EMEE – WELL-FOUNDED FEEDBACK IN LEARNING MANAGEMENT SYSTEMS

[a]MARTIN KOMENDA, [b]LUCIE PEKÁRKOVÁ, [c]DANIEL SCHWARZ

Masaryk University, Kamenice 126/3, Brno 625 00, Czech republic
email: [a]komenda@iba.muni.cz, [b]xpekark@fi.muni.cz, [c]schwarz@iba.muni.cz,

Abstract: This paper gives an introduction to effective monitoring and evaluation of education. Well-founded feedback called EMEE (Effective Monitoring and Evaluation of Education) represents an interdisciplinary project combining an informatics approach with mathematical and pedagogical methods. The EMEE idea is based on an innovative feedback method integrated into an appropriate learning management system. The added value lies in new information for teachers discovered by data mining, statistical and analytical data processing. The result will be clearly visualized in diagrammatic form (graphs and tables). EMEE functionalities will be available in the most widespread and most popular LMS Moodle. All fundamental principles including the conceptual database model are described in this paper

Keywords: feedback, learning management system, analytic tool, e-learning, Moodle

1 Introduction

Electronic support of teaching contains many sophisticated features for improving education. A learning management system (LMS) is a specialized online environment, which covers basic and advanced e-learning innovative elements and often is connected to the agenda of the administration. The term LMS represents software for delivering, tracking and managing training. LMSs range from systems for managing training records to software for distributing courses over the Internet and offering features for online collaboration. In many instances, corporate training departments purchase LMSs to automate record-keeping as well as the registration of employees for classroom and online courses. These systems are very important in education in particular. Using an LMS can offer many benefits. It provides uniform learning content, enriches the learning experience, increases student participation, manages content delivery and, by using standardized content formats, users can share course content. The business use of an LMS can also reduce training costs, increase employee competency and the flexibility of a training agenda, decrease employee turnover and manage learning facilities in conjunction with human resources goals. Due to survey (1) instructors and students believed that an LMS improved teaching and learning, although students were less positive about the effect of an LMS on instructors' teaching. There are also other benefits of using an LMS in education that are proven by this survey – for instructors it is improvement in communication with students and for students it is efficiency (saving time). However, 26% of instructors choose "efficiency (saves time)", which indicates that efficiency is important to many instructors as well as their students.

An LMS may contain information about how long it would take to work through self-study material and the length of face-to-face courses. An LMS may give immediate access to e-learning material, it may enable people to register for a face-to-face course, and it may dispatch other forms of study material. An LMS may monitor progress and provide a record for learners on how they are doing, perhaps against their own original target or against others. For the learner the LMS gives access, feedback, and a planning tool (2). One could use the data administrated in an LMS to predict the time required by the learner as a total and in hours per week, given a target for when the training has to be complete. As LMSs continue to evolve and gain popularity, further research is needed to help instructors and students identify the most effective ways to use these technologies to improve teaching and learning, and not only in higher education. There seems to be great opportunity to develop an original feedback module for a convenient and well-arranged overview of students' activities and results.

1.1 LMS feedback functions and analytic tools

Many educators expend enormous amounts of effort in designing their learning to maximize the value of those interactions. Regardless of the approach taken, a series of questions consistently arises: How effective is the course? How can the needs of learners be better supported? What interactions are effective? How can they be further improved?

The evaluation and analysis of learning has suffered from: the limited quantity of data that busy students and instructors are willing to share at the end of a course; the limited quality of this self-reported, retrospective data; and a significant delay (normally at least one semester) between the events being reported and the implementation of an intervention. However, as an increasingly large number of educational resources move online, an unprecedented amount of data surrounding these interactions is becoming available. For example, the amount of time spent reading content online can easily be captured by an LMS. When, why and with whom learners are connecting is also logged in discussion forums and social networking sites. There exist numerous other parameters which can be very useful for applications of data mining methods and subsequent appropriate analytical processing. The EMEE concept works with data stored in LMSs and effectively visualizes interesting relations and significant differences. It is a new kind of educational technology, which can be used to improve learning and teaching. It draws from, and is closely tied to, a series of other fields of study including business intelligence, web analytics, academic analytics, educational data mining, and action analytics (3).

The challenge with respect to data-gathering hardware and software is the integration of these diverse data sources. Open architecture solutions are therefore required that are capable of scraping data, information, and context from administrative and academic systems as well as from structured and unstructured data, information, and context contained in assessment solutions (4). If LMS data were correlated with additional information gathered in other systems, a richer picture of the student learning experience, instructor adoption, and institutional usage could be generated. It could in fact be possible to track individual activity throughout the entire student life cycle – from initial admission, through course progression, and finally graduation and employment transitions (5).

