LAMS AND Q&A CS-WIZARD THROUGH THE LENS OF COMPUTING GREEK TEACHERS: A PILOT EVALUATION STUDY

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Abstract

This study presents a pilot evaluation study of LAMS performed by Greek Computing teachers. The aim of this study is twofold: to investigate the usability of LAMS as a whole context of tools as well as to evaluate a specific learning tool -entitled the Questions &Answers Cognitive Skills –Wizard (Q&A CS-Wizard) - through the lens of the aforementioned teachers. This tool is integrated within LAMS for the improvement of the creation of questions to encourage the development of students' cognitive skills. Seventeen Computing teachers participated in a learning design experiment for the design of lesson plans using LAMS. The analysis of the data shows that those teachers' lesson plans were improved -through the use of the Q&A CS-Wizard within LAMS- when compared with their lesson plans designed without the use of this tool. Positive views also expressed by these teachers about the usability of LAMS and the whole experience they acquired during their participation in the said experiment.

1. Introduction

Education as a whole context has been dramatically influenced by the rapid evolution of Information and Communication Technology as well as by the multicultural composition of the student population, creating new requirements for the character and role of Computing teachers (Xochelis, 2008). In this context, the job of Computing teachers becomes more difficult, as they need continuous training in the new advances in both Computing and computing education in order to be effective teachers.

The traditional teacher-telling approach in computer courses in secondary education has been acknowledged as not having proven effective; indeed, it appears to be the major cause of the difficulties faced by the students when attempting to learn this subject matter (Seidman, 1988; Lidte & Zhou, 1999; cited in Gogoulou et al., 2008). Contrariwise, modern constructivist and social considerations regarding the construction of students' knowledge have been proposed as more appropriate for the teaching and learning of Computing (Ben-Ari, 2004). According to these considerations, the role of learning activities is essential during the learning process to increase students' interest and facilitate their understanding of the learning concepts in question, especially when these activities are related to real world problems (Jonassen, 1999; Vygotsky, 1978; Nardi, 1996). Furthermore, learning activities such as "Questions & Answers" are one of the most used educational techniques. However, all too often, the questions posed by teachers to their pupils encourage mainly low-level cognitive skills (Kordaki, et al., 2007) and, as a result, the development of students' critical thinking is unsystematically and ineffectively promoted.

Here, it is worth noting that in many countries, due to the increased availability of ICT and improved access to the Internet, teachers often design teaching interventions based on e-learning to complement their work in class or to replace parts of it (Herrington, Reeves & Oliver, 2005). However, despite the fact that there are many modern e-learning tools, their use is limited and usually restricted to the use of content management systems which do not facilitate the implementation of the previously mentioned modern educational approaches. In fact, most teachers continue to use the new media for the purpose of information delivery to their students (Goodyear, 2005) rather than to support and implement strategies based on learning activities and learning interactions. To this end, the design of effective teaching and learning lesson plans through the use of ICT, according to modern learning approaches, remains a major challenge for educators and researchers (Bates & Poole, 2003). Although there are a series of directives, recommendations and case studies (Salmon, 2002) which could be used for the design of appropriate lesson plans and the improvement of teaching - through the use of ICT- there is inadequate training, lack of practice and exchange of best practices to support teachers in general (Laurillard, 2002) - and Computing teachers in particular - in their use of the aforementioned features for the creation of educational interventions appropriate to the particular needs of their students (Papadakis *et al.*, 2007). To this end, the role of involving teachers in 'learning design' that focuses on the use of appropriate tools for the development of "digital lesson plans" through developing and sharing of sequences of learning activities is deemed to be essential (Dalziel, 2008).

Taking into account all the above, an empirical study has been designed aiming the investigation of the kind of learning design which takes place through the use of the Learning Activity Management System (LAMS; Dalziel, 2003) through the design of specific lesson plans for the learning of Computing concepts that encourage the development of students' cognitive skills and cultivate their critical thinking. This investigation is performed through a case study where 25 Computing teachers participated in a learning design distance experiment within LAMS, aiming at the design of lesson plans for the learning of Computing concepts. In this experiment, the role of Q & A CS-Wizard is also investigated through the comparison of these teachers' lesson plans realized by the availability/non availability of the aforementioned Wizard. Usability issues regarding LAMS as a whole context of tools are also addressed.

