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USABILITY INSPECTION THROUGH HEURISTIC EVALUATION IN E-LEARNING ENVIRONMENTS: THE LAMS CASE

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Abstract

Innovative learning environments can enhance learning management and knowledge transfer. It is also argued that usable learning environments can do this with an effective and efficient way, according to HCI aspects. Therefore, usability evaluation of such environments is an essential process that can significantly contribute to the enhancement of the learning process. As an evaluation methodology, an extended version of heuristic evaluation, especially for learning environments is discussed. As an innovative learning environment, this paper presents LAMS, the way this has been set up in Hellenic Open University for educational and research purposes. The application of this methodology to LAMS is described and the evaluation results and outcomes are discussed.

Ambientes de aprendizagem inovadores podem melhorar a gestão da aprendizagem e a transferência de conhecimento. Argumenta-se também que ambientes de aprendizagem usáveis podem fazer isso de uma forma eficaz e eficiente, de acordo com aspectos HCI. Assim, a avaliação de usabilidade de tais ambientes é um processo essencial que pode contribuir significativamente para a melhoria do processo de aprendizagem. Como uma metodologia de avaliação, uma versão estendida da avaliação heurística, especialmente para ambientes de aprendizagem é discutido. Como um ambiente de aprendizagem inovador, este trabalho apresenta LAMS, como este foi implementado na Hellenic Open University para fins educacionais e de pesquisa. A aplicação desta metodologia para LAMS é descrita e a avaliação dos resultados e posteriores conclusões são discutidas.

Keywords: Learning Management Systems, Learning Activity Management System (LAMS), heuristic evaluation, usability.

1. Introduction

It is in Hellenic Open University's (HOU) nature to adopt innovative learning environments exploring their potential and the way they facilitate knowledge transfer, facing at the same time the challenge of open education. To that extend, HOU has set up "Learning Activity Management System", hereinafter, LAMS (LAMS-HOU, 2011).

LAMS is an environment that supports creation and distribution of sequences of collaborative learning activities addressing the demands of participative learning. LAMS as every educational environment, has increased usability demands that will ensure that LAMS supports learning efficiently and effectively. In order to investigate that, a usability evaluation is applied, aiming to reveal all usability issues that affect LAMS' learner acceptance. In this paper, the chosen usability method is heuristic evaluation specifically transformed in order to cover learning environments' needs. The method employed was based on Nielsen's 10 heuristic rules (Nielsen

& Mack, 1994) enriched with 5 additional heuristics specifically created for educational platforms, considering a number of studies using various heuristics. These 15 heuristics focus on the interface usability and not on the learnability issues. In brief, they revealed issues related to the matching between system and real world language and to minimalistic design.

Section 2 includes a brief introduction to learning management systems (LMSs) as a mean to support e-learning activities. In the same section, LAMS set up in HOU, the environment under examination, is presented and its relation with LMSs is described. In Section 3, the evaluation methodology is presented, along with the list of the applied heuristics. Finally, Section 4 summarizes the results and findings revealed through the usability evaluation of LAMS.

2. Learning Management Systems and LAMS

The concept of Learning Management Systems (LMSs) appeared during the previous decade when educational activities broke the barriers of the physical classrooms and started getting delivered through multimedia applications and later through online applications. LMSs are used for creating, distributing and managing digital learning content and aim to the delivery of educational material and educational services to learners participating in e-learning activities. Due to the fact that e-learning services usually get delivered through LMSs, it is a usual misconception that e-learning and LMSs is the same thing (http://chronicle.com/). Yet LMSs offer a much wider range of tools and services to support education and learning and recently shift towards more participatory environments according to the Web 2.0 attitude (Davis, 2007). The immediacy of information as well as the rapid transfer of knowledge via tools and services is redefining the nature of learning as well as the expectation of users from learning tools and learning services. LMSs evolve to adapt to learning ecosystems in accordance with e-Learning which matures from its 1.0 “publishing Web” to meet the demands of the 2.0 “participative Web” possibilities. The principles of Web 2.0 affect learning and knowledge transfer, thus LMSs gradually shift to a holistic approach towards learning including delivering content, creating access channels, and supporting dynamic containers, social networks, and resource locators (Beth et al, 2009).