2 Quality of education

The World Declaration on Education for All (1990) and the Dakar Framework for Action (2000) – the two most recent United Nations conference declarations focusing on education – recognize quality as a prime condition for achieving Education for All. The Dakar Framework affirms that quality is "at the heart of education". It goes on to say, "What takes place in classrooms and other learning environments is fundamentally important to the future well-being of children, young people and adults. A quality education is one that satisfies basic learning needs and enriches the lives of learners and their overall experience of living." Despite a growing consensus about the importance of quality, there is much less agreement on what the concept means in practice. Two principles, however, characterize most attempts to define the quality of education. The first, which identifies learners' cognitive development as the major explicit objective of all education systems, sees the success with which learners achieve this as one indicator of their quality. The second emphasizes the role of education in promoting commonly shared values, and creative and emotional development – objectives whose achievement is much more difficult to assess (6).

One of the most important aspects to ensuring the rising quality of education, and not only in the academic sphere, is feedback from students to the teacher. Today many teachers use various online environments such as LMS systems. The feedback process without computer assistance is extremely time-

consuming, and there is no complex reporting application that can be fully integrated into learning management systems and provide substantiated reports to teachers.

2.1 Importance of feedback

Student support and cooperation in education is one of the areas in which e-learning differs from traditional teaching approaches. In the event that education is mostly or completely in the form of distance learning, students learn mostly by interaction with the system. Laurillard's conversational theory promotes an approach where the education is accompanied by interactions between the student and teacher. This theory also emphasizes the constructive and meaningful feedback that allows students to reflect on teaching methods and materials (7).

Feedback helps teachers to better set targets for their students, creates independent student learners and, in the process, raises students' performance levels. In order to have sustainable change in teachers' practice they must be provided with ongoing opportunities for learning, including trying new strategies, followed by reflection and discussion with peers. Throughout feedback teachers can think and work "smarter," structure learning experiences that fully engage the learner, and, most of all, provide the steps for the intended one. Learning involves taking risks, supporting each other, looking for evidence of progress and adjusting one's plans (8). The importance of feedback also lies in teachers' perceptions of the collective efficacy of the teachers in their schools. Appraisal and feedback have a strong positive influence on teachers and their work. Teachers report that it increases their job satisfaction and, to some degree, their job security, and it significantly increases their development as teachers. The greater the emphasis on specific aspects of teacher appraisal and feedback, the greater the change in teachers' practices to improve their teaching. In some instances, more emphasis in school evaluations on certain aspects of teaching is linked to an emphasis on these aspects in teacher appraisal and feedback which, in turn, leads to further changes in teachers' reported teaching practices (9).

3 Effective monitoring and evaluation of education

The underlying concept of EMEE is the idea of a clear arrangement of different feedback features, giving the teacher well-founded information on student behavior during the education cycle. A standard component of the learning management system (LMS) is access to statistics for different learning objects which, when combined with other information available, can be used for interesting statistical and analytical investigations. The key in this is the utilization of all data of informative value related to student activities, with subsequent storing of the data in a newly designed database structure. Through sophisticated mechanisms and selected data retrieval methods, student behavior can be mapped during different stages of studies – typically in semester cycles. The application of these principles in different learning management systems is specific mostly because each environment has, to a certain degree, a different data structure and has been created by using a different programming tool.

3.1 Conceptual data model

The basis conceived for the design of the database solution is a conceptual data model. The advantage of the scheme is its generality and hence the independence of the selected implementation. A direct implication is that the scheme can be applied in any environment regardless of the programming tool and database type used. The model defines relations between different entities, selected in this case to ensure that the entire learning cycle can be generally described.

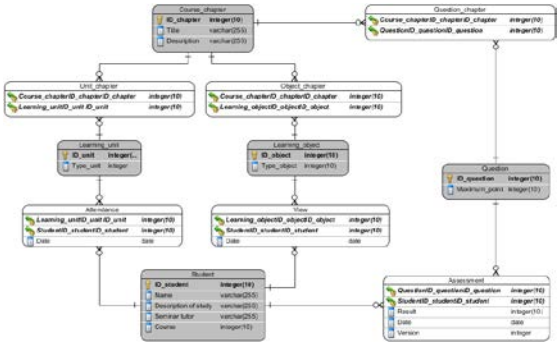

Fig.1. Conceptual model showing how data is organized in EMEE. For illustration, associative entities are differentiated and marked with a white background.

The *Student* entity describes through different attributes all major features which are necessary to know for further processing. Initial parameters are unambiguous student identification, including name, description of studies, teacher and course repetition indicator.

The *Course_chapter* entity determines a wider cycle for the topic during the semester. It is clearly identified through its *ID_chapter*, and for the sake of clarity and easier understanding also the Title and Description attributes are at hand. It is always a compact learning area to which learning objects and student activities are related.

