

QuizMe - An Interactive Learning Tool with Application to Electrical Circuits

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Abstract –Current methods for evaluating student performance and providing feedback to students regarding their understanding of a given subject are very dependent on traditional methods of evaluation, mainly in-class examinations. In this paper we propose an on-line, interactive, self-learning Java-based software package known as QuizMe to assist instructors in evaluating student performance and students in maximizing their understanding of the fundamental principles in any given course. Using QuizMe, instructors can design quizzes with a variety of built-in options, such as multiple attempts, adaptive questioning and question selection criteria. No other software tool provides similar features. QuizMe launches with an instructions page to inform students on quiz rules and how to make multiple quiz attempts. Each attempt displays a number of multiple choice questions from a chosen chapter/section of the course’s textbook. At the end of the quiz, QuizMe displays a report summarizing the user’s performance.

Keywords: QuizMe, Interactive, Electrical Circuits, Learning, Software tool.

INTRODUCTION

QuizMe is a software tool that helps students to improve their understanding of the basic concepts of a given subject and assists instructors in evaluating student performance and getting feedback. Circuit analysis is a course that is based on an understanding of a variety of methods used, where more than one method can contribute to the analysis and design of the circuit. The purpose of the QuizMe is to determine whether students understand the basic concepts that are the building blocks for circuit analysis and design [Haddad, 2].

In QuizMe, questions are divided into groups according to their type (numerical, symbolic), collections covering different concepts, and levels according to their difficulty. Students can make multiple attempts of the same quiz, but will not get the same question twice. The selection criterion is based on choosing one question per collection for each quiz, with the same difficulty level.

Numerical questions are questions displayed for the student with a numerical values panel to use for solving and obtaining the answer; the numerical values are generated randomly with a specified range during the run time of the exam to give unlimited number of numerical questions, thus maximizing the testing experience. The quiz will select a variation of numerical and symbolic questions. Students will be able to see what questions are answered, which ones are marked and which ones are left unanswered, and can jump to them directly using the question’s indication

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panel. A report will be displayed when the attempt is submitted, with all the answered and unanswered questions, indicating for each question if it was answered correctly, and offering the correct answer to the students, that makes this tool useful for students to study and practice the material by themselves after the class. Furthermore, instructors can use this software for the tests or use it for a quick quiz after every section or chapter they teach.

This paper is organized as follows: section one introduces the QuizMe method and its system technical description, section two describes the conducted experiment, section three presents the experimental results. Related work is illustrated in section four, and conclusions are presented in section five.

THE QUIZME METHOD

In this section the technique used for question writing, the incorporation of the questions into the software, and the QuizMe software modules are introduced.

Questions writing

As applied to circuit analysis, QuizMe is composed of sixteen chapters covering all topics of circuit analysis and design. Every chapter has, on average, ten sections. Each section is covered by at least ten different concepts, where every concept has around 150 problems, with four different difficulty levels. A student may choose a section to test his knowledge of a concept, such as the mesh method as shown in figure 1.

Ten questions covering ten different concepts with four different difficulty levels will be displayed to the student. The difficulty level of the problems will increase as the performance of the student begins to improve.

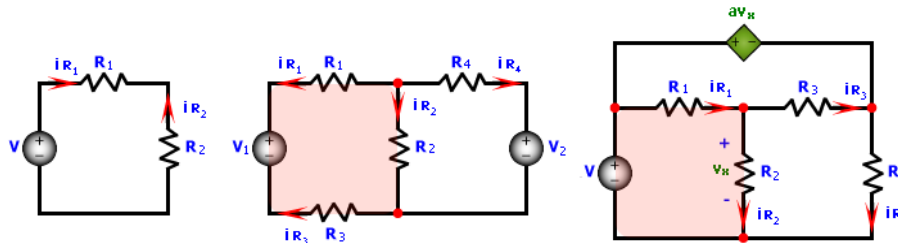


Figure 1 (a, b, c): showing three difficulty levels (1, 2, and 3) respectively, regarding one concept.

Question Selection Criteria

The questions are divided into groups according to their type (numerical, symbolic), collections according to their nature (similar questions in one collection) and levels according to their difficulty. Students can make multiple attempts of the same quiz, but will not receive the same question twice.

The difficulty level will change according to the student's performance, as illustrated in figure 2. In every attempt, the student should answer questions about all the concepts in the section/ chapter. Every question has the following parameters:

1. Difficulty level: As illustrated in figure 2, the initial difficulty level will be equal to 1, and will increase according to the student's performance.
2. Concept (Collection): the tool will display one question from every concept every attempt.
3. Group: numerical or symbolic, every group will be displayed for students in a certain percentage, assigned by the professor (as we will discuss later in the manager's view sub-section of this paper).
4. Time in seconds: this is assigned by the instructor.