This paper is organized as follows: in the second section of this paper, the theoretical framework of this study is presented; in the third section, the main features of LAMS are briefly reported; in the fourth section, the context of the aforementioned case study is described, and then the results from the analysis of the data emerging from this study are reported, while the last section includes discussion of this data, conclusions and our future plans.

2. Theoretical framework

The teaching methodology, in conjunction with the media and the educational materials used in each learning course, plays a catalytic role in student learning (Jonassen, 1999). Moreover, at the heart of every modern teaching approach is the development of cognitive skills in students. Cognitive skills are hierarchically structured and operate as systems that produce cognitive outcomes (Matsagouras, 2002). Seeking ways to transform basic components of critical thinking into elements that constitute the teaching process and of cognitive products of critical thinking into specific components of the content of teaching, a taxonomy of twenty two (22) basic cognitive skills has been proposed (Matsagouras 2002). This taxonomy is broken down into four basic categories, namely: collecting, organizing, analyzing and overcoming data. These categories correspond to different types of learning which are also known as 'levels of learning' (Figure 1). As other scholars argue, referring to similar taxonomies (eg. Bloom's Taxonomy 1950; Revised Bloom's Taxonomy, 1990), it seems that there is a hierarchical development of skills, as the person progresses from the development of their original (lower) cognitive skills to their next (higher), moving gradually from the simplest to the most complex levels of learning.

At the first learning level (named *Informative leaning*), student learning involves their ability to collect information through the use of their senses (observation) and the functions of their memory (recognition, recall). The learning process at this level is incomplete, because the possibility of reproduction of verbal information does not necessarily indicate its understanding. In addition, the passive reproduction of information does not necessarily trigger the individual's higher cognitive processes (Matsagouras, 2002).