The reference to a Learning Management System describes a set of tools integrated into a common framework transparently so as to provide a consistent environment to users. Within this environment various activities can take place either using a single tool, usually called component or module, or combining two or more together. The fact that LMSs are a collection of modules, allows any of them to be replaced by other, external tools, offering extended functionality. The trade-off is an inconsistent user experience but the benefits usually compensate for that. Such is the case of LAMS, the tool presented and evaluated in this paper, which focuses only on a very specific aspect of e-learning, the sequences of collaborative learning activities. While LAMS is supposed to provide rich functionality and a comprehensive

system for the design and implementation of learning activity sequences, it cannot be considered an LMS but more an LMS component.

LAMS is an innovative learning environment suitable for the design, management and distribution of online learning activities. HOU has setup LAMS server 2.1 since July 2008 for educational and scientific purposes. Since then, upgrades have been applied, and the evaluation described below was conducted with version 2.3.4. LAMS provides the supervisor with a visualized learning environment that permits the creation of learning activities' sequences using a variety of modules (Kordaki et al, 2007). Furthermore, a community in greek and international level provides supervision and support. Lessons in LAMS constitute of an ensemble of activities that are connected each other in an articulated way (Papadakis & Ghiglione, 2008). These activities may include individual or group assignments that potentially can involve the whole class. Hence, it is a LAMS' objective to provide opportunities for collaboration within the class (LAMS, 2010). Lessons created in LAMS have an autonomous nature: In case a learner wishes to join a lesson without interruption, the lesson's duration should be so long that the learner is not getting tired. Experience within the HOU has shown that an average duration of an hour is satisfactory. Moreover, while students join a lesson, LAMS permits the supervisor to track their progress in real time, informing him about the sequence's activities that each learner has accomplished. Figure 1 depicts the login page of LAMS-HOU.

Figure 1: LAMS-HOU Login Page (LAMS-HOU, 2010)

In LAMS, there are three standard roles: the learner, the supervisor and the lessons' author. The learner is able to join the lessons permitted to access, to navigate within the activities of each lesson and to communicate with co-learners in real time. The supervisor sets a lesson available to the learners he wishes, provides feedback to the activities and extracts a portfolio

that contains each learner's assignments. Finally, the author develops the lessons, designs sequences of activities according the supervisor's requirements. Along with these roles there are additional roles such as this of the system administrator that are not directly involved in the learning process and are not further discussed within this paper.

In the following evaluation, the lesson "Presentation of LAMS' modules" was used for the assessment of LAMS from the learner's aspect. This lesson aims to make the learner aware of the LAMS modules in an empirical way. Figure 2 depicts the activity map of the lesson opened in the author's environment, where the activity sequence is presented.

