Intelligent Examination System to Support Teacher's Reflection Measurement of Students' Guided Feedback

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Abstract

Feedback on student performance is a critical part of E-learning environments. Assessment is one of the most important activities in education to evaluate the knowledge level of a student and to highlight the mistakes and misconceptions; especially, in Multiple Choices (MC) Exam which discovers the weak points of lesson in addition to prerequisite lessons. This paper proposes an Intelligent Examination Framework (I-EXAM), which includes two different types of adaptivity: a) Student receives immediate feedback during MC exam, b) Teacher monitors and tracks the students' attempts and measure the effectiveness of his/her given feedback via a Visual Suggestion Refinement Tool (VSRT) using Data Mining Techniques. This type of analytical and diagnostic visual tool enables teachers to drill down from a high-level overview into the details of student activities, which ultimately allows enhancement of the concept map and the given feedbacks to match students' needs.

1. Introduction

The rapid development of Information and Communication Technology (ICT) has changed all aspects of human life including the way people work, learn and teach. Distance Education is an education undertaken by students in a setting remote from the physical campus of the educational institution. It implies a geographical separation between the teacher and the student [1]. Earlier, Distance learning was delivered by "Broadcasting courses" such as TV and radio broadcasting but generally this type of learning did not provide any type of feedback or communication among other members of the educational process. Nowadays, the learning materials could be delivered to learners through "Internet-based courses or E-learning". This type of distance education could be developed in the current internet environment with the help of interactive Web-Based textbooks, e-mail, mailing lists, chats, asynchronous forums, computer modeling and simulation programs, and others. It can also lead to better results while decreasing costs and improving performance [2].

Due to the growth in online course enrollments, Web-Based learning has become one of the most researched areas especially with the support of enhancements of the Intelligent Tutoring Systems. According to the 2011 Survey [3] of Online Learning, 6.1 million students took at least one online course in autumn 2010 which represents 1/3 of all students in the US. Also, there is already a boom in online education in India. According to Bloomberg Business week [3], the online market generated $200 million in revenue in 2008, and reached $1billion at 2010.

2. Students' Comprehension Level Evaluation on E-learning Systems

The Web-Based E-learning systems offer a great variety of channels to facilitate information sharing and communication between all participants but it is hard to discover students' misconceptions in the case of courses that contain areas where students commonly make mistakes and for which they commonly need extra support and require high interactivity between students and teacher.

Applying an exam is a common method to measure a student's level before moving to the next lesson. Unfortunately, the regular long format exam such as "Essay Exams" will force the students to focus on the test rather than the actual concept itself. As an alternative to the regular test formats, the MC online quizzes can be a great help in making the students i) concentrate more on the subject matters rather than the test itself, ii) correct their individual errors by giving them an instant feedback, and iii) explore the weak points of the lesson and prerequisite lessons [4]. Moreover, the flexibility and convenience are the most important advantages that distinguish the online quizzes, all what is needed to attend an online quiz is a desktop/laptop with an internet connection.

Latest versions of open sources Learning Management System (LMS) have the possibility to create MC online exams through the Instructor's Control Panel like LMS-Moodle (Quiz module tools) [5] and Sakai (Mneme testing component) [6]. According to the latest statistics published on Moodle Official

Site [5], 131 Millions questions have been entered into Questions Bank, which verify the high usage of this component by E-learning community. Unfortunately, the Quiz Module in existing E-learning systems varies in the degree of adaptivity to students' answers and misses the tracking of the effectiveness of guided feedbacks given to the students during MC exams, which doesn't enable the teacher to evaluate his/her feedback or whether his/her feedback directed the student immediately to the correct answer or it is not helpful enough.

In this paper, the authors present an Intelligent Exam Framework (I-EXAM) to support teacher understands student's behavior during a MC online exam by monitoring the interactions data logs via diagnostic visual tool which enables teachers to drill down from a high-level overview into the details of student activities in addition to the ability to track the effectiveness of the given feedback during the exam using Data Mining techniques. In Section 3, the proposed I-EXAM framework is presented in details. Section 4 presents the I-EXAM implementation and Future Plans. Finally, in section 5 some conclusions are pointed out.

3. The I-EXAM Framework

The proposed framework (shown in Figure 1) exhibits two different types of E-learning adaptivity:

- **Student Support**: students receive feedback according to their specific misconceptions during a MC online exam. The exam, which is in adaptive mode (no penalties), gives the students the opportunity to have multiple attempts at the question before moving on to the next question.
- **Teacher Support**: Using data provided by the system; teachers can monitor students' behavior and measure the efficiency of guided feedbacks given to students during the exam. These are accomplished via a web application Teacher Control Panel (TCP), which the teacher can easily use and navigate through.

