E-Learning development project at Debrecen University ICT-CRC*

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1. Project goals

Recently, e-learning has been the most dynamically developing educational form. The technological problems of its early years are vanished by the use of widespread specifications. Nowadays the development and quality issues of learning contents are coming to the front. The modern e-learning systems do provide more and more services and standards to the users to create new efficient learning contents, but there is no proper tool for measuring the quality and usability of existing contents. The Cooperative Research Centre at the University of Debrecen has started a new research and development project in the frame of the tender GVOP-3.2.2-2004-07-0021/3.0, which aims to fill this gap. The first task of this project is to produce a well-determined way of measuring the learning contents, then processing the results. The second task is to develop a new module to an existing e-learning system to do this job.

2. About the method

The main function of the system is tracking all the activities of the users. The participants of a course can read learning contents during the learning process, fill in tests and questionaries, use the forum of the course and browse the wiki pages. Generally they use the services of the learning management system. We intend to make the teachers and tutors of the course be able to reach the logged data of the current course. The statistical analysis of these gathered data can lead us to such conclusions, which highly influence the structure and content of the learning material at the next similar course. For example at the end of our current course we notice a significant difference between the low visitation number
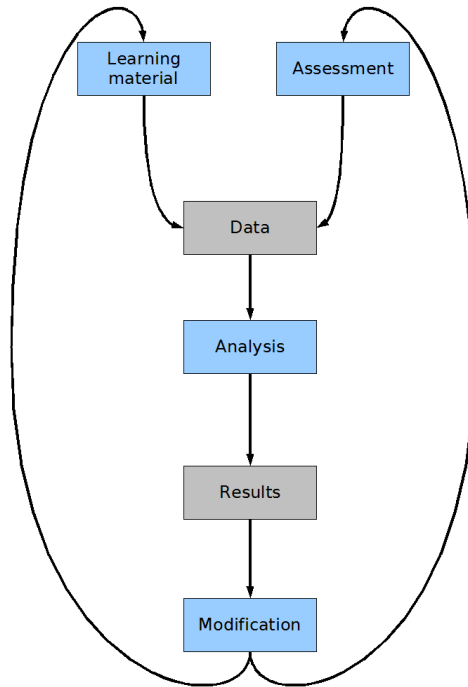
Figure 1: The model of the steps

of a particular concept in the learning content and the high number of the good answers in the tests describing that particular concept. In this case we can skip a detailed description from the learning content, or we can replace it with a most appropriate description.

In the view of the analysis the learning content and the test are the most important items of a course, so we have to know all the standards and specifications which deal with the description, implementation and execution of learning contents and tests. After getting know all these standards we can collect all kind of data that can be logged during the course.

3. Standards and specifications

3.1. SCORM

In the world of e-learning specifications SCORM (Sharable Content Object Reference Model) has a favored place. It specifies the description and execution of a learning content. The SCORM specification is a de facto standard such as the most e-learning standards, but it is generally accepted in the e-learning community. It satisfies all the needs of teachers and learners, and it is widely used by market

leader commercial and open source learning management systems. The reason for its popularity is that SCORM is not just a specification, but a collection of the most important e-learning specifications and it integrates the best methods of well-known recommendations. However it is a very useful standard, it does not deal with all the issues of e-learning, e.g. the specification of the personal data and the execution of tests.

Commonly e-learning uses object-oriented approach which is true for scorm too. The main point of its approach is to determine the smallest atomic unit of the learning content. This can be found through decomposing the learning content. The result of this procedure is the sharable learning unit, which is called asset by the SCORM specification. The asset is the electronic representation of media, text, images, sound, web pages. The assets form the foot-stone of the structured learning content. The next logical level of the structured learning content is the SCO (Sharable Content Object), which is build up by assets. The SCOs can communicate with the launcher learning management system. The basis of the communication between the content object and the system is provided by the integrated javascript functions in the main web page asset of the SCO.

For the description of the additional information on the assets and SCOs SCORM uses the IEEE Learning Object Metadata standard.

3.2. QTI

The most important and well-known specification for the standardization of the description of tests and questionaries in the e-learning field is the Question & Test Interoperability specification. This was created by the IMS Global Learning Consortium as the result of considering the capabilities of informatical tools and determining the detailed properties of the electronical assessments. The specification describes the information model for questions and tests, determines the way of questions' treatment for the learning systems, provides the interoperability with other standards and specifies the description of basic fill in statistics.

Regarding the standard the basic unit is the question, which now is called the item. An item contains the viewable information for the participants of the assessment, the interactions in the question, the rules of the scoring and the text of the feedback. Interactions determine the character of the question, because the interactions are the tools for gathering the participants responses. An item can basically have four types, which are defined by the used elements in the item. An item can be a simple question, a complex question, an adaptive question or a template question. A simple question represents the common questions in tests, technically it has only one interaction in its body. A complex question has more than one interactions, which can have different types. An adaptive question is like a complex question, where the participant gets a new interaction based on the correctness of his/her answer for the first interaction. Adaptive questions may seem to be separate questions to the learner, but it is one item. This specification gives the opportunity to express similar questions in one item called template item. It means that the frames of the questions are very similar, but some words, numeric

values or images are different. With the help of the templates we can create the common frame and we can give rules for the creation of the concrete items. The system generates the questions with the help of these rules.

