Improving participation and critical thinking of students using LAMS

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Abstract
While LAMS has proven to be an easy and intuitive interface for both teachers and learners, the authoring of learning activities to create cohesive digital activities can be intimidating. By using a cognitive skill-based wizard based on modern social and constructivist theories of learning, teachers would be able to overcome some of these issues when designing activities. The goal is to provide a more specific guided approach through the establishment of knowledge base. The proposed tool would provide functional assistance to help teachers understand how the activity works and provide instruction as to how they can create better educational activities that develop critical thinking in learners. Critical thinking is critical to achieve good teaching practices and learning outcomes. In this paper, we present how a cognitive skill-based question wizard might assist teachers to create better assessment learning activities in LAMS.

Keywords: lesson plan, teacher, cognitive skills, critical thinking, LAMS

Introduction

Traditional education emphasizes assimilating facts, following orders and pleasing others. Modern education emphasizes a more collaborative and student-centered strategy. Students often demonstrate little propensity to accepting the responsibility of being active participants who are in charge of their education. In some cases, students are treated as though they are vessels to be filled. Contemporary conceptions of learning (Jonassen & Land, 2000) have been formed from the research into such learning areas as activity theory, situated cognition, authentic learning and social constructivism. Fosnot (1996) refers to constructivism as "a theory about knowledge and learning". The basic assumption of social constructivism (Vygotsky, 1978) is that learners construct knowledge in a social context as they try to make sense of it, continually modifying prior knowledge as they apply it to new contexts. This assumption is exactly the opposite of the notion that students learn by passively receiving information from lectures and books, memorizing it, and repeating it as a demonstration of their learning.

As with many methodological or pedagogical innovations, some teachers have difficulty applying them in the classroom. This is the problem faced and by Computer Science students at the Hellenic Open University. The data provided as the basis of this study was collected in a specially designed questionnaire and the analysis of a project assignment. Twenty eight Computer Science students at the Hellenic Open University participated in the study investigating the design of learning courses teaching Computer Science concepts. These students take part in a thematic unit (3-semester course) on Computers and Education which is part of the curriculum of the undergraduate Computer Science 4-year degree at the Hellenic Open University. In this thematic unit among others, the students (possibly future teachers of Computer Science at high school) learn how to design constructivist learner-centered educational activities with computer science concepts as their content. Three years of teaching this thematic unit to over 100 students has clearly shown that the students find it difficult to assimilate modern learning theory concepts and, more importantly, to apply them in practice by designing lesson plans that utilize such

concepts (Kordaki et al., 2007; Papadakis, 2007). In particular, the analysis of the data emerged from this study showed that these students have difficulties with modern theories of learning for the design of learner-centered courses. These difficulties mainly emphasized the formation of appropriate lesson objectives and appropriate questions that can support the development of learners' basic cognitive skills.

To increase student responsibility for and participation in the course and to promote critical thinking, the teachers design lesson plans setting suitable objectives and using different educational strategies and techniques (e.g. Socratic dialogue). A teacher asks a series of questions with the intent of demonstrating what the students are able to reason out on their own. Students were asked to develop a list of expectations and responsibilities they have for themselves as students and for their instructor/teachers. Other activities include students being given an initial reading assignment and then asked to develop questions for their next activity. Students are asked to think about how the information relates to their own lives. It is necessary for students to externalize their thoughts and ideas (Dillenbourg, 1999) in order to achieve proper reflection. The focus of the class meeting changes so that students are actively involved in class or synchronous virtual classrooms meetings. To encourage greater participation and collaboration a teacher could divide the class into small groups of 3 to 5 students to discuss specific questions. Then a representative of the group reports to the class what conclusions have been reached.

It is now clearly understood that a key dimension of education is the learning which arises from interacting with teachers and other students. One of the fundamental tasks in teaching and learning is to organize your subject content via lesson plans and learning designs. Lesson plans detail description of the course of instruction that help perspective new or inexperienced teachers organize content, materials, and methods. Learning design is crucial in all types of education, namely; face-to-face, distance and blended based on different pedagogical traditions (behaviorist, cognitive, social-constructivist). In the constructivist lesson the teacher becomes a guide for the student, providing bridging or scaffolding, helping to extend the learner's zone of proximal development. The student is encouraged to develop meta-cognitive skills such as reflective thinking and problem solving techniques. Despite the fact that there is a variety of theoretical considerations and models that provide teachers with resources for the design of learning activities, in practice it remains difficult; in fact, often teachers need *more specific* support in their learning design practices, such as dedicated tools and examples.