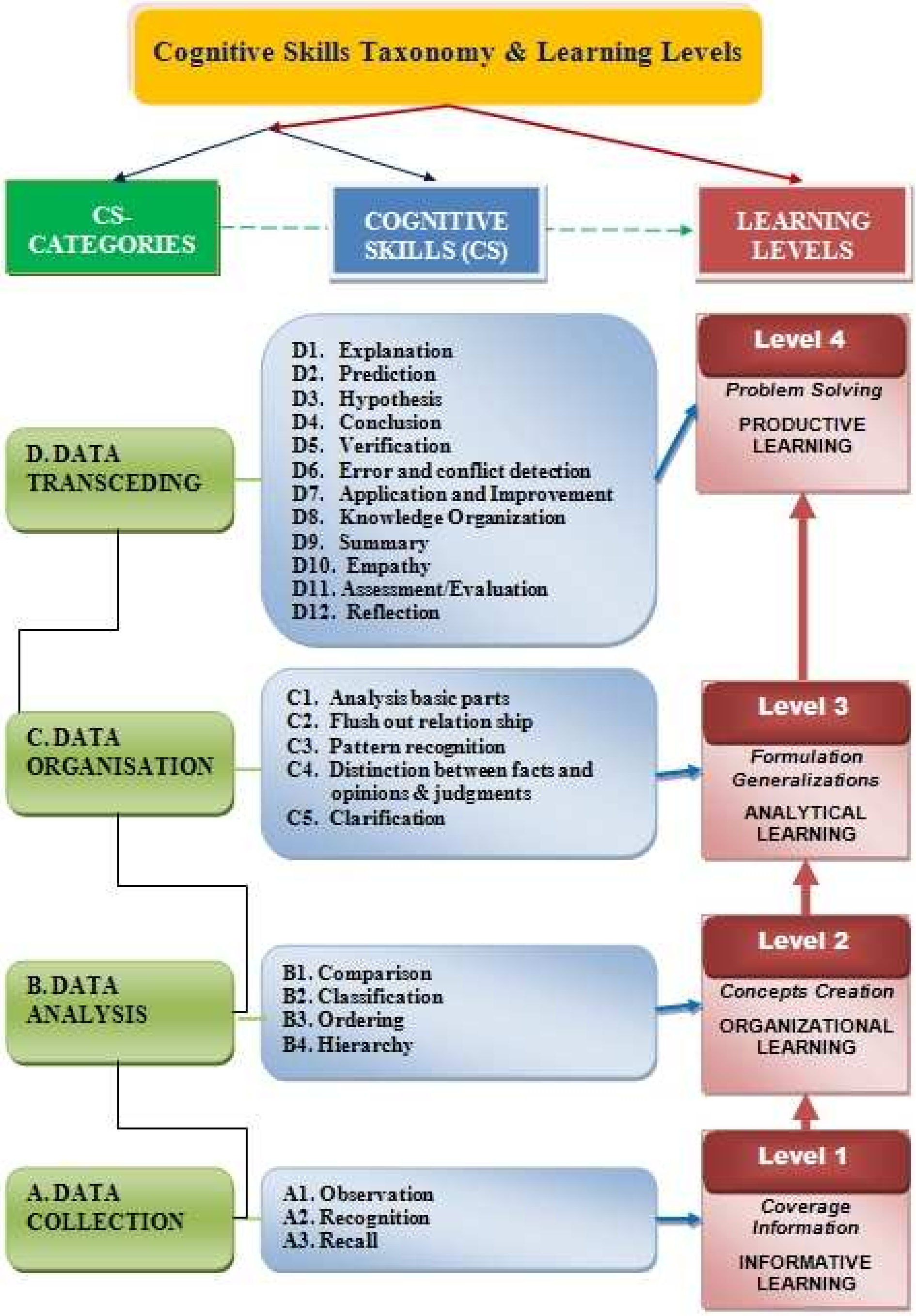


Figure 1. Learning Levels.

At the second learning level (termed *Organizational learning*), learning is cultivated by comparison, classification, order and hierarchy through data correlation and integration into a broader conceptual scheme giving the primary data organization and integration. Relationships and alternative forms of organization are also investigated, highlighted and explained at this level. This second level is higher than the first because it requires not only memorizing and understanding of individual data, but also involves data processing through inductive reasoning that primarily necessitates an amendment of the individual's cognitive schemata.

At the third learning level (called the *Analytical level*), learning refers to the investigation of essential inter-correlations of the data being sought through the analysis and induction processes concerning the internal structure of data aiming at the formation of appropriate generalizations.

At the fourth learning level (the '*Praxiako' level*), the individual uses his knowledge that is organized into patterns, principles and models in order to explain, interpret, predict, evaluate and solve problems in similar cases, to take the point of view of other individuals, reorganize their data structures and effectively address new or hypothetical situations.

Based on a critical review of the literature as well as on our empirical research (Kordaki, Papadakis and Hadzilacos, 2007a), significant problems were found in prospective Computing teachers' attempts to create appropriate questions incorporated in their lesson plans to encourage all these aforementioned cognitive skills in students and therefore their critical thinking. To address these problems, a specific tool – the Cognitive Skills Wizard (CS-Wizard) developed by Papadakis and Giglione, (2008) - was proposed for implementation within LAMS (Kordaki, Papadakis and Hadzilacos, 2007a). This tool aims to support teachers in the writing of questions that encourage the development of the cognitive skills mentioned above, and which can be incorporated into the design of their lesson plans. In the next section, basic features of LAMS are presented as well as the aforementioned CS-Wizard.

2.1. LAMS

LAMS (Learning Activity Management System) is an open source online learning environment, enabling the design, management and implementation of cooperative learning activities. Developed by Macquarie University in Australia, it is now supported by a wide community of learning (http://lamscommunity.org). LAMS can be used either as a standalone system or in conjunction with other Learning Management Systems such as Moodle, Sakai, Blackboard, etc.

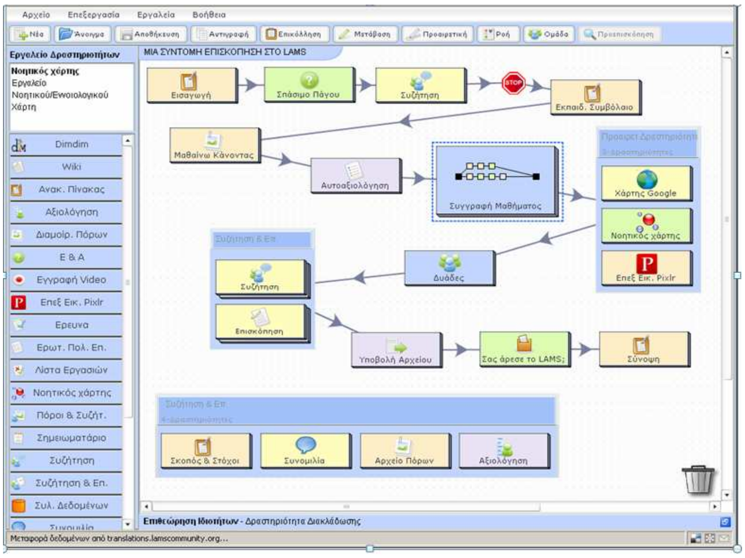


Figure 2. Author Environment.