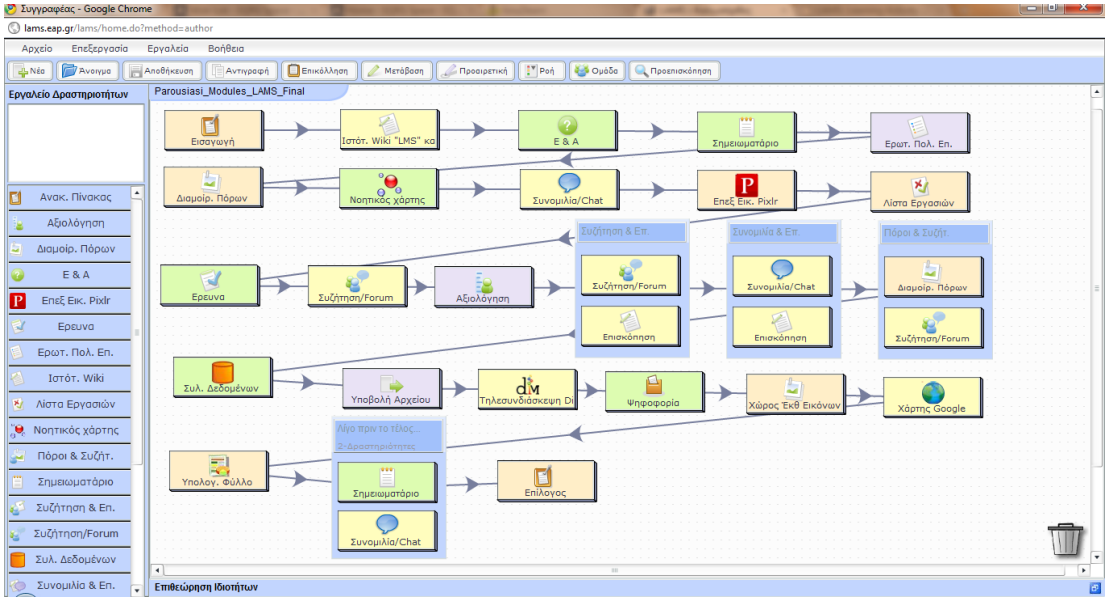

Figure 2: LAMS-HOU: Authors' environment and activity map of "Presentation of LAMS' modules" lesson

3. Usability Evaluation

After the presentation of LAMS and before continuing with the evaluation details, the definition of usability is significant to be cited. According to ISO 9241-11 (ISO 9241-11, 2003), usability is "the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use". Three factors are involved in this definition: Effectiveness, that inspects how completely and accurately user achieves specific goals, Efficiency, that measures the resources expanded in relation to the completeness and with accuracy which user achieves goals, and Satisfaction that discusses the freedom from discomfort, the willingness to reuse it and positive attitudes towards the use of the system, in general (Kostaras & Xenos, 2007).

Nielsen (Nielsen, 1993) advocates that usability is described by five parameters:

1. Speed and easiness of learning the system

2. Efficiency to use

3. Easiness to remember after some period of not having used it and level of memory load required for that.

4. Low user error rate and easiness to recover from them

5. Users' subjective satisfaction

Several methods for usability evaluation have been developed. These methods require various resources; the number of users, the users' level of skills and the required equipment vary. They also may be employed on various phases of the software life-cycle and they are applied as field studies or in usability laboratory environments. For LAMS, the employed method was the heuristic evaluation. The main reason for choosing this method is that it provides good results, and it is adequately well-established and requires relatively low resources. Hence, it is often called as "discount method" (Nielsen, 1993). This method is based on a set of relatively simple and general heuristics (i.e. rules or guidelines or general principles that are used to guide a design decision or to critique a decision that has been takes). Based on these heuristics, a structured critique of a system is conducted (Nielsen, 1993).

Heuristic evaluation can be applied to already operational systems such as LAMS. Regarding the number of the evaluators required, it involves a number of 3 to 5 usability experts who can reveal 75% of the overall usability problems, as Nielsen advocates. These experts (evaluators) judge the system under evaluation, checking whether it complies with the established usability principles mentioned above. In this method, a simple user cannot participate as evaluator, because the experience and point of view of the latter regarding the system he inspects is essential in the context of this method.

3.1 The Method applied

As many researchers consider (Avouris 2003, Dix et al, 2004, Kostaras & Xenos, 2007, Sharp et al, 2006), heuristic evaluation is employed in two phases: a. Overall inspection: In order to get familiar with the environment examined, the evaluator navigates through the interface for several minutes, as well as with the flow of the interaction and the general scope of the system, and b. Focused inspection: The evaluator goes through the interface several times, inspecting a variety of dialog elements. In order to facilitate the whole process, he is usually asked by the usability coordinator to follow. While the evaluator executes the scenario, he compares the system's performance and behavior with the list of heuristics and notes: the detected usability issue, the step of the scenario, where the problem was detected, and the heuristic that was violated with this issue.

Nielsen and Mack (Nielsen et Mack, 1994) have proposed the following list or heuristics that provide an effective coverage of the most common usability problems and fit into the majority of web-based systems.

1. Visibility of system status

2. Match between system and the real world

3. User control and freedom

4. Consistency and standards

5. Error prevention

6. Recognition rather than recall

7. Flexibility and efficiency of use

8. Aesthetic and minimalistic design

9. Help users recognize, diagnose, and recover from errors

10. Help and documentation

As many researchers in the field of usability (Dix et al, 2004, Nielsen, 1993, Sharp et al, 2006) mention, this list is not static and may be enriched of modified; this depends on the domain of the software under evaluation. In order to modify the list aiming to use for the evaluation of an e-learning environment such as LAMS, numerous evaluation studies (Ardito et al, 2005, Evans & Sabry, 2003, Karoulis & Pombortsis, 2003, Norman 2004, Reeves et al, 2002, Schunck, 2000, Ssemugabi & de Villers, 2007, Squires & Preece, 1999, Vrasidas, 2004) that use various heuristics, have been taken into consideration. This leads to a new list that is specifically created for the heuristic evaluation of e-learning platforms, and derives from the enrichment of the abovementioned list with five additional heuristics (Koulocheri et al. 2011):