The actual learning objects are represented in the model by the *Learning_object* entity, which contains, besides the primary key *ID_object*, the *Type_object* attribute where numeric values are used to specify the type of learning material (textbook, lecture materials, exercise materials, teaching tutorials, video records, etc.).

Lectures, exercises and seminars are represented by the *Learning_unit* entity which, again, contains the *Type_unit* attribute besides the primary key *ID_unit* for precise identification of the learning unit. Examples include a lecture, a seminar, or practical training.

The key student activity during the semester is shown through coupling (associative) entities Attendance and View. In the Attendance entity, a new record appears if the student has not been physically present at a lecture or training. In the View entity, a new record appears if the student has accessed the particular learning object.

It is logical that each learning object and each learning unit are related to one of the thematic blocks. The link between the learning chapter and learning unit/object is represented by coupling entities *Unit_chapter* and/or *Object_chapter*.

Different questions forming part of different test specifications are represented by the Question entity. Besides the primary key *ID_question*, this entity features the Maximum attributes (maximum possible point gain). If the student comes to a test, the associative entity Assessment keeps information on the point gain of the respective student within different questions of the task. It is obvious that each question must be incorporated into any of the learning chapters. This relationship is represented by the *Question_chapter* coupling entity.

3.2 Work with data

The model designed in this way enables access to data via SQL queries. Variability and possible modifications of the database structure are very easy thanks to the generality of the design, so it can be customized for the LMS system which is in use. A practical showcase of access to data are the following examples, applied within the EMEE pilot project at Faculty of informatics Masaryk university:

Example 1

```
SELECT   DISTINCT
         question.maximum_point,
         assessment.points,
         assessment.student_ID
FROM
         chapter_course,
         question_chapter,
         question,
         assessment
WHERE
         chapter_course.id_chapter=question_chapter.id_chapter AND
         question_chapter.id_question=question.id_question AND
         question.id_question=assessment.id_question AND
         chapter_course.id_chapter= 'chapter_11'

ORDER BY ID
```

The SQL query in example 1 returns gained points and possible maximums ordered according to the *ID_student* attribute. These are only questions belonging to thematic chapter 11.

Example 2

```
SELECT
         assessment.id,
         assessment.points,
         assessment.id_question
FROM
         assessment,
         question
WHERE
         assessment.id_question= question.id_question AND
         assessment.id='123456' AND
         assessment.date='2011_01_05'
```

The SQL query in example 2 returns the point count for different questions on a test from 5 January 2011 answered by a student with identification number 123456.

3.3 Practical use

EMEE – Effective Monitoring and Evaluation of Education has been already applied in practice within a large-capacity course at the Faculty of Informatics of Masaryk University where the data pool for further processing was provided by the Information System of Masaryk University, belonging to the LMS systems category. Data collection, editing, organization in the database and analysis were prepared, to a large degree, on an experimental basis by adopting manual procedures and simple scripts (10). The output of this pilot project was a set of statistical and analytical investigations which gave the teacher a realistic view of the teaching and vital feedback. An example can be found in the two charts showing the application output for multiple statistical and analytical methods for available data. Figure 2 shows the average point gain of students expressed in percentage points on questions from the respective chapter. The students were divided into two groups: students attending a lecture devoted to a chapter topic (grey column) and students not attending (white column). The total of all columns of the respective color always indicates 100% = all attending/non-attending students in the lecture.

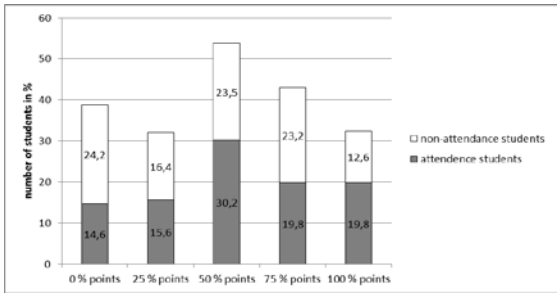

Fig.2. Chart showing correlation between average results on questions from the respective chapter on attendance of a lecture (11).

The chart in figure 3 demonstrates the point gain of students in a final test (maximum 40 points) depending on how active they were over their learning cycle. The students were divided into four groups:

• Active students – students who have attended at least 75% of lectures;

• Lightly active students – students who have attended at least 50% but less than 75% of lectures;

• Lightly passive students – students who have attended at least 25% but less than 50% of lectures;

• Passive students – students who attended less than 25% of lectures.