LAMS provides teachers with a highly intuitive virtual environment (Figure 2) for the authoring of sequences of learning activities (learning scripts), which are based on the standard IMS Learning Design. In the environment of the author-teacher, a set of elementary learning activities is available, so as to enable the practical creation of lesson plans in the form of a flowchart of a sequence of learning activities. In addition, teachers can create, customize and share sequences of learning activities. The activities designed within LAMS can include individual work as well as work in large and small groups that could be based on specific content and cooperation standards. LAMS, also provides tools that support various learning activities, such as: presentation of different types of information, communication, supervision, branching, sharing resources, asking and answering of questions, etc. The integration of specific tools such as the aforementioned CS-Wizard - that support the author-teacher in his efforts to design appropriate questions that encourage the development of students' cognitive skills has been also reported (Kordaki et al., 2007a) and is briefly presented in the next subsection of this paper.

2.2. The Cognitive Skills Wizard (CS-Wizard)

The CS-Wizard is an extension of the tool 'Questions & Answers' included within LAMS and provides specialized support during the writing of questions. This tool can support the encouragement of a number of essential cognitive skills in students, depending on the teaching strategy adopted. Its development was performed using Java & Java Script (front end). From the system management, it is possible to: a) regulate the availability or not of the CS-Wizard, b) select the Taxonomy of Cognitive Skills (see Figure 1) and c) add new patterns of questions or change existing ones. The operation of the CS-Wizard (Figure 3) is based on the following progressive choice: a) a specific category of cognitive skills, 2) a specific cognitive skill included in the selected category during the previous step, 3) a list of appropriate models illuminating incomplete questions that support the development of the specific cognitive skill selected in the previous step and 4) a specific model preferred by the teacher. Next, this model is transported to the space where questions are formulated and the teacher uses it to produce the specific questions that she/he considers appropriate. In this way, the teacher-author of a course is provided with help on demand in order to create questions that encourage the development of diverse types of students' cognitive skills. In addition, teachers-authors may propose additional question models and are also able to characterize the existing question models (stems & samples).

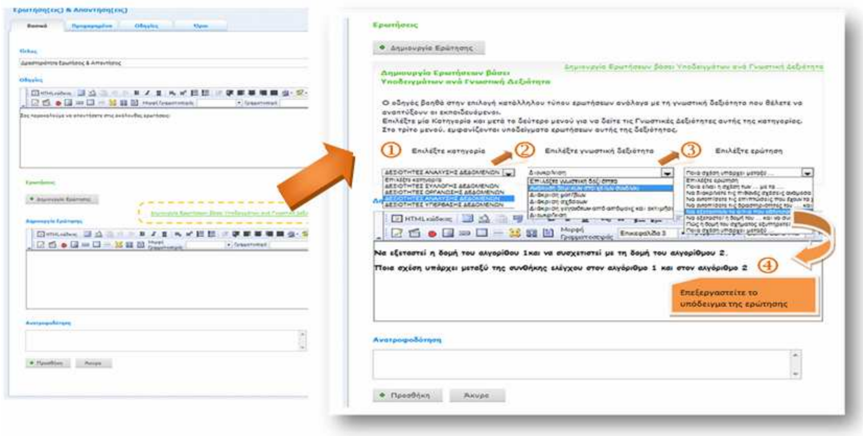


Figure 3. Questions & Answers and CS-Wizard.

3. Experimental evaluation

This work is part of a wider research study which aims to investigate the effect of tools provided by LAMS on the design of learning courses in Computing. Specifically, the part of the action research described in this paper aims to explore two questions:

(a) 'What is the effect of the CS-Wizard on the type of questions –in terms of the development of the cognitive skills mentioned above- included in the lesson plans authored by the Computing teachers participating in this experiment using the tools of LAMS?'

(b) 'How Computing senior teachers evaluate LAMS in terms of its' Usability'.

