products or anything related to them. Among other things, metacognition refers to the active monitoring and consequent regulation and orchestration of these processes, usually, in the service of some concrete goal or objective' (Flavel, 1976; p. 232). Metacognition involves knowledge and control of both self and process. Knowledge and control of self means: monitoring and controlling; commitment, attitude and attention to the tasks at hand. By modeling the commitments as well as the beliefs and attitudes of successful learners as they approach particular problems and decisions -using appropriate tools- learners have the opportunity to reflect and self-regulate. To exert metacognitive control over a process, learners have to know: a) what knowledge is necessary for the task at hand, b) which solving strategies are appropriate and c) how to apply each particular strategy heuristic or procedure. In addition, on the one hand, learners have to control their behavior before, during and after the completion of the tasks at hand. That means they -throughout the entire learning process- have to: d) evaluate their learning, e) plan their strategies to fulfill a specific goal and f) regulate their learning behavior by checking their progress towards their learning goals. On the other hand, teachers need to monitor, scaffold and evaluate students' learning activity at both; individual and group level. In particular, teachers should be able to: a) intelligently monitor learners' progress, by exploiting their abilities in order to let them learn better, b) give learners purposeful and meaningful advice, specially in decision making situations, c) offer adequate support at the appropriate time and in response to the situation, d) track learners' involvement to assure that they will reach a satisfactory level of involvement in the learning process, and thus avoid high abandonment rates, e) evaluate the entire learning process more objectively, and f) adapt and personalize the course and its contents to each learner's characteristics, preferences and rhythm.

Mapping metacognition skills to 'learning design'. To fulfill the above mentioned skills and features, our framework proposes specific design patterns that include an approach of interaction analysis and an ontology that model the learners' interactions produced in a learning environment. In addition, it provides tools/services for the automatic generation of monitoring reports with visual information regarding students' learning activity, which provide an easy identification of students' progress, behavior and performance (Juan Pérez, Daradoumis, Faulin and Xhafa, 2009). Our ultimate aim is to represent and manage three dimensions of knowledge (support, evaluation and

adaption), which is achieved through the definition of complex indicators that are associated with the different learning purposes and dimensions we wish to model (e.g., awareness, feedback, self- and peer-assessment, etc.).

The relationship of content-area knowledge to thinking

Thinking skills cannot and should not be taught apart from content because content is inseparably linked with cognition (Marzano, Brandt, Hughes, Jones, Presseisen, Rankin and Suhor, 1988). However, each content area represents a particular way of mapping out the world and has specific approaches to investigation and analysis resulting in a body of ideas that are the discipline's conceptual core. Four main perspectives on content area were reported that could be used in teaching and learning: a) content-area learning as schema-dependent, b) content areas as models and metaphors, c) content areas as changing bodies of knowledge and d) content areas as special approaches to investigation.

Mapping main perspectives on content-area to 'learning design'. Taking into account the previously mentioned four main perspectives on content area, our framework proposes design-patterns representing essential learning techniques for schema developing, modeling and investigation as well as tools (aiming) for the study/generation of metaphoric representations.

Summary and future research plans

This paper describes a sound conceptual framework for 'learning design', based on basic thinking dimensions and critical thinking and propose the mapping of basic dimensions of thinking onto curriculum and instruction within e-learning through the design of appropriate features (basically, design patterns and tools). This framework can be used for the design of curriculum, instruction and assessment within a 'learning design' based e-learning context. Specifically, our approach aims for the formation of a 'learning design' environment integrating: i) a set of design-patterns for the design of appropriate learning activities towards the development of the reported thinking dimensions, ii) communication tools such as structured forums and chat rooms using appropriate initiators aiming for the development of these thinking dimensions, iii) regulation tools to be used by the learners to take control of their learning, iv) monitoring tools supporting appropriate teacher interventions encouraging critical thinking in terms of: questions and suggestions, constructive feedback, proposition of alternative representations and tasks, as well as focusing learners' attention, developing a positive attitude towards the tasks and also expressing their thinking, v) teacher scaffolding elements in terms of providing a teacher education curricula based on thinking skills, and vi) meaningful online help for teachers in the form of Wizards providing explanations and examples regarding the pedagogical and technical use of the tools proposed. A full development of the proposed 'learning design' environment is currently under construction.

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