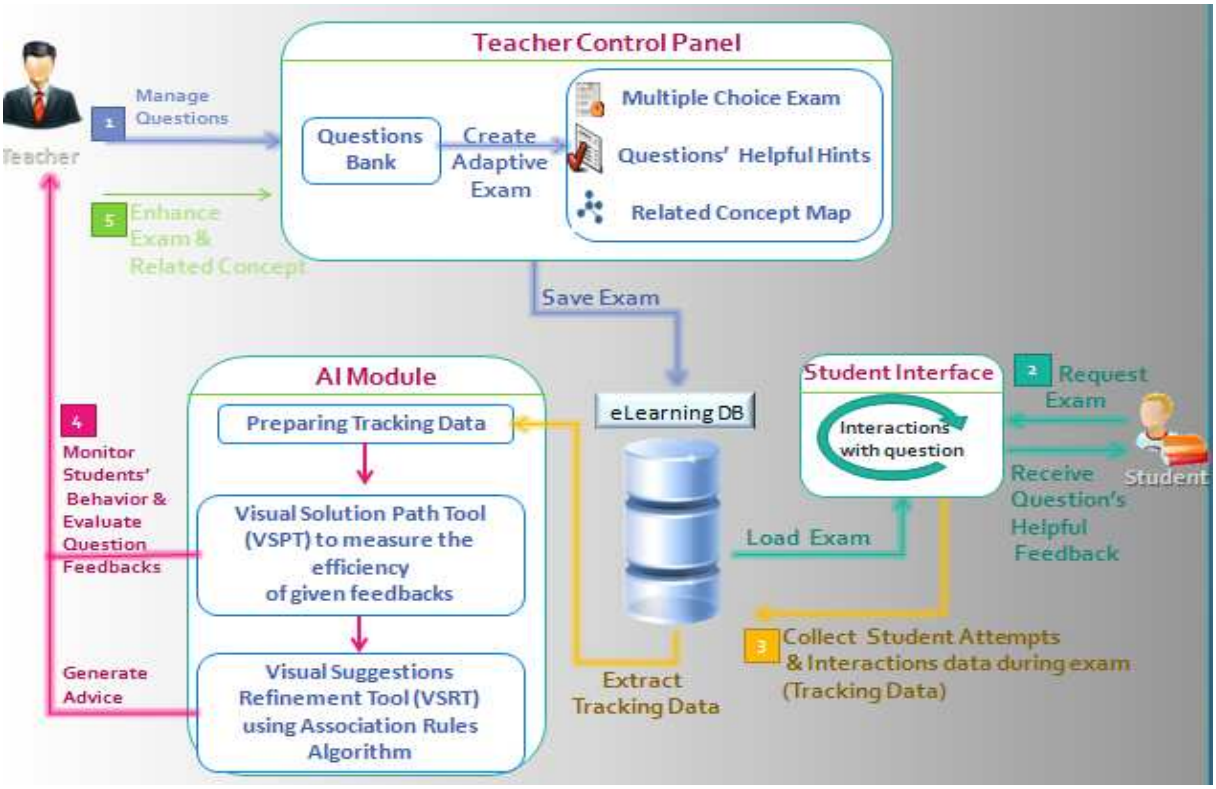


Figure 1. The I-EXAM Framework

3.1 Create Online Exam

Using TCP, teachers can insert the questions into the E-learning Database (Questions Bank Module) then create the online exam by selecting certain questions. Both the exams and questions can be edited, deleted, and re-used anytime. Exam's questions designed to gradually teach course concepts within the domain, the teacher prepared detailed adaptive feedback for a variety of anticipated misconceptions (as shown in Table1). Figure 2 shows a sample question from MC online exam at "Introduction of Programming" course that contains areas where students commonly make mistakes and for which they need extra support and require high interactivity between students and teacher.

Table1. Feedba

Q#1:
What does the following code fragment write to the monitor?

```
int term = 4;
if (term >= 4)
{
        System.out.print("Your ");
        System.out.print("Term : "+term);
}
else
{
        System.out.println("..Good Luck..");
}
```