To evaluate the Q&A CS-Wizard, a comparative experimental study has been performed that can be characterized as a case study (Cohen & Manion, 1989). This experimental evaluation study was carried out with the voluntary participation of Computing teachers in an online learning seminar entitled ‘Introduction to teaching and learning through LAMS’. This seminar was implemented from March to May 2009 and through a combination of synchronous and asynchronous communication settings as well as through a combination of individual and collaborative activities. The trainees were provided with an instruction guide and enrolled in courses that were developed within LAMS, in the form of sequences of learning activities. Trainees were provided with the opportunity to spend two weeks on completing each of these sequences. Optionally, trainees were provided with additional sources of educational materials on LAMS for study. Once, every fortnight, an Advisory Group Teleconference (AGT) was undertaken. Advanced features and functions of LAMS were also demonstrated using the synchronous virtual class environment, as well as presentations by trainees, and medical queries. Throughout this seminar, the trainees received support and guidance from one of the authors of this paper, who acted as a teacher for these Computing teachers during the said experiment.

Trainees were assigned two learning tasks during the aforementioned evaluation study. In fact, they undertook to produce two learning sequences - lesson plans dedicated for the teaching of a specific Computing subject. In terms of duration, each sequence had to be analogous to a one hour face-to-face teaching intervention. The first sequence involved designing a lesson plan in LAMS dedicated to the learning of a Computing concept that these teachers had taught recently. To produce the second sequence, teachers were asked to dedicate it to the learning of the repetition structure in programming by a group of students of their choice. Before the first sequence of learning activities was designed, the Q&A CS-Wizard was not made available to these teachers and nor was reference made by the teacher to the theoretical issues regarding the development of students’ cognitive skills. However, before trying to form the second sequence of learning activities, these teachers had attended a demonstration of this Q&A CS-Wizard, that was also available for use, and they also provided with suggestions to use it. The following two criteria were used to characterize teachers who had successfully attended the above seminar: (a) their participation throughout the seminar and (b) the quality of lesson plans built.

After the end of the learning design activities, the participants were provided with a questionnaire dedicated for the usability evaluation of LAMS. This questionnaire has been inspired by Nielsen’s *ten usability heuristics* and adapted for empirical interface evaluation (Hartson, Andre, & Williges, 2001). The aforementioned questionnaire is consisted of 10 questions using a 5-point Likert scale. These questions are presented along with the teachers’ answers in the ‘Results’ section of this paper.

3.1. Sample

The participants (17 teachers) in the aforementioned teacher training seminar were selected by lot from the 38 applications made after an open invitation. Five of these teachers dropped out after the completion of the first task due to lack of time while three of the remaining teachers did not manage to fulfil the second task. Thus, this study sample ultimately consisted of the remaining seventeen (17) teachers who actively participated in all sequences of the learning activities during this seminar and who also successfully completed both of the tasks assigned. In terms of sex, the sample consisted of twelve men and five women who worked in six different regions of Greece, namely: Athens, Thessaloniki, Achaia, Ioannina, Evia and Chania. The majority of the participants (17 teachers) were active Computing teachers in diverse type of schools, namely: junior secondary schools (five teachers), general high schools (five teachers), and technical and vocational schools (7 teachers). All the participants were experienced teachers with seven to eighteen years of teaching practice.