Taking into account all the above, we implemented a Lesson/Activities' Objective Wizard and a Cognitive Skill-based Question (CSQ) Wizard (previously proposed in Kordaki et al. (2007)) to support teachers in their attempts at lesson planning and learning design, specifically to form appropriate objectives and questions. These tools were designed to take into account theoretical considerations arising from modern social and constructivist theories of learning so that they might aid teachers in forming questions that should develop their students' cognitive skills.

In the following section the theoretical framework and the rationale of the design of the implementation of a Cognitive Skill-based Question Wizard are presented. Finally, the advantage of using the proposed wizard is discussed and conclusions are drawn.

Theoretical framework

One of the basic questions facing teacher has always been "Where do we begin in seeking to improve human thinking?" (Houghton, 2003). One place to begin is in defining the nature of thinking. The term *cognition* (Latin: *cognoscere*, "thinking deeply on … knowing or apprehending by the understanding of something") is used in several loosely related ways to refer to a faculty for the human-like processing of information, applying knowledge and changing preferences. The word "cognition" is defined as "the act of knowing" or "knowledge". Cognitive skills therefore refer to those skills that make it possible for us to know. *Cognitive skills* include any mental abilities and skills that are used to think, study, and learn in the process of acquiring knowledge; these skills include reasoning, perception, and intuition. They include a wide variety of mental processes used to analyze text, sounds, images animation, and video, recall information from memory, make associations between different portions of information, and maintain concentration on particular tasks. Cognitive instruction according to Vockell (quoted by Jones, 1986), is defined as "any effort on the part of the teacher or the instructional materials to help students' process information in meaningful ways and become independent and reflection learners".

Reflection is thinking for a period by linking recent experiences to earlier ones in order to promote a more complex and interrelated mental schema. Reflection is not necessarily critical (Brookfield, 1995; Ecclestone, 1996). The thinking involves looking for commonalities, differences, and interrelations beyond their superficial elements. The goal is to develop *higher order thinking skills*. Most of the teachers believe that "reflection" is useful in the learning process and "critical reflection" is one of main goals of adult education. However, it is often difficult to encourage reflection among the learners and to promote adult learners for critical reflection (Brookfield, 1988). Providing feedback probes may cause the learner to continue critical think about the topic. A wizard like CSQ could provide hints for encouraging reflection like: “Seek alternatives”, “View from various perspectives” “Seek the framework, theoretical basis, underlying rationale of behaviors, methods, techniques, programs” “Compare and contrast” “Give an example that contrasts” “Put into different/varied contexts” “Ask "what if...? Consider consequences”.

Critical thinking

The term “critical thinking” when used by educators has varied meanings in different contexts. *Critical thinking* is a process that allows people to gain new knowledge through problem solving and collaboration. Critical thinking focuses on the process of learning than just attaining information, involving discovering how to analyze, synthesize, judge and create-apply new knowledge to real-world situations (Walker, 2005). Teachers can improve student critical thinking and learning by helping them to develop all their cognitive skills. This means to help students learn how to find answers, solve problems, apply knowledge and make decisions the way practitioners in that descipline do. According to Ferguson (1986) critical thinking was promoted by utilizing Bloom's taxonomy. "Taxonomy” simply means “classification”, so the well-known taxonomy of learning objectives is an attempt to classify forms and levels of learning.

Bloom's taxonomy (1956) serves as the basis for what are now called *higher order thinking skills*. He created this taxonomy for categorizing level of abstraction of questions that commonly occur in educational settings. The cognitive domain taxonomy helps to create a standard around which further work could be done with the concepts of higher and lower order thinking. Within the cognitive domain, Bloom identifies six levels or type of objective: knowledge, comprehension, analysis, synthesis, application, and evaluation. Each level not only asks more of our thinking skills but includes the previous levels as subsets of the new level. (Houghton, 2004) The collection provides teachers with a structure which can be used to build lessons that take learners more deeply into any area of study.

