A Method for Learning Scenario Selection and Modification in Intelligent Tutoring Systems

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Abstract. Computers have been employed in education for years. In this paper, a concept of an intelligent e-learning system will be proposed. The main purpose of this system is to teach effectively by providing an optimal learning scenario in each step of the educational process. The determination of a suitable learning scenario depends on the student's skills, ability to answer on predefined questions, learning styles, personal features, interests and knowledge state. The importance of acquisition of the final educational result is considered to be the main disadvantage in the classic test system where the learner chooses the correct answer from the suggested set of answers using predefine question selection algorithm; this does not motivate a person to define the answer themselves or to create a logical chain of problem solutions. The integration of the intellectual processes into training systems will prevent the drawbacks of the existing knowledge assessment systems and will make it possible to assess the learners' ability to make logical decisions, to clarify the answers using examples and to evaluate the method of achieving the result.

Keywords: Intelligent system, Moodle, Student classification, Quiz systems.

1 Introduction

One of the ways how to check the learners' knowledge in the EU educational system is a test. Test in a broader sense is a standardized assessment of knowledge and comprehension using different types of tasks. In a narrower sense, it is an assessment of knowledge and comprehension through tasks with multiple choice questions. Tests can be used for the initial assessment, the formative assessment as well as the summative assessment. However, tests may be used during the learning process and for self-assessment in an equally successful way.

The tests used for evaluation are based around everything that has been learnt during the learning process. In order to create the task system, it is recommended to progress from simpler to more complex tasks, thus checking the students' knowledge and understanding of using the appropriate knowledge in a standardized situation as well as in a new situation that has not been dealt with prior.

Tests are often used for formative assessment purposes and the number of questions that they contain should not exceed 7 to 10 questions. By contrast, summative

assessment involves a complex test consisting of test questions and tasks which examine the use of knowledge and creative skills. The summative assessment can also take a combination such as this: test + research.

Nowadays there are many views related to the testing systems. The importance of acquisition of the final result is considered to be the main disadvantage in the classic test system where the learner chooses the correct answer from the suggested set of answers [1]; this does not motivate a person to define the answer themselves or to create a logical chain of problem solutions. This is the reason why testing does not always allow determining the actual level of the learner's knowledge. Other authors have proven [2] that when carrying out the assessment of the learner's knowledge by using open questions and tests, the results obtained by using tests are 48% better than using the open question form.

Intelligent tutoring systems provide directed, customized and individualized instructions or feedback to students [4]. They are able to offer educational material suitable for a user's learning style, knowledge, interests, abilities, etc., adapt the learning environment to the student's preferences, and offer adaptive tests appropriate to the learner's current knowledge level. It has been shown that students are interested and more motivated if they learn using intelligent tutoring systems where the learning process is individualized. Such formulated tasks are required to apply algorithms which allow proposing an individual learning process for each user.

2 Knowledge Structure

In the field of education, several postulates specify how educational material should be taught. It is natural that for designing and creating e-learning systems, results of education researchers should be used. It has been reported that students prefer learning materials divided into smaller pieces. Therefore, in this paper the division of the educational material into lessons (scenarios) is assumed. Each scenario exists in one of the following forms: textual, graphical, interactive. This solution allows offering interesting, multimedia courses and creating a learning environment suitable for a student's preferences selecting topics that fits learner needs. Between lessons linear orders occur. This means that all lessons from our repository need to be learned, but some of them should be learned before others. The relation between lessons defines the order in which lessons should be presented to a user. After each lesson, the student has to pass a test. The exception is the first lesson which contains information about the goals of the coursework and its requirements.

The knowledge structure consists of lessons, relations between them and their versions. Some data stored in an e-learning system are used to define the knowledge structure for improving and making it more flexible. During the functioning of an intelligent tutoring system, it collects and stores information such as the average score for each lesson, the average time of learning of each lesson and the difficulty degree of each lesson, which is measured by the number of failed tests. These data should be stored in two different databases for different student and lesson classification and ordering.

In order to provide the customization of information for every student, an intellectual agent has been integrated into the Moodle system and by taking four steps it makes it possible to define the necessary requirements for the selection of information from the common Moodle data sets which corresponds to the specific learner's ability and needs:

- Data selection. The training system identifies each user through a unique identification code and collects the information on the system usage intensity and the number of resources used. By taking this step, the user's model has been defined indicating the topics which the learner has mastered as well as the topics which they have viewed on a regular basis following the current task.
- Pre-processing the information. The received information is automatically summarized and structured in the format of a new table. MySQL System Tray Monitor and Administrator tools are used for data pre-processing by using the expert-defined requirements.
- Apply association rule mining. The data mining algorithms [7] are applied to discover and summarize knowledge of interest to the teacher.
- Defining the user model coefficient. One of the factors that determines the learner's achieved results are the results of the electronic training system self-assessment tasks. The received results define the learning process of the category and the further direction in order to achieve the final results. The teacher will use the received data for making decision about the students and the Moodle activities of the course in order to improve the students' learning skills.