3.2. Data and analysis

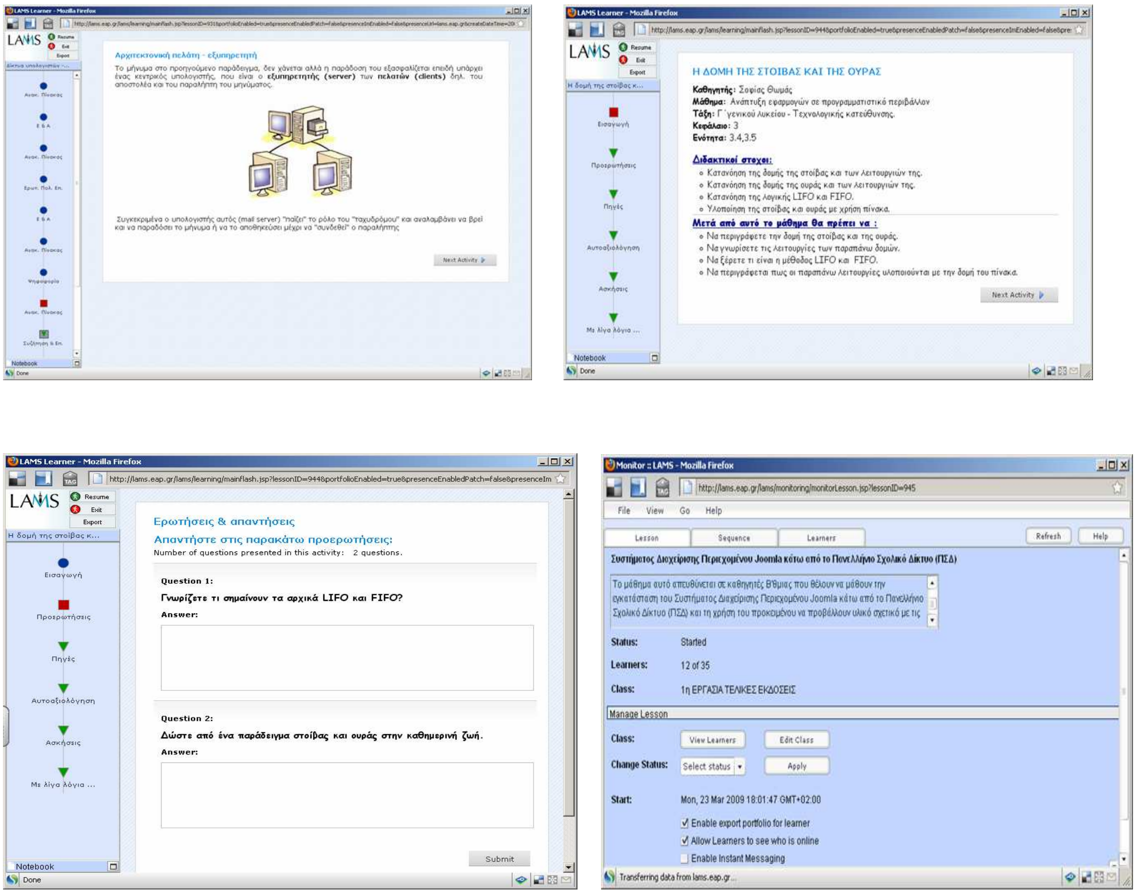
Diverse types of data were collected throughout this experiment, namely: (a) the lesson plans designed by the teachers to fulfil both tasks assigned, (b) two self-assessment sheets, which were completed by the participants after the completion of each task and which referred to their progress after each task, (c) two evaluation sheets for the aforementioned seminar and the tools provided by LAMS, each of which was completed after the end of each task, (d) the electronic recording of synchronous discussions (7 discussions in total), carried out using the CENTRA platform and the Dimdim, and (e) semi-structured interviews, where five teachers were interviewed (4 teachers using skype and one teacher in person). Qualitative data was recorded through follow-up memos and notifications, reflecting observation and recording data from the online seminar procedure. The data from oral dialogues, from interviews and quantitative data of the questionnaire were cross examined through our personal bias and innate reflections.

In this paper, the findings emerging from the analysis of questions included in the lesson plans formed by the teachers with and without the use of CS-Wizard are presented. These questions were classified – by the researchers- taking into account whether each question is intended to encourage the development of one or more of the cognitive skills outlined above (Figure 1, section 2 of this article). Therefore, 22 types of questions emerged which correspond to the 22 cognitive skills mentioned in the previous section. Finally, the data emerging from the two evaluation sheets reflecting the participants' views about the LAMS' usability are also presented.

3.3. Results

3.3.1. Pilot evaluation of the Q&A *CS-Wizard*

Teachers used the whole duration of the seminar -2 weeks- to attempt to complete the two lesson plans they were asked to carry out. Some screen shots of computing teachers' work are presented in Figure 4.



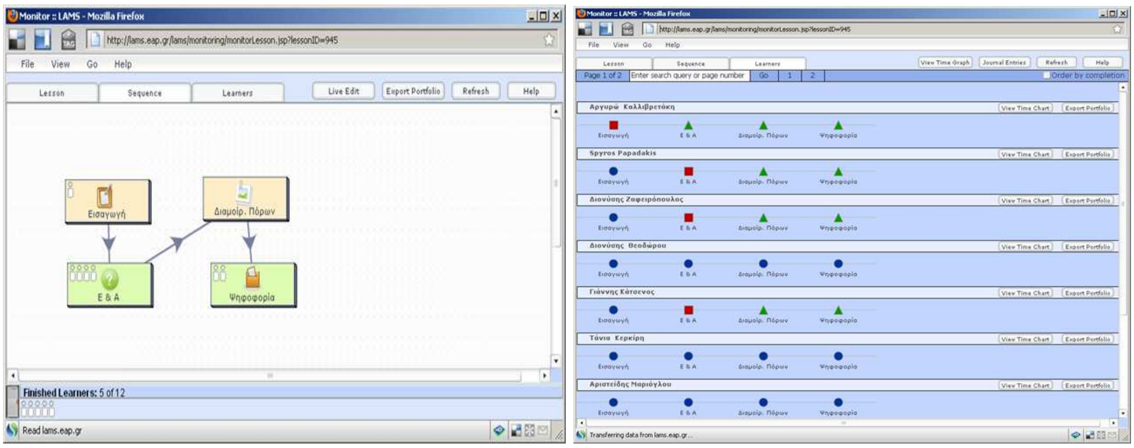


Figure 4. Screen shots of senior computing teachers' work.