Critical thinking is essential for all learners (Lipman, 1988; Resnick, 1987) as it is related to their abilities to reach sound conclusions based on observation and information (Paul, 1993), to assess the authenticity, the accuracy and the worth of knowledge claims, beliefs and arguments (Beyers, 1987) and also to apply everything that they know and feel in order to evaluate their thinking (Norris, 1985). Accordingly, teachers need to diversify their teaching methods in order to encourage learners to develop their critical thinking. Conventional lesson planning focuses on what the *teacher* will do (Gagnon & Collay, 2008). However, when designing a learning experience for students, teachers have to focus on what *students* will do if they are to help them develop basic cognitive skills and, consequently, critical thinking. It is worth noting that, in developing lesson plans, teachers bring with them their prior knowledge and experience, which usually reflect traditional views of behaviorist learning.

Lesson/Activity Sequence objectives

Lesson planning begins with a *mission* or *goal* statement (what the lesson is supposed to accomplish). The goal of lesson provides the teacher with the *destination* when he/she begins the instruction. Once he/she has a clear well defined mission statement, it will be obvious what he/she and his/her students need to do to achieve the goal and *how* to determine achievement. Generally, learning objectives (*how does he plan his/her students to achieve the goal*) are written in terms of learning *outcomes.* What does teacher wants his/her students *to learn* as a result of the lesson? They describe precisely the intended purposes and expected results of teaching activities and establish the foundation for assessment. It is a description of what a student does that forms the basis for making an inference about learning.

There are different frameworks of levels of thinking that inform the writing of objectives, questions and assessments. Constructing behavioral learning objectives for lessons authors usually provide indicators (behavioral) which will indicate how a teacher will know objectives have been reached or achieved. A committee of colleges, led by Bloom (Krathwohl et. al, 1973), identified three domains: a) Cognitive:

mental skills (*Knowledge*), b) Psychomotor: manual or physical skills (*Skills*), and c) Affective: growth in feelings or emotional areas (*Attitude*).

Teachers could introduce Bloom's taxonomy of educational objectives. Behavioral verbs are the heart of learning objectives, which are in turn the core component of effective lesson plans. They describe an observable product or action. A teacher makes inferences about student learning on the basis of what a student produces or does. When an author is creating objectives or student learning outcomes for a course, sequence of learning activities or degree program could helped with tools that suggest some terms (verbs and definitions) suggested to be used. For example:

i) Verbs suggested to be used for levels of learning (Bloom, 1956): Knowledge (*Count, Define, Describe, Draw, Identify, Labels, List, Match, Name, Outlines, Point, Quote, Outline, Read, Recall, Recite, Recognize, Record, Repeat, Reproduces, Selects, State, Write*), Synthesis (*Categorize, Combine, Compile, Compose, Create, Design, Devise, Explain, Generate, Group, Integrate, Modify, Order, Organize, Plan, Prescribe, Propose, Rearrange, Reconstruct, Related, Reorganize, Revise, Rewrite, Summarize, Transform, Specify*), Evaluation (*Appraise, Assess, Compare, Conclude, Contrast, Criticize, Critique, Determine, Grade, Evaluate, Explain, Interpret, Judge, Justify, Measure, Rank, Rate, Summarize, Support, Test*).

ii) Definitions of Behavioral Verbs for Learning Objectives (Kizlik B., 2008): *classify* (to place objects, words, or situations into categories according to defined criteria for each category, the criteria must be made known to the student); *construct* (to make a drawing, structure, or model that identifies a designated object or set of conditions); *measure* (to apply a standard scale or measuring device to an object, series of objects, events, or conditions, according to practices accepted by those who are skilled in the use of the device or scale); *order* (to arrange two or more objects or events in accordance with stated criteria).

A wizard could help teachers write better objectives by reminding them of these verbs and definitions.