Within a working system it is impossible to obtain all the necessary information to define the user model [3]. Some base values of the model, such as the time which is spent using the Moodle system or the amount of resources viewed, do not always indicate the actual time spent in the system, but only the time while a remote session is open and the system remains active.

It can be concluded that in order to monitor the result of the learner's knowledge acquisition, a physical audit is necessary and it can be conducted by using self-assessment questions. There are often situations when previously prepared tests do not provide the actual results and they do not motivate the learners to revise the material acquired prior. Thus, when receiving the minimum permitted mark in a test, the learner moves on to the next topic where the previously skipped topics are no longer discussed. Nowadays, this issue can be resolved only by involving a real expert who will manually adjust the learning materials of each topic for learning model of the learner.

3 Modification of the Learning Scenario

In traditional learning, if a student has a problem with passing a test, the teacher tries to analyze the reason for mistakes. Sometimes the learner is not concentrated or well prepared. It is also possible that lessons are too hard or not well explained. The student is proposed repetitions of learning material and the retaking of the test. Some-

times learning the same educational material is enough to master this part of knowledge. Sometimes the student needs to read additional books, notes or receive credit for different lessons. [5, 6]

To enable communication between system and learner at content level, the domain model of the system has to be adequate with respect to inferences and relations of domain entities with the mental domain of a human expert (teacher). Therefore, the knowledge domain representation in an adaptive and/or personalized tutoring system is an important factor for providing additivity. The appropriate approach for knowledge representation makes easier the selection of the appropriate educational material satisfying the student's learning needs. The most common used techniques of knowledge domain representation in adaptive tutoring systems are hierarchies and networks of concepts.

3.1 The use of question metrics in the process of designing a test

In this article described scenario proposed a method for designing self-assessment tasks where the selection of questions is implemented by using Fuzzy logic rules. Suppose that a set of questions which can be used to achieve the result D has been assigned a matter of metrics l(S(s)), a value which is located in the indexed set and can be used in comparison. In the models suggested by other author [1, 4, 7], the metrics are built using recursive approach from top to bottom, defining the conditions for establishing the route.

For the question selection algorithm to be effective it is necessary to meet three conditions: determining the importance of the question, preservation of priorities, and the determination of the importance of a question.

Its condition plays an important role. All metrics, whose rates are low, will be selected from the metrics list S(u) (the questions were not covered before or the learner has made several errors while filling in questions of a similar category). Accordingly, there will be no possibility to choose the test questions which the student can easily answer or has already answered successfully before. [8]

Preserving the priorities for question selection means that before adding a new question u to the questioner list, it is evaluated as to whether it will be better than anyone else from this list.

Defining the importance of a question. It determines the behavior of the metrics through the full test question reconfiguration.

3.2 The algorithm of the intellectual question selection

The Dijkstra's procedure is considered to be the basis of the classic information search algorithm in the graph. When implementing the procedure each question in the database is accompanied by two variables – prior(v) indicating the frequency of using the question v and pred(v) which indicates the location of the question v in the test. The starting value of the variable prior(v)$\rightarrow\infty$ has been defined. This means that the question has not been viewed yet. The starting value of the variable pred(v)=0 – this

means that the questions do not have a determined location in the test or that the location does not matter.

It is defined that the usage ratio of a question is a positive number. In this case, it is proposed to use the Dijkstra's algorithm provided that - $l(u,v) \geq 0$. As a result, the path of the graph must be built through questions with a minimum utilization coefficient.
A significant difference in the procedures is the use of line H where all the elements are sorted using prior(v) values. The procedure CreateQueue() creates the line of question priorities H by replacing the question of the start of the line with the lowest usage coefficient prior(v)=0. The procedure Rearrange_Queue(H,v) provides the reconfiguration of the line in case of priorities or usage of the questions.

Every time when performing a while cycle two conditions are met:

There is a $d>0$ value where all the questions viewed - $prior(v) \leq d$ and all the remaining questions of the line - $prior(v) \geq d$.

The value prior(v) for each question v in the line is equal to ∞ or the minimum coefficient which points to the need of including the question; moreover, the frequently used in questions or the questions which do not meet the aim are removed from the line.

4 Conclusions

Nowadays, an intelligent E-Learning system allows teachers to monitor students' learning process. Online analytics tools prove to be highly practical when working with students' process validation, what mistakes they can have, and how they are interacting with course content. Teachers can change or adapt their lessons structure and main content. Moodle framework is highly reliable and encourages students with semantic and other motivated courses by using adaptive e-learning. But it lacks the feature of social interaction especially when it comes to interact with teachers and the meaning of sharing experience.

The article describes the algorithm for creating the intellectual, user adapted education scenario template; this algorithm uses the model of the learner from the set of questions and by fulfilling the modified Dijkstra's algorithm chooses the questions that help the learner reach the result that is most appropriate to their competence level. In result, general architecture of intelligent questioner module for e-learning intelligent system was described in this paper. The objective is to make a system work like a real teacher which can model the description of pedagogic resources and guide the learner in his educational process according to his assets and to the pedagogic objective that is defined by the teacher.

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