The types of questions constructed and included by teachers in their first and second lesson plans are presented in Table 1. The second column of this table shows the type of cognitive skills that would be encouraged by the relevant questions designed by all teachers within their first lesson plans (without the use of the Q&A CS-Wizard). In the third and fourth columns of this Table, the number of these diverse types of questions and the percentage of each type of question are also demonstrated. In the fifth column of Table 1, the number of the diverse types of questions designed by all teachers within their second lesson plans (using the Q&A CS-Wizard) is presented. The 6th column of this Table also shows the percentages of each type of these questions. For example, the first row of Table 1 shows that teachers designed a total of 30 questions which encourage the development of skill A1 (observation skills) within their first lesson plan and also that they designed a total of 17 questions that encourage the development of that skill during the development of their second lesson plan, which was realized using the Q&A CS-Wizard.

Table 1. Questions & Cognitive Skills with & without the use of Q&A CS-Wizard.

No	**Cognitive Skills**	**Questions designed without the use of Q&A CS-Wizard**		**Questions designed with the assistance of Q&A CS-Wizard**	
		Number	**%**	**Number**	**%**
1	A1	30	13%	17	5%
2	A2	25	10%	19	6%
3	A3	47	**20%**	36	11%
	Total	***102***	***43%***	***72***	***22%***

4	B1	26	8%	14	4%
5	B2	28	9%	12	4%
6	B3	87	**27%**	17	5%
7	B4	87	**27%**	9	3%
	Total	***141***	***44%***	***52***	***16%***
8	C1	21	9%	33	10%
9	C2	2	**1%**	4	1%
10	C3	7	3%	9	3%
11	C4	0	**0%**	2	1%
12	C5	11	5%	19	6%
	Total	***41***	***17%***	***67***	***21%***
13	D1	4	2%	13	4%
14	D2	8	3%	11	3%
15	D3	2	**1%**	6	2%
16	D4	0	**0%**	10	3%
17	D5	2	**1%**	7	2%
18	D6	10	4%	11	3%
19	D7	11	5%	18	6%
20	D8	6	3%	7	2%
21	D9	2	**1%**	15	5%
22	D10	2	**1%**	13	4%
23	D11	5	**2%**	12	4%
24	D12	7	3%	12	4%
	Total	**59**	**25%**	**135**	**41%**

As can be seen in Table 1, most of the types of questions incorporated within the teachers' first lesson plans have been classified as able to encourage the following cognitive skills in students: A3 (Recall), B3 (Ordering), B4 (Hierarchy) (rates: 27%, 27% and 20 % respectively). It is worth noting that of minimum rates were the following types of questions: C2 (Flush out relationships), C4 (Distinction between facts and opinions and judgements), D3 (Hypothesis), D4 (Conclusion), D5 (Verification), D9 (Summary), D10 (Empathy) and D11 (Assessment /Evaluation) (rates: 1%, 0%, 1%, 0%, 1%, 1% and 2% respectively). However, the questions constructed with the assistance of CS-Wizard and incorporated within teachers' second lesson plans were smoothly distributed across the range of different types of questions, while the number of questions included in the informative and organizational levels of learning is reduced. To this end, one can see that the rates of questions (included in teachers' first lesson plans) that fall in these levels were 43% and 44%, while the rates of these types of questions included in teachers' second lesson plans are lower, at 22% and 16% respectively. It is also worth noting that the types of questions relating to the development of cognitive skills to the analytical and praxiako level learning increased (rising from 17% and 25% to 21% and 41% respectively).

Overall, the data that emerged from this survey provided some evidence that the mediation of the Q&A CS-Wizard tool dedicated to the creation of appropriate questions by teachers encourages: a) the increase of the number of questions designed by these teachers in order to cultivate a variety of cognitive skills in students and b) the reduction of the number of questions designed by these teachers to foster low-level cognitive skills while increasing the number of questions designed by these teachers to foster high-level cognitive skills.