11. Customization of the content: The system should allow the presentation of the content through multiple ways, permitting the user to customize it, without confusing him. The content provision should be carried out through alternative forms, while the transition from one form to the other should be performed with a visible and effortless way. Thus, all representations and metaphors should be meaningful. Customization of the platform: The system should let the user give a personal “look and feel” in the user interface, making him feel free to adjust the settings according to his preferences, while protecting him from potentially harmful actions with a discreet way. This heuristic also judges if the platform provides the user with the control to adjust what is published and to whom, with an efficient way.

12. Navigation: The platform should allow users to navigate within, with a clear and understandable way. The platform should inform the user continuously on where he is and where he can go to. This can be conducted ideally with visual means. In order to avoid user

attention destruction and consequently user disorientation, navigation fidelity is vital; the representation of elements of real world and the provision of complicated options should be managed effectively.

13. Interactivity: Interaction with the content: Interactivity between user and content should be encouraged by the platform with an apparent and pervasive way. The platform should make the user aware of the dynamic nature of the content; everyone can contribute to its creation whenever he wishes to. The platform should also promote collaborative leaning, allowing the community of users to create content jointly. An interaction option for that should be provided in the appropriate location on the interface. Interaction with peers: The platform should encourage interaction with peers promoting thus, ideas and experience sharing. Throughout the platform interface, it should be apparent that the user deals not only with the learning content but with his co-learners, and ideally even with the community of users, that are all ready to connect and collaborate with him.

14. Tools and Multimedia integration: This heuristic inspects if the platform allows the user to install new tools and widgets that will increase interactivity both with content and in peers. Ideally, the platform should allow him to manage the tools changing their location on the user interface. Additionally, the integration of external media and tools that allow content exporting should be supported by the platform effectively and efficiently.

15. Role management: In the case of platforms that support different roles of users, this heuristic inspects if these roles are discrete and if the access to the content is provided easily, for each one of the different roles. In case that role switching is supported, this should be accomplished with a clear way; the platform should allow the tutor to view the content with the same form as the learner views it.

3. 2 The Experiment

In the heuristic evaluation of LAMS, 4 evaluators were involved; 2 of them were usability experts with more than 7-year experience in the scientific domain and the rest of them had at least 3-year experience in heuristic evaluation. Prior to the evaluation, the coordinator of the process presented briefly LAMS and distributed the evaluation scenario to each evaluator. The scenario had been designed by the usability coordinator is such way, so as the evaluation lasted between one and two hours for each evaluator. The evaluation consisted of two parts: In the first part, the evaluator logged in as an author, designed a lesson, and the whole design process was inspected. The evaluators also had supervisor access rights, and after the design, he made this lesson available to his classroom selecting from a list of learners. In the second part, the evaluator logged in as a learner who attended the lesson “Presentation of LAMS’ modules”. This part critiques the platform from the learner’s aspect. During the evaluation, the tasks of the scenario were followed by each evaluator who validated the implementation of each

heuristic rule. When the evaluator discovered a usability issue, he examined which heuristics were violated, and identified the part of the scenario where the violation occurred, keeping notes in an evaluation form.

The couple of usability experts reported 38 and 56 usability problems respectively, that lead to 66 and 91 violations of the heuristic rules. The other two evaluators detected 31 and 21 problems respectively that lead to 48 and 32 violations. Totally, 146 issues were detected, that lead to 237 heuristics' violations. But, 63% of the reported problems were reported by more than one evaluator. Considering these duplications as a single problem, the aggregation of the evaluation forms, shows a total number of 54 usability issues that correspond to 127 violations of the heuristic rules, as the following Table 1 depicts.