Whenever a question is selected, the class Derby Data Layer places a flag on the question in the database, to indicate that it has been selected and to avoid selecting it again within the same quiz. QuizMe will have an instructor's page

where the instructor can decide on the selection criteria, decide how many numerical questions for example and put certain constraints on the quiz for better student evaluation.

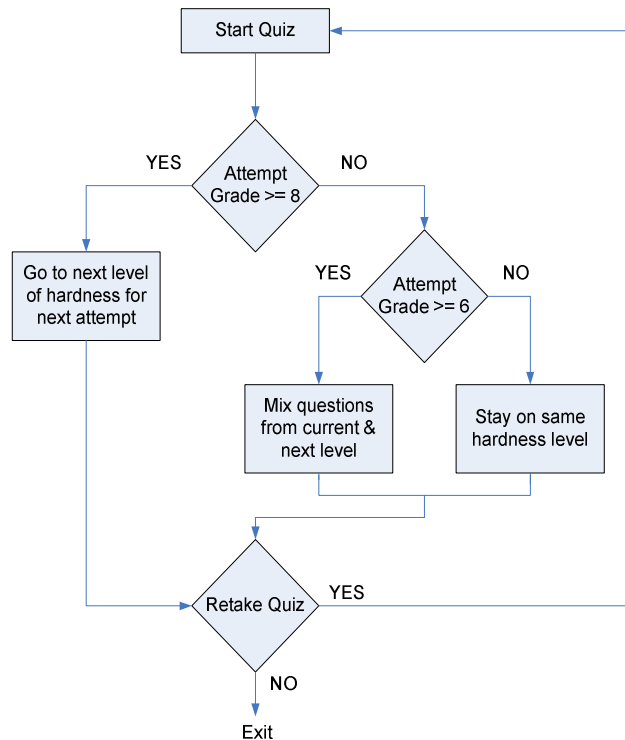


Figure 2: Questions Selection Criteria according to the difficulty level

The student starts with difficulty level one, if the attempt's grade is eight or more, the next attempt will display questions from the next level of difficulty. If the attempt's grade was more than six, then the next attempt will display a mixture of the current difficulty level and the next one, else if the grade was less than six, the student will have same difficulty level questions again. This process is illustrated in figure 2.

THE QUIZME SOFTWARE TOOL

In this section, the main modules of the QuizMe tool are presented.

Questions table/ template

The Excel workbook contains all the questions' information for different sections of the textbook material, with different information about levels of difficulty and groups. Additionally, with each question a circuit image and the four choices are associated.

The instructors fill in their questions into this table, and attach any kind of image/ circuit drawn on any software to any question by writing the image's path in the right column in the excel sheet (Note: every column has a name in the template, the columns of this table are: *question's text*, *image path*, *difficulty level*, *choice A*, *choice B*, *choice C*, *choice D*, *group*, *collection and time*). After the Excel sheet is filled with all the questions' information, it is placed in the folder of the software, and the program will find it and read questions from it into the SQL database.

Circuits table

In this table we assign different values for questions that have a numerical representation potential, giving that question a numerical value range for all the circuit components. The program randomly picks a number for each component within that range and calculates the intended answer, displaying the correct answer and three incorrect answers. (Note: this table is used for electrical circuits' quizzes only).

JAppletQuiz

This class is an extension of Java's JApplet [7], and it is the main container of the software. It holds the question, the report, and the welcome panels.

JPanelQuestion

This class is an extension of the Java swing object JPanel [7], and is the main screen that the software displays for students, and it has the question and all related data, including: the attempt number, the section/ topic title, the circuit image (or any image wanted), time left status bar (percentage of time left), calculator, timer (showing time left), and mark question (a QuizMe feature to help students remember to come back to a question they marked, either to think about, resolve, or any other purpose they want).

The student can switch between questions either by the next and previous buttons, or by means of the questions indication panel with the key color code as shown in figure 3. In the questions indication panel, students can jump between questions, and see questions states, answered, not answered or marked. Before submitting the quiz, the software will inform the user of the number of questions that are answered, not answered or marked. The JPanelQuestion interface is shown in figure 3.

JPanelReport

This class is an extension of the Java swing object JPanel [7], and it is the screen display where the student views the correct and incorrect answers, checks for grades and has the opportunity to retake the quiz for the same section, or exit the software. The JPanelReport interface is shown in figure 4.

Class QuizState

All the data about student performance information such as grades, number of quiz attempts, and sections already tested are saved in the program in a class we developed called Quiz State.