A Cognitive Skill-based Questionnaire wizard

Modern constructivist and social learning perspectives emphasize learning as an active, constructive and subjective activity where students are at the center of the learning process and it is the role of teachers to prepare fruitful environments and act as catalysts that encourage their students to develop both cognitive skills and their critical thinking (von Glasersfeld, 1987; Vygotsky, 1978). Inter-disciplinary, real-life learning activities that make sense to students are the best motivators for their active and passionate engagement in learning; combining this kind of activity with the posing of appropriate questions could create strong learning tools. In the context of these modern learning theories, the emphasis is on the design of objectives, learning activities and appropriate questions for reflection play a crucial role in the development of students' cognitive skills (Matsaggouras, 1997).

Questioning is also crucial in the development of 'design thinking' implied in any scientific discipline (Dym & Little, 2003). Questions, in general, can play a crucial role in the development of students' critical thinking and higher level thinking, enabling them to successfully face problem-solving situations and to 'transfer' knowledge from any subject area or curriculum to other areas, including everyday life (Flanders, 1970). Suitable preposition and questions play a significant role in, for example, setting objectives, introducing students to a learning activity, forming groups, building bridges between their prior knowledge and the knowledge to be learned, expressing their thinking and supporting problem solving, reflection and assignment.

Our approach (Kordaki et al., 2007) encourages teachers to focus on how best to organize what learners will do while at the same time developing their basic cognitive skills. There are 24 basic cognitive skills (CSi, i=1…24) reported in the literature. These skills have been classified into four basic groups (Matsagouras, 1997). Teachers could describe each of these types to the students and give example of questions representing each type. Most of them have a clear initial preference of writing "knowledge"-level questions.

Table 3: Examples of question-models to develop basic cognitive skills (Kordaki et al., 2007)

Groups & Categories of Basic Cognitive Skills		Examples of question-models
Data collection	**CS1. Observation**	*What do you observe ...* *What do you see…?*
	CS2. Recognition	*Please identify…*
	CS3. Recall	*Give the definition of…* *What is the meaning of…?* *What has been said by… about…?*
Data organization	**CS4. Comparison**	*Compare these… using the following criteria…* *Find the pros and cons of…* *Find both the similarities and the differences between.. and…*
	CS5. Classification	*Group these elements using the following criteria…* *Find the pros and cons of these…solutions*
	CS6. Ordering	*Find a criterion to order these…* *Order these…* *Find the 5 biggest/smallest …*
	CS7. Hierarchy	*Arrange these…by the following criterion…* *Sort these… by the following criterion…* *Put these…in an ascending/descending sequence…*
Data analysis	**CS8. Analysis of basic parts**	*Identify the parts/units/characteristics of…* *Define the data given and the objectives of….* *Refer to the appropriate phases of the solution plan for…*
	CS9. Flush out relationships	*Distinguish possible relationships among the data…* *Is there any reason that affects this phenomenon…?*
	CS10. Pattern recognition	*Is there any pattern that is repeated in…?* *Find out what is common in…* *Find out what is similar in…*
	CS11. Distinction between facts & opinions/judgements	*Clarify whether this …describes a fact or if it is a personal opinion* *Provide more than one view about the following…* *Provide logical arguments to support the following statement*
	CS12. Clarification	*What do we mean by…?* *Provide an example to clarify…* *When does this…have a meaning…?*
Data transcendence	**CS13. Explanation**	*Please explain how/why/what/the meaning of/…* *Could you provide any interpretation of the behavior of…?*
	CS14. Prediction	*Could you make any predictions about…?* *If we do…then what will happen?* *In the case of…find out…*
	CS15. Hypothesis	*If … then…*
	CS16. Conclusion	*Based on this/these…what do you conclude?* *Are there any exceptions to…?* *Are there any weak points in…?*
	CS17. Verification	*Please verify that…* *Please confirm that…*
	CS18. Error and conflict detection	*Point out the mistakes of/in…* *Are there any contradictions in…?* *What is missing in…?*
	CS19. Application and Improvement	*How can you improve this…in order to…?* *How can you apply this…in order to…?*
	CS20. Knowledge Organization	*Make a hierarchical tree to describe…* *Can you form a sequential structure of…?* *Characterize it according to the following criteria…*
	CS21. Summary	*Form an abstract of …(number) words to describe…* *Which are the main points of …* *Which are the top 5 essential points of …*
	CS22. Empathy	*Could you accept the role of…?* *What would be your answer if you were in the position of…?*
	CS23. Assessment/Evaluation	*Assess/evaluate this…* *What kind of criteria can you use to evaluate the…?*
	CS24. Reflection	*What have you learnt about…?* *Are there any points that you…?*