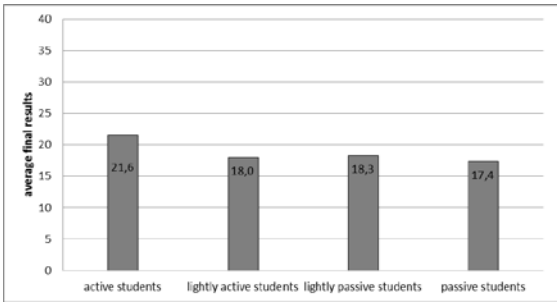

Fig.3. Chart showing correlation between average results and student activity during lessons (11).

A comprehensive list of charts and tables from the project at the Faculty of Informatics can be found in the diploma thesis of M. Komenda with the title Monitoring and Evaluation of Education Forms in IT.

3.4 Generalization of EMEE

The previous chapter provides evidence that the EMEE concept is fully applicable in practice. One fact is that almost all adjustments related to data retrieval from the LMS system as well as subsequent processing have not yet had any conceptual or systemic solution. Therefore, it is desirable to take a more general look at EMEE and calculate with the idea of maximum possible automation. This would mean that for example selected functions could be available in the teacher's standard environment (LMS) which the teacher is using in his/her e-learning agenda. Based on past experience, EMEE can be divided into the following four phases:

1. Data retrieval from LMS on student behavior during the learning cycle.

2. Selection of useful data and its organization in the database.

3. Statistical and analytical processing.

4. Presentation of output.

Each of the above steps correlates to a certain degree with the environment in which EMEE is to be implemented. Now it is essential to design a specific application enabling efficient and effective feedback to the teacher on his/her students. The technical solution to communication with the selected LMS is subject to further development. Since the architecture of LMS systems is not standardized and hence varies significantly, no uniform and fully compatible solution can be developed. Development will always have to be customized for the system supporting the e-learning agenda. What will play the key role prior to implementation will certainly be the analysis and collection of requirements from teachers who themselves want to use this functionality (10).

4 Integration of EMEE into the Moodle system

Selection of the right development and integration system for EMEE was a relatively easy task. In recent years, the popularity of open-source software products has been growing. The most popular choice in the area of learning management systems is without any doubt the Moodle LMS. Also available of course are alternatives such as Claroline, Dokeos, ILIAS, ATutor, SAKAI, etc. In its number of installations and thanks to its large community, Moodle can confidently claim the leading role. Teachers and students all over the world know and enjoy this e-learning management system. In the Czech academic environment Moodle is also widely used, which is why it was selected as the environment for which the actual EMEE module was developed and integrated. The new separate module Moodle-EMEE will fully correspond with the license policy of Moodle and will be distributed free of charge in the open-source format under the GNU General Public License.

Like most software solutions, also Moodle-EMEE will undergo a development life cycle. One essential development phase is demand specification. This phase is crucial for successful completion and implementation. Extremely high emphasis will be placed on correct specifications to ensure seamless application. For this reason, a survey has been carried out among the public with the objective of collecting suggestions and ideas about the functionality of the model from the teachers for who this model will be relevant. As the function and output variability connected with data describing student behavior is rather broad, a targeted feedback should provide a list of the most desired features to be used as the core of the first version of the Moodle-EMEE analytical model. Tutors and teachers will have the opportunity to influence how the application will look in practice.

The target group in this survey are experts and senior users of the e-learning tool at universities.

• Users of LMS Moodle – teacher community working with the open-source system Moodle who attended the MoodleMoot.cz 2011 conference.

• Users of LMS systems from academic and commercial institutions (collaboration with Pragodata Consulting s.r.o.).

• Selected teachers across the MEFANET education network (pooling all Czech and Slovak medical faculties).

• Selected teachers working at the Institute of Biostatistics and Analyses at Masaryk University.

• Attendees of the Summer School of Applied Informatics 2011 in Bedřichov.

• Teachers from LaSARIS (Lab Software Architectures and Information Systems).

• Selected active teachers at Masaryk University engaged in e-learning over the long run (10).

5 Conclusions

This paper described a brand-new EMEE concept which shifts learning feedback to better optimization from the point of view of the end user. Without the need for complicated and often bothersome questionnaires and surveys, the teachers will have a tool providing a well-founded and hence valuable picture of their teaching. The pilot experiment showed clearly that the proposed principles are applicable in practice and the output opens not only an objective insight into student behavior, but also follow-up modification of teaching methods. Another logical step is the development of a new module for the LMS system environment – specifically for Moodle. Moodle-EMEE will give teachers feedback options not only on student activity but also and firstly on their own teaching. The entire chart and table output will be presented in anonymized form, used only for optimization purposes and continuous quality improvements in the teaching process. If successfully applied in the Moodle system, further spill-overs into closed university environments are foreseen. A vital prerequisite for future incorporation of advanced functionalities and new requirements is collaboration between teachers prior to implementation.

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