eTutor – An Interactive Module for Electrical Engineering Curriculum

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Abstract— The interactive technical electronic book, TechEBook, currently under development at the University of Central Florida (UCF), introduces a paradigm shift through replacing the traditional electrical engineering course with topic-driven modules that provides a useful tool for engineers and scientists. The TechEBook has comprised the two worlds of classical circuit books and an interactive operating platform such as iPads, laptops and desktops. The TechEBook provides an interactive applets screen that holds many modules, in which each had a specific application in the self learning process.

This paper describes one of the interactive techniques in the TechEBook known as, Tutor-Me Module (*eTutor*). The *eTutor* Module is a step-by-step problem solving program that will help in testing the understanding of key components presented in the TechEBook using an interactive circuit solver. This module will be displayed after each section in the TechEBook for the user to interactively solve problems. This tool also guides the user through detailed analysis steps of common electrical circuit problems. A practical example of applying the *eTutor* feature is discussed as part of a basic electrical engineering course currently given at UCF and results show improved student performances in learning materials in Electrical Circuits.

Keywords-component; Tutor-Me Module; Tool; Electrical Circuits; Interactive book

I. Introduction

The interactive **technical electronic book** (TechEBook) serves as a modern, media-rich innovative approach to a topic-driven modular electrical engineering curriculum that recognizes the different learning approaches for different users. The TechEBook consists of 16 chapters, a total of 75 sections representing typical content for the introductory circuit course at most universities in the world. Each section discusses a new theory and concept that are supported with examples and problems [1]. Different topics are presented in discussion text material that provides full understanding of the concept while maintaining user's self-remediation and self-paced learning. At the end of each section, QuizMe Modules are provided to quiz the students' understanding of the section [2]. Also, Design Modules (DM) are intended to help students develop their ability to design real life problems, and to link the theories they study in books with real design challenges, while the Practical Relevance Modules (PRM) are set to enhance the student thinking about real life problems and also teach students how to relate the theories they have learned with practical applications [3]. Finally, the Tutor-Me Module is intended to help understanding basic concepts in a step-by-step manner.

II. Objectives

At the University of Central Florida, efforts are underway to develop the full content of the TechEBook using the above attributes of each section. Tutor-Me Module is one major component of the TechEBook currently being developed through partial funding from the National Science Foundation (NSF). The main objective of including this module is to illustrate a further level of interactivity, where the user can contribute to the solution of circuit's parameters by inputting equations and getting immediate feedbacks about the validity of the mistakes, how to overcome them and the specific areas they need to improve in.

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The *eTutor* tool guides the user through a step-by-step analysis of common electrical circuit problems. In each step, the tool prompts the user to enter a formula that best describes the current step in the analysis method. Then, the tool responds with personalized feedback that is dependent on the user's formula. Through the feedback process, the tool targets all lexical and analytical errors in the user input. The tool compiles a list of errors and warning messages that are reported back to the user. Trials and interactive elaboration on errors allow the user to better understand the targeted concept in circuit analysis. More importantly, each user learns at his/her own pace, based on their individual learning styles.

The modular and template-based design for the tool allows the instructor to add and modify key problems. With the *eTutor* tool, users will be able to solve problems and obtain the same type of specific feedback they would receive from the class instructor.

III. Tutor-Me Architecture

The *eTutor* was developed using Java programming language as a backbone to collect data for testing purposes [4].

TABLE 1

Window	**Functionality**
Step Instruction	Provides a brief overview of the problem and description of the followed procedure
Circuit	Provides an illustration of the specific method used through circuits
Input	Provides the place to solve the question by inputting the resulting equation for the specific step
Feedback	Provides feedback based on the equation entered. If the wrong equation was entered, the feedback window will specify the error

The *eTutor* Graphical User Interface (GUI) screen is composed of four main windows; the *step instruction window*, the *circuit window*, the *input window* and the *feedback window*. These windows are designed especially to provide the ultimate help and guidance throughout the learning process. Table 1 summarizes the main functionality of each window.

The software will easily allow the user to select the circuit example of interest from the 'Choose Circuit' dropdown menu which is designed such that the instructor can add circuits easily as shown in Fig. 1. *eTutor step instruction* window will then introduce the problem and what method of analysis to use and how to proceed with the solution. In this paper, a mesh-loop example will be presented to fully explain the functions of the different interactive windows.

Each step provides the needed description of the problem and what are the parameters that need to be solved for (*step instruction* window) and the associated circuit image (*circuit* window) as shown in Fig. 2. The user can then walk through the example step-by-step using the navigation buttons.