Heuristic Rule	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Number of violations	9	27	6	12	2	12	8	19	1	4	4	14	7	2	0

Table 1: Number of violations per heuristic rule

Hereinafter, a number of characteristic usability issues per heuristic rule are presented and discussed:

1. Visibility of system status: The evaluators in the role of author reported that the system didn't inform on the estimated duration for actions such as saving a new lesson. They also reported lack of communication with the system in the authoring environment; in actions such as deleting an activity, the system didn't inform them if this was done successfully. The evaluators in the role of supervisor reported that the system didn't inform them on the result of their action when they made a lesson available to their chosen learners. The evaluators in the role of learner found that the text box that followed almost every activity seemed to be useless and in case they used it as a notepad, they found no option to save their notes. In the same line, options like "Done" were not in a visible location and the user should scroll in order to track them.

2. Match between the system and the real world: The evaluators in the role of author reported that dialogue messages that appeared when saving a lesson, were confusing. They also reported that many buttons had unusual or confusing names, for example "Add URL" button that finally leads to an edit URL action. They also mentioned that the module names were not adequately understandable (Fig.3, Area B). The evaluators in the role of learner, they found problems with button/link names in many activities (such as "Assessment", "Notepad", "Multiple choice questions", "Forum/Review", "Image Editor Pixlr"); some button/link names did not match with the action they lead to. Finally, some general issues were remarked; some options of links had faded colors and wrongly gave the impression that they were inactive, and in other cases, some button names didn't match with their icons, where they were present (Fig.3, Area A and C). The same happens with the tab options in the page right after login (Fig.5, Area B).

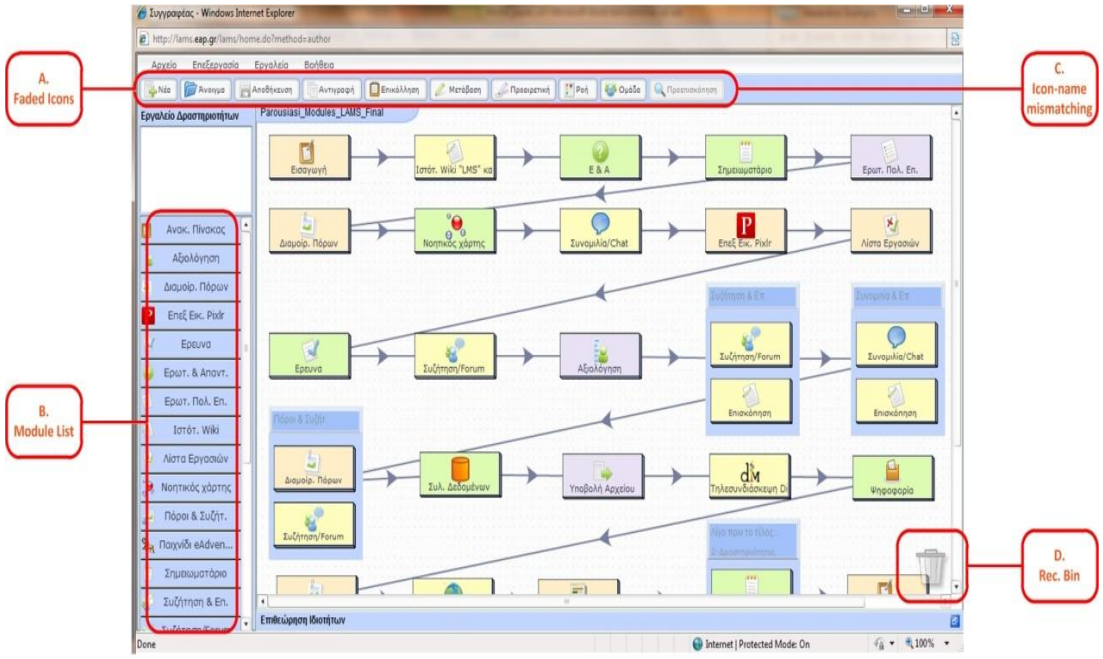

Figure 3: LAMS-HOU: Author's environment

3. User control and freedom: The evaluators in the role of learner found the text box that followed almost every activity very confusing and in case that they tried to fill in with some notes they found no button in order to save their text. They also mentioned that there is no "Back" button in every activity page. More specifically, the navigation within the "Mindmap" activity was considered to be complicated. Finally, they also reported a lack of user control during the creation of a new topic in the "Discussion/Forum" activity.