Class Derby Data Layer

This class is the program's interface with our SQL database [5], where we select questions according to our selection criteria, edit, modify and delete records from the data base.

The screenshot shows the QuizMe applet interface. At the top, it displays 'Applet Viewer: quizme.QuizMeApplet.class'. Below this, the 'Applet' header includes a 'QUIZMe!' logo, a progress bar at 92%, 'Attempt#1', a timer at 9:16, 'Level = EASY', 'Section 2.5', and 'Question 6'. A small calculator icon is also visible. The main question area contains the text: 'Which of the following is a correct Kirchoff's Current Law (KCL) equation, in terms of the current source, I_1 , and resistor currents i_2 and i_3 :' followed by four multiple-choice options: A) $I_1 - i_2 + i_3 = 0$, B) $I_1 + i_2 + i_3 = 0$, C) $-I_1 - i_2 - i_3 = 0$, and D) $I_1 + i_2 - i_3 = 0$. To the right of the options is a circuit diagram showing a current source I_1 on the left, and two resistors R_1 and R_2 in parallel on the right. Currents i_2 and i_3 are indicated flowing downwards through R_1 and R_2 respectively. At the bottom of the question area, there is a 'Mark this Question' button and a row of question indicators numbered 1 through 10, with indicator 6 highlighted in red. Below the question area are 'Submit Quiz', 'Previous', and 'Next' buttons.

Figure 3: Questions Panel

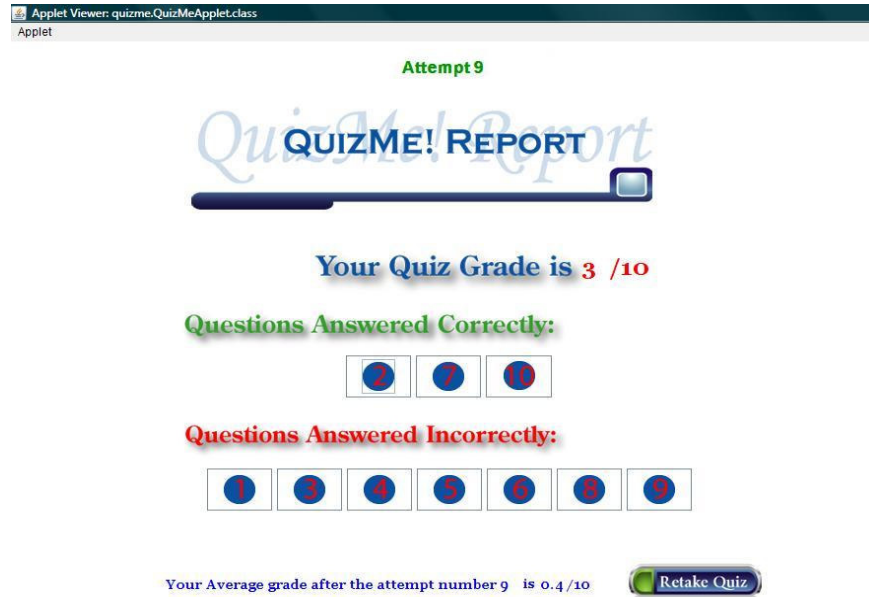


Figure 4: Report Panel

Editor's View

This interface allows the instructors to view the questions they have entered and browsing through the database by selecting topics or sections. Instructors can comment on questions, they also can see the numerical ranges for numerical questions in a tabular view. The Editor's view is shown in figure 5.