3.3.2. Usability evaluation of LAMS by Greek computing teachers

Heuristic evaluation is a variant of usability inspection conducted by specialists, where usability is judged whether each element of a user interface follows specific established usability principles. According to Nielsen (1994; 152-158), there are ten general principles for user interface design. They are called "heuristics" because they are more in the nature of rules of thumb than specific usability guidelines:

1. *Visibility of system status*: The system should always keep users informed about what is going on, through appropriate feedback within reasonable time.
2. *Match between system and the real world:* The system should speak the users' language, with words, phrases and concepts familiar to the user, rather than system-oriented terms. Follow real-world conventions, making information appear in a natural and logical order.
3. *User control and freedom:* Users often choose system functions by mistake and will need a clearly marked "emergency exit" to leave the unwanted state without having to go through an extended dialogue. Support undo and redo.
4. *Consistency and standards:* Users should not have to wonder whether different words, situations, or actions mean the same thing. Follow platform conventions.
5. *Error prevention:* Even better than good error messages is a careful design which prevents a problem from occurring in the first place. Either eliminate error-prone conditions or check for them and present users with a confirmation option before they commit to the action.
6. *Recognition rather than recall:* Minimize the user's memory load by making objects, actions, and options visible. The user should not have to remember information from

one part of the dialogue to another. Instructions for use of the system should be visible or easily retrievable whenever appropriate.

7. *Flexibility and efficiency of use:* Accelerators - unseen by the novice user - may often speed up the interaction for the expert user such that the system can cater to both inexperienced and experienced users. Allow users to tailor frequent actions.
8. *Aesthetic and minimalist design:* Dialogues should not contain information which is irrelevant or rarely needed. Every extra unit of information in a dialogue competes with the relevant units of information and diminishes their relative visibility.
9. *Help users recognize, diagnose, and recover from errors:* Error messages should be expressed in plain language (no codes), precisely indicate the problem, and constructively suggest a solution.
10. *Help and documentation:* Even though it is better if the system can be used without documentation, it may be necessary to provide help and documentation. Any such information should be easy to search, focused on the user's task, list concrete steps to be carried out, and not be too large.

In this usability evaluation, a questionnaire section based on the previously mentioned heuristics has been adapted to investigate the Computing teachers' satisfaction level of LAMS. Reliability analysis using Cronbach alpha scale indicated a value of 0.835 for the internal consistency of the questions, while the mean value of the section scored a strongly positive 4.28 (table 2).

Table 2. Computing teachers' satisfaction about the usability of LAMS.

Category	**N**	**Mean**
1. Visibility of system status	14	4.30
2. Match between system and the real classrooms	15	4.48
3. User control and freedom	13	4.14
4. Consistency and standards	13	4.08
5. Error prevention	12	3.95
6. Recognition rather than recall	14	4.30
7. Flexibility and efficiency of use	16	4.28
8. Aesthetic and minimalist design	15	4.16
9. Help users recognize, diagnose and recover from errors	14	4.40
10. Help, Documentation and tutorials	12	3.81

4. Conclusions and future plans

In this study, we investigated the possibility of supporting the difficult and laborious task of creating lesson plans by teachers aiming at the encouragement of the development of diverse cognitive skills and the fostering of critical thinking in students. The conscious effort to develop the cognitive skills of students by their teachers is essential because receiving, processing, producing and disseminating new, valid, accurate and factual information is important in life. The analysis of data emerging from this study indicated that the process of designing such lesson plans and learning activities aiming at the encouragement of the development of critical thinking in students can be facilitated by using appropriate tools and environments that support learning design as LAMS. Specifically, the use of Q & A CS-Wizard to support the creation of questions based on taxonomy of cognitive skills played an important role in the improvement of the questions and consequently in the advancement of the quality of lesson plans designed by the teachers who participated in the survey reported in this paper towards the encouragement of critical thinking in students. This survey also showed that Computing teachers need training and support in the form of being provided with specific tools and examples for the construction of appropriate lesson plans. To this end, these teachers expressed their satisfaction about LAMS in terms of usability as well as a whole context of learning design. However, the number of participants in this study is limited, and thus its results cannot be generalized. Therefore, research with a larger sample of teachers from different schools and different countries would be appropriate. Our future plans are to extend the CS-Wizard to simultaneously support multiple taxonomies of cognitive skills and to create queries that are reusable even in different educational contexts and disciplines.

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