The QTI specification uses a tree-hierarchy to represent a test. In this tree there are different types of elements at different levels. The root of this tree represents all the properties of the entire test. We can define the time limit of the test, the rules of the score processing and a global feedback for the participants based on the achieved score in this element.

The children of the root element must be the testPart elements. Every test must contain at least one testPart. In this element we can set up the limitations of the life cycle of the questions like the maximum count of attempts, the time limits for this part, the navigation mode (linear or nonlinear) of the sub elements, when the response processing should take place in time (individual or simultaneous submission) or the branch rule, which is a precondition for this element and controls the behavior of the test for the participants.

The children of the testPart must be section elements. In a section we can determine the time limit for the section, the number of questions from its children to be delivered to the participants, can the questions appear more times in the section and their order must be kept or can be randomized.

The children of the section can be an item or a subsection. Subsections have all the properties that the normal sections do. The item represents the question.

So the test is a tree structure and it has at least four levels and its leaf elements are the questions, the other elements of the tree contains the options for that level.

The description of other kind of data can be expressed by the IEEE's Learning Object Metadata standard.

4. Logs and analysis

A system to perform a statistical analysis has to have sufficient amount of data about the learning habits of the users. The system can monitor how many times a learner browsed the assets and scos an how much time it took. The system also knows how the participants performed on the electronical tests. The amount of these data can form numerous log entries for only 10 active learners, so its human processing is inconvenient. There is a need for a procedure which can calculate simple and accumulated values from the huge amount of log entries. Statistical analysis can help us. We must only clarify which statistical method can compute our desired values.

There was no opportunity to link tests and learning contents together, which would enable us to estimate the quality of the learning content from the results of the test. The best practice should be to attach each question and its answers to the parts of the learning content. This can be solved in the learning management systems by using a new database table which performs the associations. Using specifications can be now a little restrictive. We had to find a solution which can do the associations using e-learning standards and we have found that IEEE

Learning Object Metadata standard enables us to record multiple identifiers or URLs in its relation category. So we can connect a question to a SCO or asset, but we cannot connect the answers to the question to any part of the learning content.

The results of this statistical analysis must be accessible to the learning content creator (usually the teacher) in an understandable or easily explainable form. The best representation way is to show graphs or diagrams which contain self-explanatory information. This is applicable when the statistical method produces small amount of information. The representation can also be implemented in a tabular form when the system must show huge amount of information. Whatever representation the system use, the learning content creator (or the teacher) has to decide about the modifications of the learning content and the tests.

After the examination of the e-learning standards we knew what kind of data can be logged in a learning management system. We created questions which study the pedagogically relevant information considering the available usage data. We cannot overrun or skip the basic statistical methods like the determination of mean, average and distribution. We can compare the learners personal data with their performance in the tests and the learning activity. This kind of analysis can unfold why a separate group of learners can achieve better results then the others.

A group of our questions deals with the results of the tests and examines the "goodness" of test questions. The multidimensional scaling can explore similarities or dissimilarities in the answers of the test questions. If every learner who chooses the right answer for a question chooses the right answer for an other question too, then the two questions may cover the same idea and one of them should be unnecessary.

Another group of our questions deals with the the learning content and the tests. Suppose we have explored all the connections between the learning content and the questions in the tests, then we can compare the results of their analysis. For example we can check how much time the learners spent on examining the SCOs connected to the actual question of the test. Generally we can examine the learning content usage tendency only at the extreme results of the test. This group of our questions causes the most problems for us.

5. The learning management system

For the implementation of the procedure of rising quality of e-learning materials there must be a learning management system. This system must provide detailed logging services and an extensible module subsystem to implement our services as new modules. In the beginning of this project we examined the e-learning systems of the market. After the preliminary tests we reduced the number of the applicable systems. The test conditions contained that the chosen system must be free and open source application and we highly required the support for the Hungarian language or a usable translator feature to create the new language files. The e-learning system must be well-known and wide-spread, must have a high quality support for users and a detailed documentation. Our methods are based on e-

learning standards, so the new learning management system must support at least the SCORM specification. We examined all the features of the four remained e-learning system to be able to give usable environment for learners and teachers in the every day work. The systems were the Sakai project, the OLAT, the Moodle and the Ilias.

After the examination we found Moodle the most appropriate system to implement our ideas. The Moodle proved its strength multiple times, no doubt it is the proper system for all the job we have to do.

6. Conclusion

The aim of this project is to develop a procedure for examining learning behavior and performance of the users to give the teachers useful information about their learning materials and tests. The secondary goal is a reference implementation of this procedure in an existing e-learning system. We achieve this by tracking all the activities done on the SCOs like the number of visits, the time spent with this SCO and the time spent with the whole SCORM learning material by each learner. The learning management system can log all the results of the tests, too. Our implementation knows about the structure of the entire test, the responses and the scores of the learners for each question and the score for the whole test. After collecting these data we can analyze test results in the scope of learning behavior, so we can get interesting results which can show for example that the learners did not know the right answer for the 5th question because they spent too less time with the related SCOs. We need to connect the SCOs and the test questions together to make such a conclusion.

The teachers or the creator of the SCORM packages can modify the learning material after considering the results of our analysis, and they can enhance its quality and usability.