4. Consistency and standards: The evaluators remarked a number of inconsistency issues; Both as learners and authors, they mentioned that the "Next Activity" button wasn't followed by a "Previous Activity" button as expected. And in some cases, they couldn't even find this button despite the fact that there was a next activity. In author's environment, when they added content, for example a multiple choice question, they expected to find a standard button "Save", but saving was accomplished through the "Add question" button. The method for deleting (i.e. drag and drop to a recycle bin) an activity on the designing canvas was not visible enough while no alternative standard methods, such as right click and delete option, was provided (Fig.3, Area D). They also remarked that pop-up windows appeared more often than expected. The evaluators, in the learner's role, mentioned that "hand" cursor that was used for the navigation within the activities, didn't work with single click as expected, but with double click. They also reported that while attending a lesson, the icons for "Replay" and "Exit" from it, didn't follow the standards, and the "Extract" icon was missing (Fig.5, Area A). Finally, they reported that the "Chat" interface was not the expected one, and this affected the chat launching among the co-learners (Fig.5, Area D).

5. Error preventions: In this case, the windows that popped up didn't provide any navigation buttons and the users in general felt confused. The windows that often popped up and their lack of navigation buttons made the evaluators believe erroneously, that they have done an error. Furthermore, they noticed that in the module "Mindmap", there was no "Undo" button and the interaction with the activity created through this module, was complicated.

6. Recognition rather than recall: Issues on matching between button names and their actions, increased memory load, according to the evaluators. Reported inconsistencies on buttons and icons matching had the same result, as well. They also reported that in the home page right after logging in, the design of the tabs confused them. In the role of author, the evaluators reported that they had to recall how the steps they should follow in order to edit some activities, such as "Wiki Page", "Resources sharing", "Tasks' list".

7. Flexibility and efficiency of use: Throughout the LAMS platform, the evaluators reported problems with resizing of pop up windows. In the author's role, they reported confusion when opening a new lesson and in the learner's role, they mentioned that in the "Spreadsheet" activity, the usual shortcuts didn't work. In the "Mindmap" activity, they found the editing of the map complicated. Furthermore, in the page after login, the "More Options" button pops up a search field, as Fig.5, Area D depicts. It was reported that this nesting has no obvious meaning and makes searching difficult.

8. Aesthetic and minimalistic design: In the home page, right after the logging-in as an author/supervisor, the evaluators noticed that the tabs were not designed in a consistent way. Moreover, the "Add a class" link was located in two places without obvious difference. Another redundancy was that the "More options" button included only a "Search" option. Thus, this nesting had no meaning. In the profile editing, they reported that menus may need redesign in a more efficient way. They also found that pop-up windows appeared too often. In the learner's role, they reported that activities designed through modules such as "Tasks' List", "Wiki Page", "Chat" and "Mindmap" had no clear, usable and minimalistic, interface and this provoked problems while interacting with them. The same difficulty was reported for activities such as "Resources/Forum", "Forum/Review" and "Chat/Review"; the effect of two parallel activities lead to confusions (Fig.5, Area C).

9. Help users recognize, diagnose and recover from errors: The evaluators remarked that as learners, they found many error messages that were not adequately understandable and this caused them confusion.

10. Help and documentation: The evaluators mentioned an important lack of help during their logging-in as an author. The Help link leads to a new page that didn't provide clear help and didn't help them practically. On the contrary, the help documentation was provided on the login page of LAMS with a non-visible way and none of the evaluators noticed it. Consequently, none of them found the documentation when he needed it. They also mentioned that after their login

(either as a learner or as an author/supervisor), they noticed a Help tab but they reported that it didn't lead to really helpful content (Fig.5, Area A).

Figure 4: LAMS-HOU: After login page

11. Customization of the content: In the author's environment, the deletion of the transition arrow (the arrow that prescribes the sequence between two activities) was not a clear action (Fig.3, Area C). They also mentioned problems on saving the lesson they designed. The evaluators in the role of supervisor reported that after the login page, they noticed the option "Add a lesson" in two different locations close each other, without any obvious reason for that (Fig.5, Area C). This does not facilitate the customization of the lesson in order to be provided to the classroom.