Learning Design and Learning Activity Management System

As regards to online education, a variety of tools is provided by well known e-learning environments. These tools can be classified into four main categories: a) communication, such as chats, forums, bulletin boards, etc. b) content presentation, c) learning organization, such as group formation, timetabling, etc. and d) learning assessment, such as automatically-corrected multiple-choice questions, portfolios, etc. In addition, a number of tools that facilitate the design of sketchy plans for learning activities and roles that learners can play are also provided (Koper and Tattersall, 2005). The latter can support a different perspective on online and blended education. Despite this plethora of e-learning platforms, tools that support the formation of constructivist lesson plans incorporating such questions that can support the development of students' cognitive skills have not yet been reported.

The potential of learning design to improve teaching and learning through web applications is a subject that is currently gaining recognition. Learning Design provides a conceptual model for the description of teaching and learning processes determining all the sequence of activities to be followed by actors (staff, students) teaching/studying a topic. We use 'learning design' when the human activity of designing units of learning, learning activities or learning environments is meant (Koper & Tattersall, 2005). The benefits of Learning Design arise from its emphasis on how an educator selects and sequences a series of student learning activities, with this selection and sequencing described using a standardised and shareable format. In many ways, a Learning Design is the digital equivalent to a traditional lesson plan, with the important feature that the digital lesson plan is "runnable", ie, it contains the instructions needed to tell a Learning Design software system how to present a series of online activities for students, and manages the progression of students through these activities (Dalziel, 2008).

The Learning Activity Management System (LAMS; http://www.lamsfoundation.org/) is a free open source tool developed at the Macquarie E-Learning Centre of Excellence (MELCOE). LAMS is based on the theoretical basis of learning designs and it is used by teachers to design, manage and deliver online collaborative learning activities with resources. When using LAMS, teachers gain access to a highly intuitive visual authoring environment for the creation of sequential learning activities which may be individual tasks, small group work or whole class activities. These activities are not limited to content presentation (e.g. viewing multimedia materials or web pages) but can also include collaborative tasks and reflection.

While LAMS has been demonstrated to be an easy and intuitive interface for teachers and learners, the authoring of learning activities to create cohesive digital lesson plans can be intimidating. Currently LAMS provides about 16 different learning activities that teachers can use to create their learning activities. These learning activities, in most cases, are specific purpose tools like Forums, Chats, Multiple-Choice Questionnaires, Q&A, etc. (see Figure 1).While a lot of effort has been made to simplify and provide functional help for the activities interfaces (Ghiglione & Dalziel, 2007), currently LAMS does not provide support or assistance for teachers on how they create better teaching activities for learners. ie. offer pedagogical advice.

Previous research (Papadakis, 2007) shows that representing constructive tasks in learning design practice and providing appropriate support for learning designers is difficult. By using a cognitive skill-based wizard we hope to overcome some of these issues. Our goal is to develop a guided approach and to instantiate the knowledge base to allow more specific advice. These wizards would be combined with a series of learning design templates focusing on a core set of approaches to learning activities.

While providing functional assistance about how a particular activity is might be used, we believe that providing assistance to the teacher about how they can create better educational activities that develop critical thinking in learners is critical to achieve good teaching practices and learning outcomes.

Implementing the proposed CSQ-Wizard in LAMS

As an example for this approach, we have done an implementation for the LAMS Questions and Answers (Q&A) tool. In this implementation we have added a "Questions Wizard" to the authoring screen for the Q&A tool (available for testing at the moment: http://translations.lamscommunity.org/lams/). Similarly it could be implemented as a Learning Objective wizard.