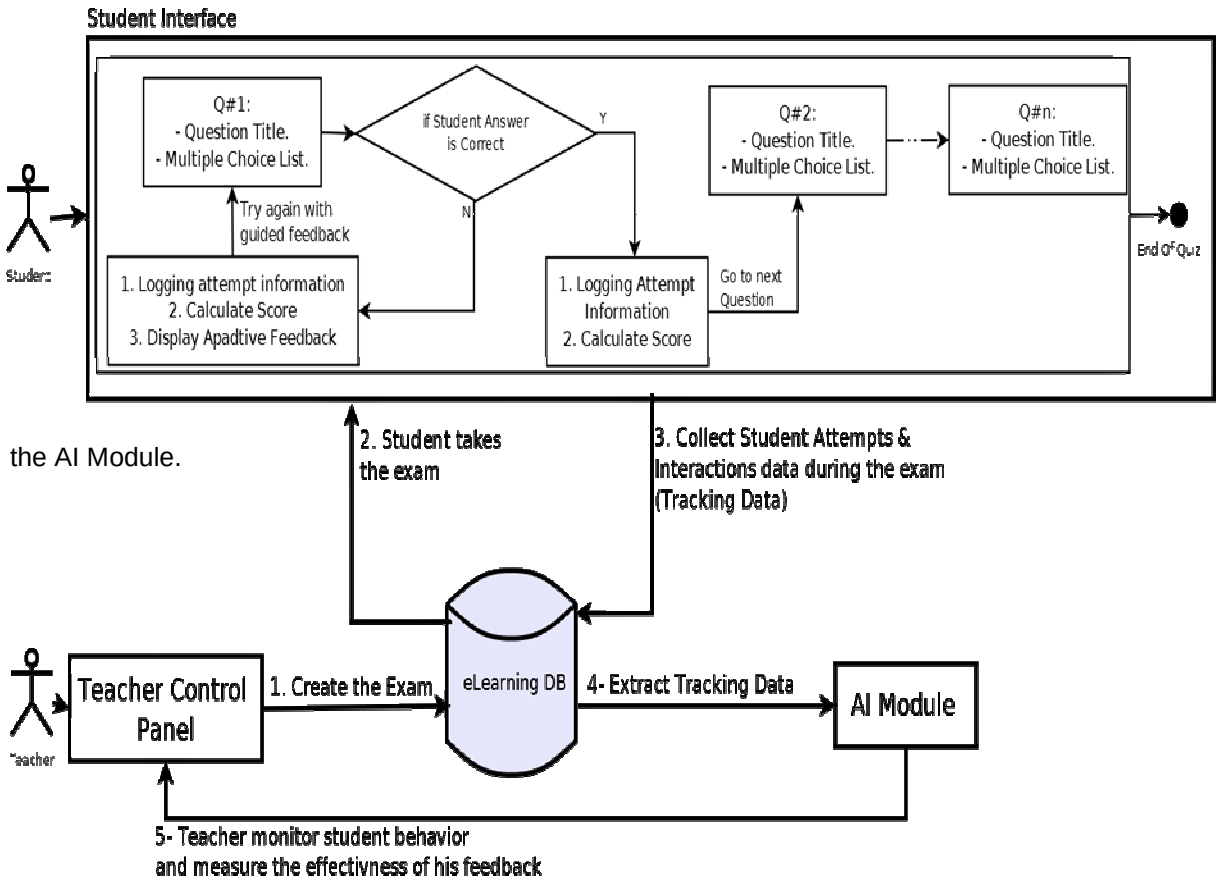
- A) Your
- B) Your Term : term
- C) ..Good Luck..
- D) Your Term : 4

Q#1	Feedback Text	Related Prerequisite Concept
Option: A	You are very close to the correct answer, look inside the parenthesis block.	Parenthesis Block
Option: B	You passed the conditional part successfully, get a look for variable assignment.	Variable Assignment
Option: C	Please get a look at the conditional part, make sure that the condition return true.	Boolean Expression
Option: D	Correct Answer	

Figure 2. Sample question from the MC online exam

3.2 Supporting Student during Adaptive Exam

As shown in Figure 3, the student takes the MC online exam. Student interacts with the exam and he/she knows his/her incorrect answer and why it is not correct from the feedback entered by teacher. The teacher's feedback helps the student evaluate his/her knowledge, know and discover his/her misconception at the lesson and at the prerequisite lessons. I-EXAM will track and record every click that students wil make at all questions' attempts and save it into E-learning DB to be used as input for the AI Module.



3.2 AI Module using Logged Interaction Students' Attempts (Tracking Data)

The usage of data mining in E-learning systems is an iterative cycle in which the mined knowledge should enter the loop of the system and guide, facilitate and enhance learning as a whole, not only turning data into knowledge, but also filtering mined knowledge for decision making [9].

Nowadays, most of data mining tools and frameworks such as Weka [7] and RapidMiner [8] are designed for expert users but not for instructors who are non-experts in data mining [9]. Our aim is to employ the mining and the visualization techniques in order to monitor students' progress, analyze students' behavior and support teachers in a web-based educational system without bothering teachers using such tools.