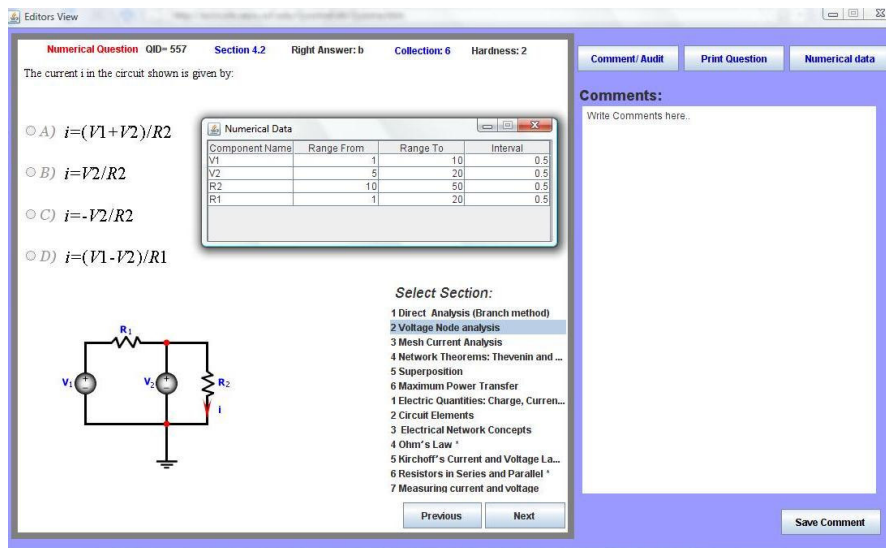


Figure 5: Editor's view

Manager's View

This view is where the manager can upload the questions from the Excel spread sheet into the tool by using the Database tab shown in figure 6. Furthermore, in this view the instructor can assign the number of questions per quiz, and can decide on the percentage of numerical questions per attempt, by using the "quiz settings" tab shown in figure 6.

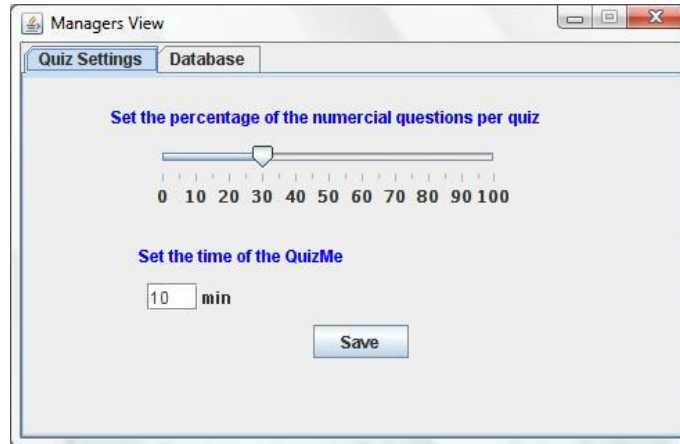


Figure 6: Manager's view

EXPERIMENTAL DESIGN

QuizMe was tested on students taking the circuit analysis class at the University of Central Florida. The experiment was set as follows: Students were given a demo version of QuizMe to get them familiar with the new software interface and the quiz timing. In the first Test, the students were granted an access to the training exams for six hours, where every student was expected to take six exams covering six sections: series-parallel circuits mesh analysis, nodal analysis, superposition method, Thevenin and Norton methods [Dorf, 6].

Each student was allowed to make up to five attempts per section, where the best score per section was the one to be considered. Each section was covered by 10 questions. All questions were one minute (10 minutes exam for every section). Student scores for all their attempts were recorded and processed. These attempts were considered to be part of their final grade for the course. In the final exam, a week after, the students were tested on the same topics covered in the online quiz.

Final exam scores were collected and compared with the two midterm exams and the training exams using QuizMe. After using QuizMe, students were given a survey consisting of eight questions. The questions considered various aspects of QuizMe, for every question they had to select an answer from very good, good, neutral and bad; the questions were:

1. How did you see the clarity of the question in terms what is being asked?
2. How did you see the clarity of the question in terms of circuit schematic and equation?
3. How do you evaluate the software features in terms of navigation and interface?
4. Did the quiz improve your understanding of the concepts in the class?
5. Do you think this quiz would help EE majors or none EE majors more?
6. What is your overall assessment about the quiz?
7. Do you think this tool should be used for other classes?
8. Would you like to have this tool from the beginning of the semester?

RESULTS

The survey results from the electrical engineering students at UCF were analyzed the results were encouraging since more than 58% of the students' answers were positive (very good and good), 27% were neutral, and 15% were negative (bad). Furthermore, we analyzed the answers for questions seven and eight only, 61% indicated that they

would like to have had the tool from the beginning of the semester, and 54% said they would like to have this tool in other classes. Figure 8 shows the results of student reaction toward QuizMe. The collected data based on student performance in their course written exams, the training quiz and the final exam, showed that as the number of attempts in the training exam increased, the scores for the final exam improved. Additionally, when we compared the final results for students who were consistent in their grades on the two midterm semester exams, we found that 18% of the students improved their grades and thus their overall class performance.