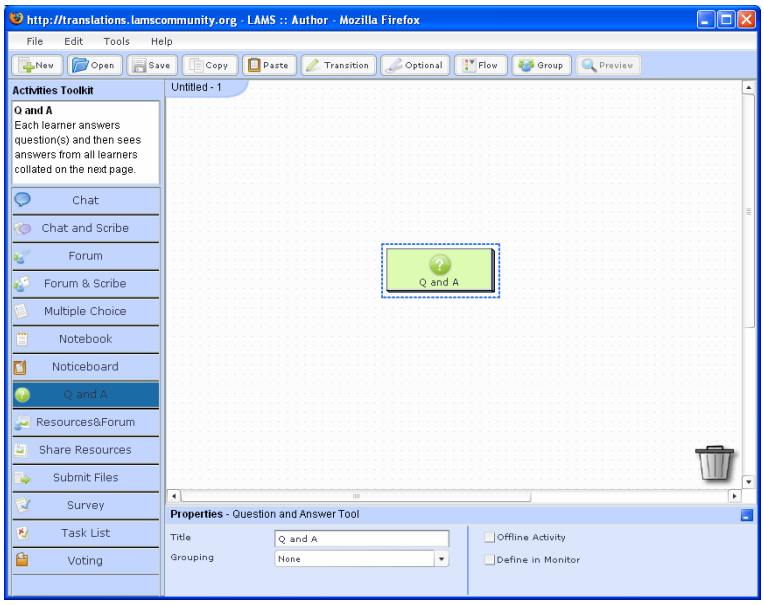

Figure 1: LAMS Authoring Tools

As the author is ready to start adding questions for this activity, we provide a non-intrusive question assistant (wizard) that allows the author to think about the objectives that he or she wants to achieve by asking these questions (see Figure 2).

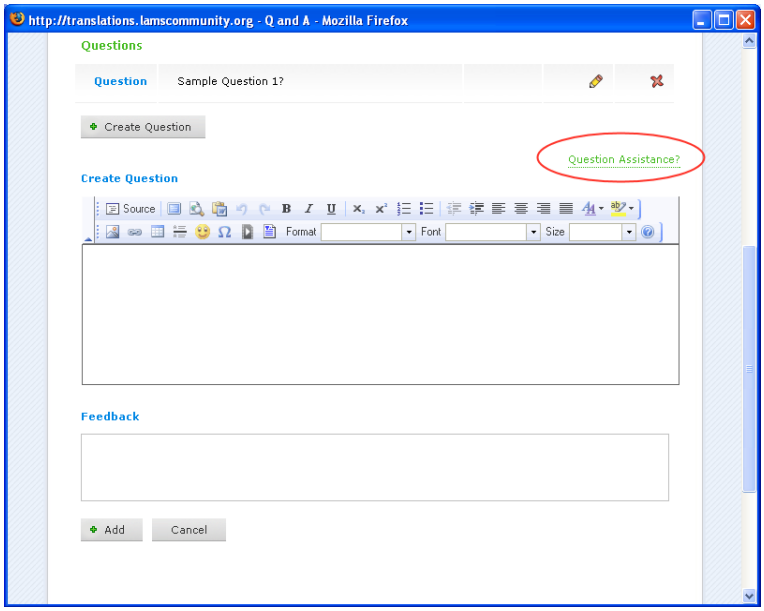

Figure 2: LAMS Q&A Authoring

The Question Assistance in the top left hand corner provides the CSQ Wizard to authors when required. The "Question Assistance?" link opens up the CSQ Wizard (Figure 3).