The AI Module is a Web-based application which applies the Association Rules algorithms. This module is oriented to be used by the teachers (not necessarily experts in data mining) to drill down from a high-level overview into the details of student interactivities, which ultimately support teacher to make a decision for enhancement of the concept map and update the given feedbacks to match students' needs. The proposed mining tool performs the following functions:

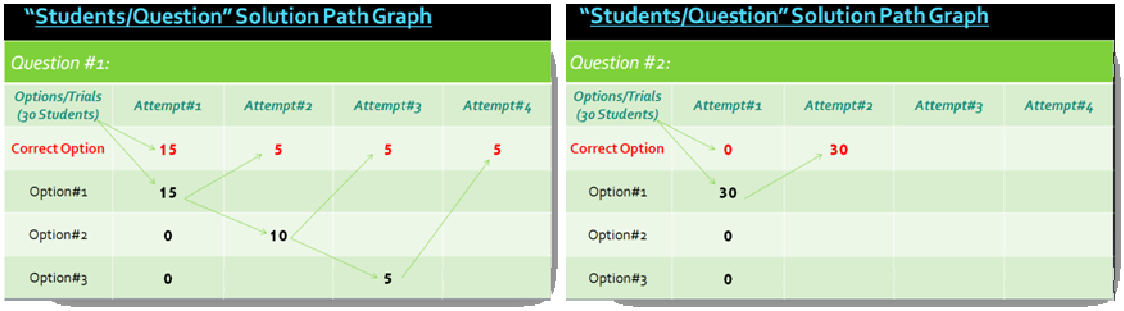
- Collect Tracking Data: Extract exam's interaction logs from the database.
- Preparing Tracking Data: The data is cleaned and transformed into an appropriate format.
- Generate Visual Solution Path Tool (as described in Section 3.4.1).
- Generate Visual Refinement Suggestion Tool (as described in Section 3.4.2) which advice the teacher with suggestions to improve his/her guiding feedbacks.

3.3 Visual Presentation for Supporting Teacher Analyzing Students' Misconceptions

In this section we will describe the visualization tools which will show summarized data in visual forms allowing teachers to interpret the output and make a decision.

3.3.1 Visual Solution Path Tool (VSPT)

Collected Tracking Data is used to generate the Visual Solution Path Tool (VSPT) as shown in Figure 4. VSPT is a visual representation that shows how many students got a question correct answer and what mistakes were made by those who got wrong answer, as well as how many attempts were made until a correct answer was reached. The teacher can track the behavior of all students within each



question to explore whether given feedback is useful or not.

As shown in Figure 4, for Question #1, we can conclude that the efficiency of teacher feedback is very low which means that the feedback did not help the student because of 50% of students who made mistakes during the first attempt not redirect immediately to correct option nor at second attempt. For Question #2, we can conclude that the effectiveness of teacher feedback is 100%, because of all students who read the feedback of incorrect option at first attempt redirect immediately to the correct option which means that the feedback is very clear and very useful. It can also be noted that all students at first attempt were answered with an incorrect option which means that a problem is encountered with the concept related to this question and teacher may take a corrective action.

Figure 4. Prototype of the Visual Solution Path Tool

3.3.2. Visual Suggestion Refinement Tool (VSRT)

Using the Tracking Data together with the summarized data generated by VSPT and Association Rule Algorithm, a Visual Suggestion Refinement Tool (VSRT) is required to suggest and advice the teacher with some suggestions, for example, a) the question is too easy (means at every exam, all the students answer the correct option at first attempt), b) the question is too difficult, c) a particular adaptive feedback seems to be ineffective, d) a misconception in a prerequisite concept for a particular student (i.e., this student chose the incorrect answers to the questions referring to a prerequisite lesson), etc. VSRT draws teachers' attention to possible issues that might need enhancement. Teachers can act on those suggestions by accepting and saving them into E-Learning DB to refine and adapt their feedbacks by adding new feedback, change existing feedback to be more specific, and/or enhance and adapt E-learning contents by changing the sequence of activities.

4. Future Plans

According to the proposed solution previously described, the system must be suited so as to provide a visual tool to the teachers helping them understand the students' behavior during the MC Online Exam using Data Mining Techniques. The proposed system will be implemented and integrated with an open source LMS such as the Moodle to allow any university, college, school or educational institute to use I-EXAM to track the effectiveness of teacher feedback in online exam. In implementing I-EXAM we will use JpGraph [17] to implement the mining visualization tools applying Association Rules algorithms or use the Windows Presentation Foundation (WPF) [18] which is graphical subsystem for 2D/3D rendering user graphics interfaces in web-based applications. The I-EXAM prototype will be evaluated in Arab Academy for Science, Technology, and Maritime Transport (AASTMT) [19] and Introduction to Programming course is selected cause it contains areas where students commonly make mistakes and for which they commonly need extra support and need high interactivity between the students and the teacher. The evaluative study will contain experiment and control groups.

5. Conclusion

In this paper, the I-EXAM framework is presented. I-EXAM helps the teacher understand students' behavior during MC Online Exam by monitoring the interactions data logs via diagnostic visual tool which enables teachers to drill down from a high-level overview into the details of student activities in addition to the ability to track the effectiveness of the given feedback during the exam using Data Mining techniques.

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