Abstract. As a part of E-um project, whose aim was to create an online e-learning material, various computer aided support systems were developed. In this paper we present our main achievements.

An admin section with a review system was required to maintain high level of quality of our e-Learning materials. Its design and background algorithm had to match the project specifications and support the processing of a large quantity of data. The description of developed algorithm and the structure of the database will be presented.

Main reasons for choice of authoring tool eXe in the project will be presented. We also describe our modifications to it required for the purpose of the project.

Further, we designed and developed descriptive language for our dynamic exercises generation system. Main concepts of the system will be described.

Keywords. e-learning, review cycle, algorithm, authoring tools

1. Introduction

The aim of the E-um project was to provide students of primary and high school students in Slovenia interactive e-learning material to either serve as study help or to increase student’s interests, initially focused on mathematics. Several online systems for mathematics e-learning have already existed when the project was started, e.g. MathAid [1], HCPS Math Course [2], so a challenge to provide a better services was even higher.

The project initially involved more than 50 authors from different parts of Slovenia and more than 10 other persons with various responsibilities. It was designed as a complete online system, including the upload and control of the e-material. To enable this, the admin section of the portal was created.

While the environment, where the e-material was to be offered to the students is very important, it was even of greater importance that the e-material reaches the required level of quality. The general rule was to follow SCORM guidelines by using the tools we created or modified to fit our requirements. Regarding the fact that all the authors chosen were experienced teachers, the main task was to prepare them to properly use the prepared technology.

To ensure that the designed material was developed as required, i.e. to follow SCORM standards, a cyclic procedure for the review of e-
materials was designed. In order to follow the improvements done on the material, we created an online review system under the admin section.

This paper presents the design of such an online review system, the data flow in the system and algorithm used to control this flow.

Furthermore, some of the extensions on the system that this structure allowed, is presented.

In the last section we present main authoring tools which authors of the E-um project use for making the E-learning materials. We describe main reasons for choosing the tools and our modifications, which were necessary to accomplish the goals set at the beginning and as developed through the creative development.

2. The Review Cycle

The cycle of the designed review system involved 4 people besides the author. A main reviewer was assigned to each author, that communicated the most with the author and whose role in the cycle is the most important. Following the first review, the second reviewer and finally the practitioner look at the e-lesson. Finally, after the e-learning material was approved by all three parties, a lector was assigned to check the spelling and grammar.

The individual reviewers of the cycle were defined by the administrator of the system, for each material independently. The administrator had insight on the upload of the e-material and the progress in the review cycle.

2.1. The Review Document

For the purpose of the review cycle, the review document was designed, consisting of 3 descriptive areas and a group of evaluation fields. The descriptive areas were as follows:

General comments, where the basic feedback to the idea of e-material and basic evaluation was given

Detailed comments, where the writer of the comment referred to the specific section in the material and commented on it

Final comments, where general instructions for the author were given on how to improve the quality of the e-material (if needed)

The evaluation fields were answers to 11 evaluative questions regarding the quality and usefulness of the e-material, rated as inappropriate, appropriate and outstanding. The questions were related to the didactical content, technical content, tasks given to the students, etc.

2.2. The actors in the review cycle

After the e-learning material was uploaded, the administrator assigned the three reviewers. The reviewer was the first to receive the material. If the material required several corrections, the reviewer could decide to return the material back to the author, without passing it through the review cycle, by filling in the review document and returning the comments to the author. This was so-called pre-review cycle. Each time, a cycle has been closed the author could see the comments from the last review cycle.

When the e-material reached the certain level of quality, the reviewer could pass it on to the second reviewer. The aim of the second reviewer is to eliminate the possible faults, missed by the first reviewer and to gather further ideas for improvement. The second reviewer had the right to either reject the material or to pass the document on to the practical reviewer. In this case, the reviewer could request another review of the material in the next cycle. The practical reviewer’s job was to check the mathematical validity of the material, i.e. to verify all the calculations and to check all the definitions and explanations. Just as the reviewers before, the practical reviewer could reject, accept the document with request of another review or simply accept the material.

The review cycle was closed if reviewer rejected the material or if the practical reviewer wrote the final comments. The reviewers wrote their comments just by adding them to the previous. When the cycle was closed, the first reviewer received all the comments to combine them into final review document and decided to either publish the material, if it was approved by the editor and the practical reviewer, or to return it to author in any other case.

Finally, when all three actors in the review cycle accepted the material, it was on the administrator to assign the lector and pass on the material for spelling and grammar check. When the lector finished, the material was ready for publishing.