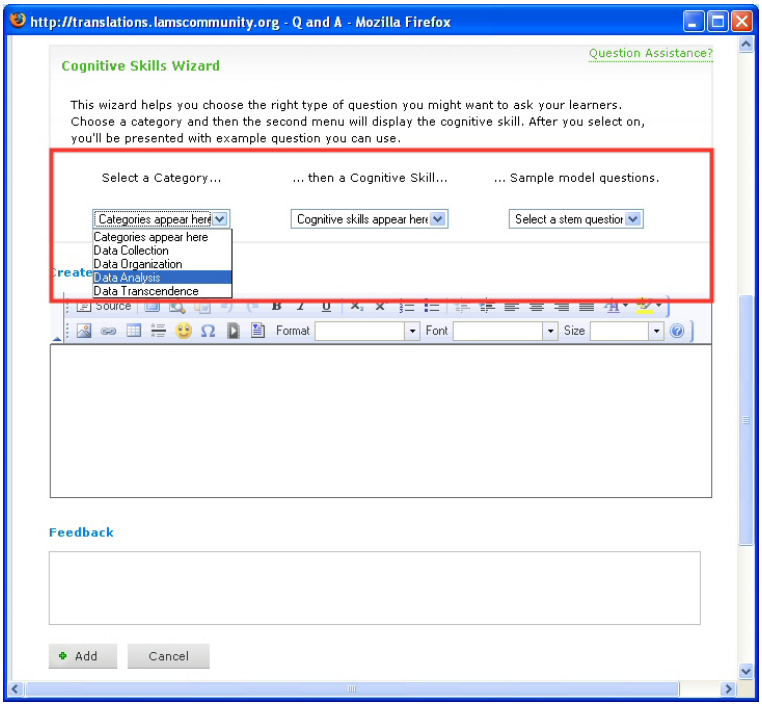

Figure 3: CSQ Wizard in LAMS Q&A

The CSQ Wizard displays three drop-down menus. The first one is for the categories: Data Collection, Data Organization, Data Analysis and Data Transcendence. Note that the second and third drop-down menus do not display a Cognitive skill or sample-stem question at this point.

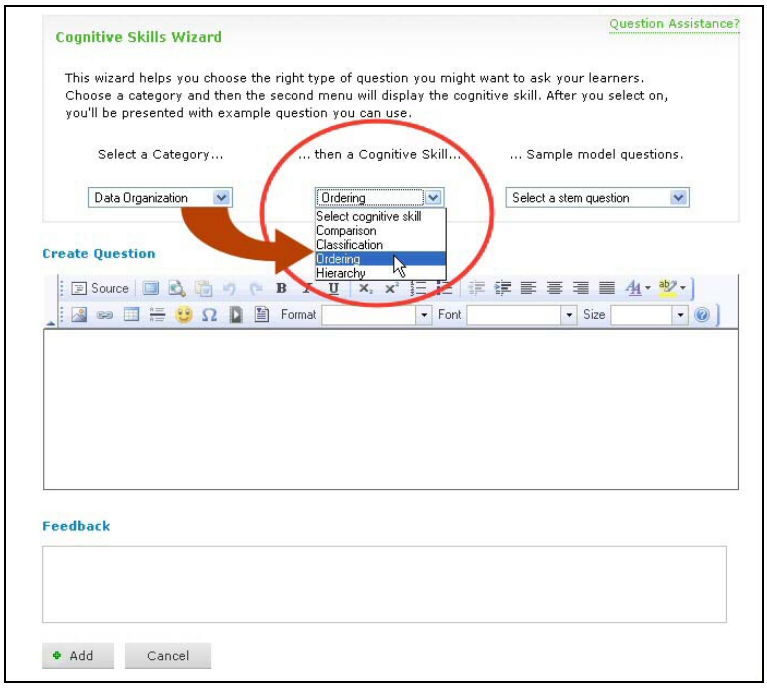

Figure 4: Cognitive Skills menu

Once a category is selected, the corresponding Cognitive Skills for this category is displayed in the Cognitive Skill menu (second drop-down menu). See Figure 4.