Figure 7: Students using the QuizMe tool in the Harris Lab at UCF

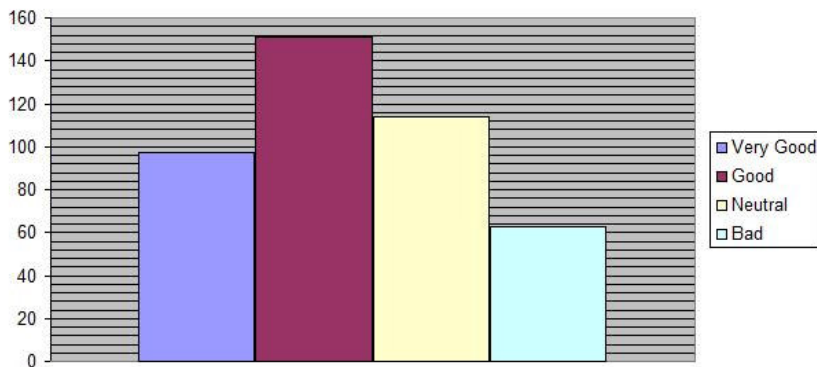


Figure 8: Students Reaction towards QuizMe

However to further improve the tool, and since the version we tested was the beta version 1.1, we need to test the software in greater depth, revise the questions and have more variations within the same topic by adding more questions with different difficulty levels and groups. It is also necessary to conduct more experiments on more students at different educational institutions.

RELATED WORK

Several electrical engineering quizzing tools had been developed and used, however none appears to be as interactive and generic as the QuizMe. The other tools tend to ask a fixed number of repeated questions, followed by grading of the quiz. Our tool gives a full quizzing experience to the student with multiple capabilities and features as discussed in this paper's previous sections.

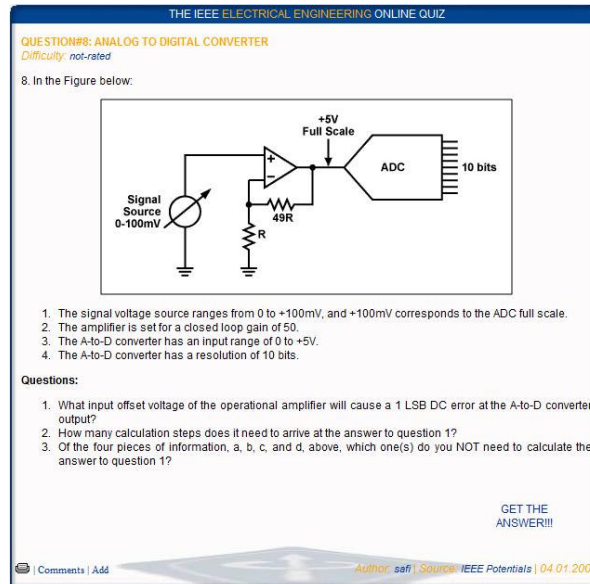


Figure 9: IEEE Quizzing tool

For example one of the tools we found is the IEEE electrical engineering online quiz (see figure 9) [3] which is similar to any written quiz, with a circuit image and a number of questions. This quiz doesn't have the interactive capability the QuizMe has since the user cannot get feedback to questions answered. It has no multiple attempts and no adaptive capability in choosing the questions.

9.) A student connects three identical resistors as shown in the sketch to the right. The potential difference across the battery is 12 Volt. What are the readings on V_1 and V_2 respectively?

	V_1	V_2
1 <input checked="" type="radio"/>	4	8
2 <input type="radio"/>	6	6
3 <input type="radio"/>	8	4
4 <input type="radio"/>	9	3

[Explanation](#)

10.) A 9 V battery is composed of six 1,5 V cells, which are connected in series. Each cell has an internal resistance of 0,2 Ω . What is the highest current that can be obtained from such a battery?

1 <input checked="" type="radio"/>	7,5 A
2 <input type="radio"/>	1,5 A
3 <input type="radio"/>	1,2 A
4 <input type="radio"/>	0,3 A

[Explanation](#)

Results

[See your results](#)

2 of 10 questions answered correctly (20%)	
Question 1 wrong	Correct = 2
What are the correct answers?	

Figure 10: University of Guelph Quizzing tool

We also found one electrical engineering online quiz on the University of Guelph (Ontario, Canada) website (see figure 10) [4]. This tool has a number of questions, with no interactive questions marking capability, no calculator, and no feature to let the students make multiple attempts. As a result, the student may not practice sufficiently on the concepts and will not have different variations.

CONCLUSIONS

In this paper an interactive learning and testing software tool is introduced. This tool represents a method of providing real time feedback to students, giving them the opportunity to improve quickly, until all concepts are mastered. The tool also represents a means for instructors to evaluate their students' understanding and help them grasp the material.

Experimental results showed that QuizMe has improved student performance. In the questionnaire answered by the students (shown in detail in the experimental design section), answers to questions seven and eight only showed that 61% indicated that they would like to have had the tool from the beginning of the semester since it helped them to better understand the material, and 54% said they would like to use this tool in other classes.

For anyone interested in using this tool, the tool is available online [Batarseh, 1], a user name and a password can be sent to you if you email the author, and you will have full access.

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