The sketch of the review cycle can be seen on Figure 1.
3. The Implementation of the Review Cycle

The decision was to include the review cycle in the admin section of the e-um system. The idea of the system was based on user rights, where the behavior was split into 2 main branches on the basic level:

Administrator of the system, with the rights to control all the materials in the system and having additional functions (e.g. for setting up the users)

“Regular users” who could control only their materials

As the administrator’s role in the system was independent from the content of the lessons, there was no need to include any reviewing functionality in this section. Similarly, if the user was only the author, he or she had no need to be able to access the reviewing process. But all the reviewers had to be assigned a special functionality within the system.

For the reviewers, a menu item called “review” was introduced. It links to the list of e-learning materials which need their review. By choosing a single material, the review document is opened to be filled out. As some of the reviewers were having two different roles in the cycle, being the first and the second reviewer at the same time (not for the same e-lessons), the materials which required only less detailed editing, which is the second phase of the review cycle, the menu item “editing” was introduced. This provides the list of all the materials ready for their editing. The action after the material is chosen is the same – the review document pops up.

The three sections for comments in the document were added as text areas. To distinct between the inputs of each participant in the review cycle, different background for the text was assigned to each party. This allowed the writers to insert comments not only at the end of the text, but also in between. For the implementation of such a text area, JavaScript Content Editor TinyMCE [3] was used.

The evaluation questions appeared under the detailed comments section and were implemented using a group of three radio buttons for each question, by default set to appropriate.

The document finishes with the buttons, which define further actions in the review cycle:

Return to the author – this option appears only to the main reviewer and returns the material to the author for further improvement

Publish – this allows the main reviewer to finish the review procedure after all reviewers approved the material.

GO – passes the document to the next actor in the review cycle

NO – rejects the material and sends it back to reviewer to return it to the author (available to all but the main reviewer)

LOOP – accepts the material with some remarks and requests another review after the corrections are done.

3.1. The database

It was not only the review system algorithm that needed to be carefully designed – the large amount of data being processed throughout the system required well designed database. As there are two main parts of the system, the lessons and the reviewing documents, so does the database reflect this structure.

For introducing the review cycle in the system, two new tables were added in the database: the ‘review’ table for storing the textual parts of the review document and the ‘review_details’ table for storing the evaluative part and the actions taken.

The ‘review’ table linked to the lessons table using ‘lessonID’ attribute. There was 1:1 relation between the ‘review’ table and ‘review_details’ using ‘reviewID’ attribute.

Having the underlying database set as described allowed us to implement the review cycle algorithm. The control of the document flow was controlled by two flags:

The loop flag in the ‘lessons’ table was set to 1, if either the reviewers (except the main) need to review the document again in the next cycle

The ‘final’ flag in the ‘review’ database is set to one, if the entry presents the final review written by the main reviewer in that cycle

Two more attributes were added to the ‘lessons’ table: the ‘position’ attribute which reflects the position of the material in the review cycle (0 - author, 1 - main reviewer, 2 – second reviewer, 3 – practical reviewer, 4 – lector) and the ‘version’ attribute for denoting the version of the e-content currently being in the review cycle. The ‘authorized’ attribute is set to 1 after the main reviewer passes it on to the editor for the first time, the ‘reviewed’ attributes is set to 1 after all the reviewers accept the e-content and ‘lectored’ is set to 1 after the lector finishes its job.
According to the decision on further action by the reviewer (return, publish, go, no, loop) the values of the ‘position’ and ‘loop’ attribute get populated. When the author uploads the new version of the e-material, the ‘version’ attribute get increased by 1.

3.2. The algorithm

The algorithm, shown on Figure 2 and described on Figure 3 below, determines the complete flow of the e-material during the review cycle.

The control on the actions that a reviewer can take is based on their rights and the previous actions taken in either current or past review cycle.

3.3. Extensions of the system

The controlled design and implementation have lead to further benefits of such a structure. All the users of the administrative section can at any moment control, where their e-material is currently in the system. This is beneficial especially in individual’s timing planning.

Another simple task was to introduce statistical overview on the development phases of the e-material. Having the statistics done not only by authors but also by main reviewers (knowing their goal amount of e-materials reviewed) and having it available to all the users, increased peer-to-peer and administrators’ control. By periodic control of the statistics, weak parts of the review chain could be easily noticed and possible problems can be promptly resolved.

The last but not the least, having each review stored separately in the database allowed documenting the review cycles on the fly, so not only all the versions of the e-material get archived, but also corresponding review documents.

4. Authoring tools

Authors which were participating in the E-um project needed, besides the great ideas, also authoring tools in order to make their ideas work. E-learning materials made under the E-um project must also satisfy both contextual and technical demands. By later we mean possibility of integrating it in the World Wide Web, using it in the learning management systems (LMS) and interactivity, which is possible with the latest web technologies.