12. Navigation: In the learner's role, the evaluators mentioned problems with the navigation within activities such as "Chat/Review", "Resources/Forum" and "Forum/Review" that supported two parallel activities in parallel (Fig.5, Area C). Furthermore, the "Chat" window in a medium size screen covered the "Next Activity" button and this disoriented the user (Fig.5, Area D). Moreover, the navigation in the activity sequence was not conducted with a clear way (Fig.5, Area B). They also noticed that the transition from one activity to the other, was accomplished with a not uniform way; for example in the "Image Editing Pixlr", the user should press "Show all images" in order to go to the next activity instead of "Next Activity". A similar problem was reported in the "Question & Answer" and "Survey" activities.

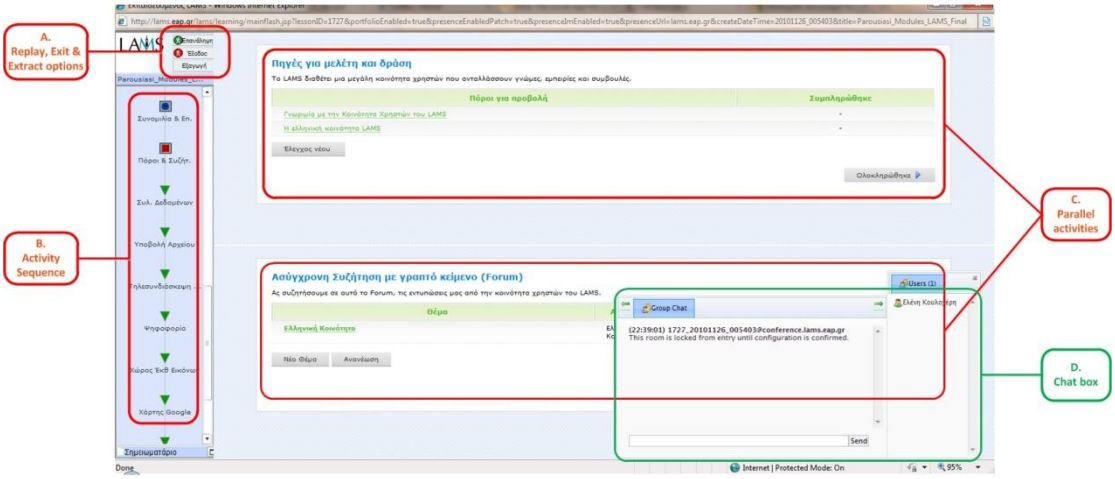

Figure 5: LAMS-HOU: Learner's environment

13. Interactivity: In the learner's role, the evaluators mentioned that activities such as "Chat/Review" and "Forum/Review" that supported two activities in parallel did not encourage the interaction among the participants (Fig.5, Area C). According the evaluators, interaction with content was influenced by usability issues; when an author saved a lesson and tried to open a new one, he got a message informing him that his previous lesson was going to be deleted and that was confusing. The interaction with content wasn't encouraged enough due to difficulties occurred by parallel activities, as mentioned above.

14. Tools and multimedia integration: The evaluators reported that the module "Google Maps" did not work efficiently and it was difficult to set points on the map. They also noticed problems with the "Image Editor Pixlr" module which interface was considered as uncomfortable, since much scrolling was required. But no further problems within this heuristic rule were detected.

15. Role management: The evaluators didn't report any violation of this heuristic. This was expected to happen as the roles in LAMS are discrete and no switching between them is supported.

4. Conclusions and future goals

This paper presented the procedure and the results of the heuristic evaluation of a learning environment named LAMS, whose nature is based on sequences of learning activities. The evaluation revealed 54 usability issues and this paper also includes a brief description of the most important of them; A number of problems related to communication through dialogue boxes, and icons' design, as well as to the aesthetic and minimalistic design, the consistency and standards compatibility, the navigation and the interactivity with the content and in peers were discovered. The lack of help documentation in the right location was also revealed. Furthermore, abnormalities on button names were also tracked and need to be taken into consideration in future upgrades of LAMS-HOU.

Future research on the area aims at further evaluation of LAMS through user testing. During testing potential users of LAMS will interact with its user interface, during a predefined scenario. The experiment will take place in a usability evaluation Laboratory where the users' actions and observation of the screen will be recorded with the use of a camera and an eye-tracker; the comparison of the results of these two evaluations (Heuristic and Experimental Evaluation) will provide useful feedback regarding the use of the Heuristic Rules employed in the assessment of an e-Learning tool. Furthermore, it will provide useful data that will lead to solid conclusions regarding the improvement of LAMS user-interface, in terms of usability.

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