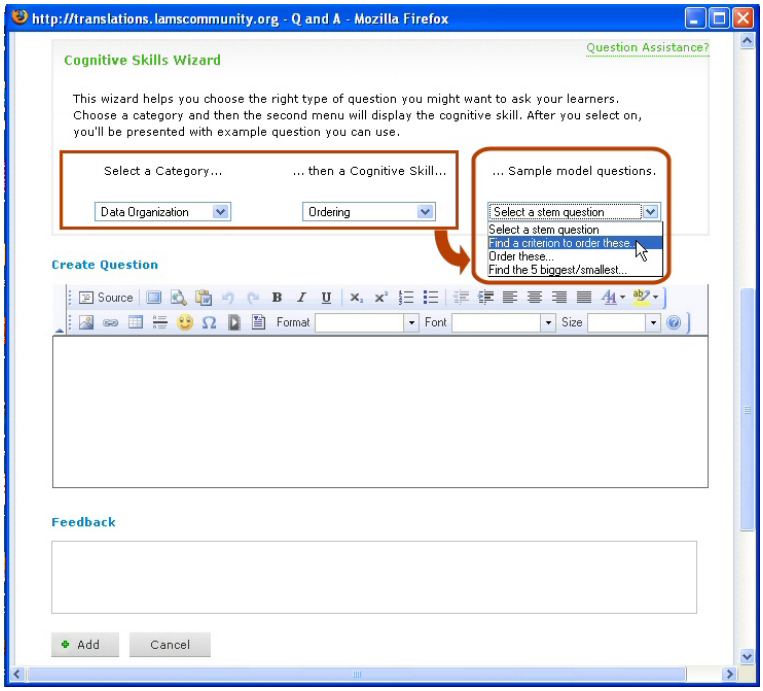

Figure 5: Sample questions for a selected Cognitive skill

As a Cognitive skill is selected in the second drop down menu, the sample model questions corresponding to the Cognitive Skill will be revealed in the third drop-down menu (see Figure 5). The selection of a sample question automatically results in appending the question text directly into the Question text area (see Figure 6). The teacher can append as many sample questions as he or she wishes without any system limitations.

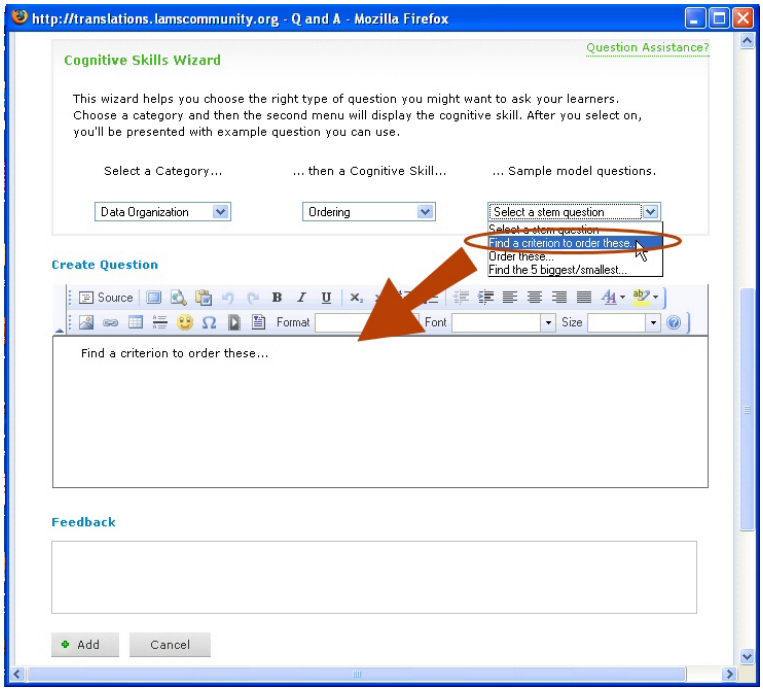

Figure 6: Sample model questions are appended to Question area

As can be seen, this non-intrusive assistant gives teachers the ability to frame their questions under a particular cognitive skill they want the students to develop.

Conclusions and Future Work

In this paper, we presented how a cognitive skill-based question wizard might assist teachers to create better assessment learning activities in LAMS. The wizard can enhance their attempts to design appropriate lesson plans and encourage the development of cognitive skills in learners. We presented an implementation of how cognitive skill-based question wizards can assist teachers to create better assessment activities in LAMS. In terms of future work, we would like to incorporate the CSQ Wizard to other LAMS tools as well. We acknowledge that the content of the categories, skills and sample questions might need to be changed so an editor to modify or extend these would be needed. Additionally, we would like to get feedback from the LAMS Community and other LAMS users about how these CSQ can be improved. These wizards are a new concept for LAMS and they are being developed with the aim of making them helpful for LAMS users is a priority.

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