4.1. Authoring tool eXe E-um

We decided that for the project E-um the most appropriate available open source authoring tool is product named eXe from eXe Learning team [5]. The tool is written in programming language Python [6] and integrates many advanced and emerging computer technologies. Main reasons for choosing these tools were the possibility to export to HTML web page, compliance with SCORM standard, open source and very clear main editor.
Setting the style of text in e-learning materials

Sometimes authors need to emphasize certain mathematical facts in their e-learning materials. We modified our authoring tool in such a way, that now makes it possible to emphasize abstracts, definitions and important facts, respectively, with changes to the background and to the fonts of the text. These changes are made as a globally controlled style and thus help to make all E-um e-learning material of a unified style.

Writing mathematical texts

E-um project is currently mainly focused on mathematical e-learning materials, therefore we had to modify authoring tool eXe, which was unable to represent mathematical texts at that time. We extended the tool with the application Mimetex [7], which renders mathematical texts into the GIF images, which can be easily inserted into any e-learning material. Mimetex accepts as the input mathematical expressions written in the LATEX format, which is in mathematical circles widely accepted format. When authors want to insert some mathematical expression, authoring tool opens an input form as shown in Figure 4.

Author needs to input the expression in input field Insert/Edit Expression and when finished application instantaneously shows preview of the expression in the field Preview in lower area of the window. Because the expression is inserted in the text as an image, we can set various parameters that are common for the images. It is important to note, that these mathematical expressions are editable, meaning that authors can, when necessary, edit them.

Inserting Video, Audio files and the Applets in the eXe E-um

Many interesting motivations for various mathematical subjects are possible to realize with help of the Video or Audio snippets and also with help of the Java Applets. We extended the original authoring tool eXe E-um so as to make it possible to insert video in the swf and flv video formats [8] and audio in the mp3 audio format.

Some mathematical ideas can be demonstrated more clearly through interactive mathematical constructions, which provide students with the possibility to change various parameters in the construction and learn from the interaction. Authors in E-um project use C.a.R [9] for making such mathematical constructions and various other interactive elements. This tool can easily export constructions to the Java applet, which can easily be incorporated within our e-learning materials by the use of eXe program.

5. Dynamic Exercises generation system

Exercises play important role in the education of the mathematics, since learners want to train and finally also test their knowledge of some particular subject. Exercises or more precisely numbers in the exercises in the books are static, by later we mean, they don’t change. World Wide Web on other hand is in his origin dynamic and therefore we only had to use this dynamic property and create authoring system for generating dynamic mathematical exercises.
Authors that work and contribute in E-um project are primarily mathematicians and therefore have limited knowledge of the higher programming languages. Motivated by the fact that these authors will have to create exercises, we designed descriptive language with some basic formal rules, which is on one side easy to use, but on other side very powerful in action. To make the creation of the exercises as simple as possible, we made web pages which lead and help author to compose and create dynamic exercises fast and intuitively.

Procedure for the creation of one dynamic exercise is as follows: authors first have to set the variables that will be dynamically generated when page loads. Next the authors define how the result will be computed with the help of the variables defined previously. In the last step user writes exercise similar to the static exercises, but with the incorporated variables and result in the text. Result of this process is a dynamic exercise which can be used on various places across our website.

6. Future Work

The E-um project has finished his first period and almost all the e-learning materials is offered to the wider public. In the next period we plan to improve current e-learning materials and add dynamic exercises. The well prepared data algorithms and structure of the database were tested in first period of the project and is now ready to use on any other subject and requires no further modifications.

Being aware that the end-users might have their own view on the materials, feedback section is available for each e-material and the comments are sent back to the author and main reviewer. If the comments are noted as relevant, the review cycle might be restarted again. As shown by the research of Impedovo et all [4], this will considerably increase the quality of the e-um portal.

The tools we developed and have been using are stable and working well, but we are in continuous communication with the authors and we provide a constant support and work on ever new improvements…

7. Conclusion

Reviewing process of the designed e-learning material is a crucial part for the effectiveness and usefulness of our project. The presented design of the review cycle and its implementation in the online system has enabled easier control faster and more efficient reviewing procedure.

The online review system ensures data consistency, easier communication and better overview of our work. It speeds up the procedures as there is no time loss due to transfer of the reviews. It also allows for round-the-clock accessibility of materials and thus provides a possibility for totally individualized working timetable

At the moment first period of the project has been finished and we can claim that the continuous control shows a very positive results of such a system

Authoring tools in the E-um project are one of the cornerstones of the project, since they provide means for the authors to make e-learning materials. Our modifications provided ideal tools for writing and designing appealing mathematical e-learning. Basically, we are very content as we succeeded to fulfill all the initial demands and resolved all the technical challenges that evolved throughout the project.

The E-um projected was supported by the European Social Fund and the Ministry of Education and Sport of Slovenia

8. References