The next step is solving the problem. The *eTutor* will now enable the *feedback* window and the *input* window. Clicking on the 'Check Eqn' after inputting the answer will enable the *feedback* window, which will show the results of the parsing and analysis operation and will provide feedback on whether the inputted equation is right or wrong as shown in Fig. 3.

The *feedback* window will not only inform the users if their input to a question was right or wrong, it will also specify what type of error was made in the symbolic equation and will provide the standard

equation for the step. The *eTutor* can accept many forms of an answer; it will know all the equivalent answers, analyze them and provide the proper feedback.

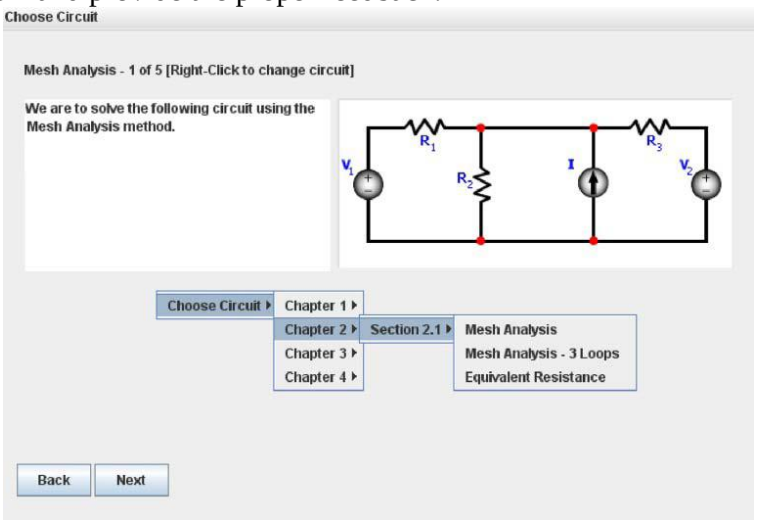

Figure 1. *eTutor* main GUI.

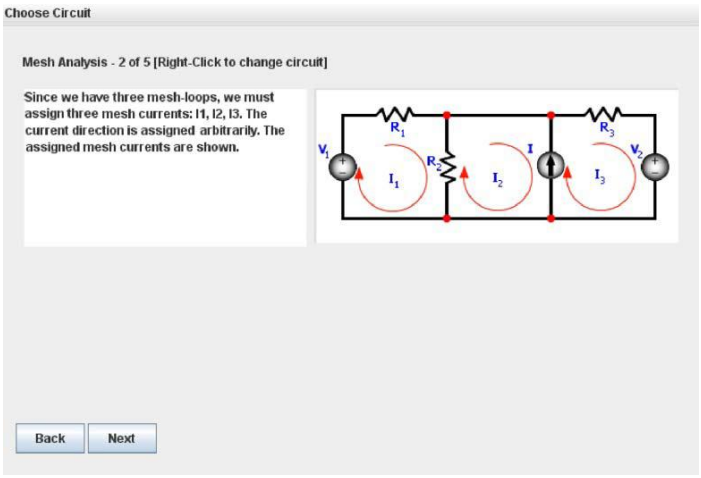

Figure 2. *eTutor* step instruction window.

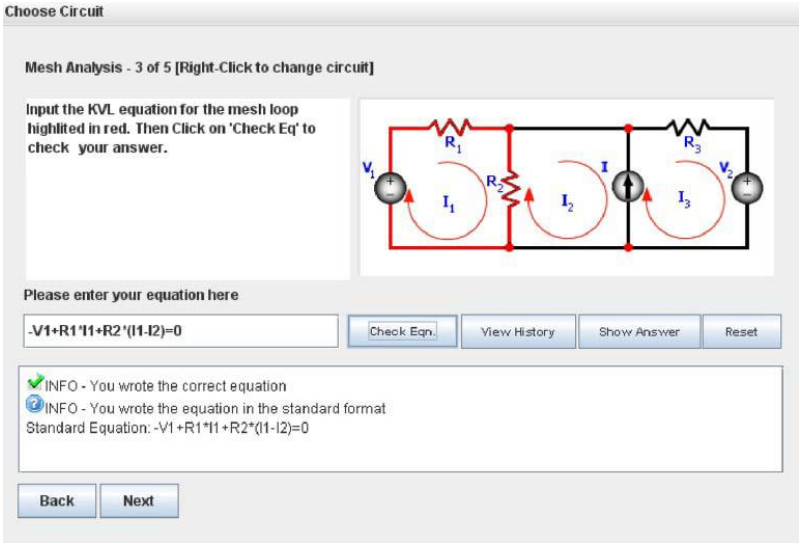

Figure 3. *eTutor* input and feedback windows.

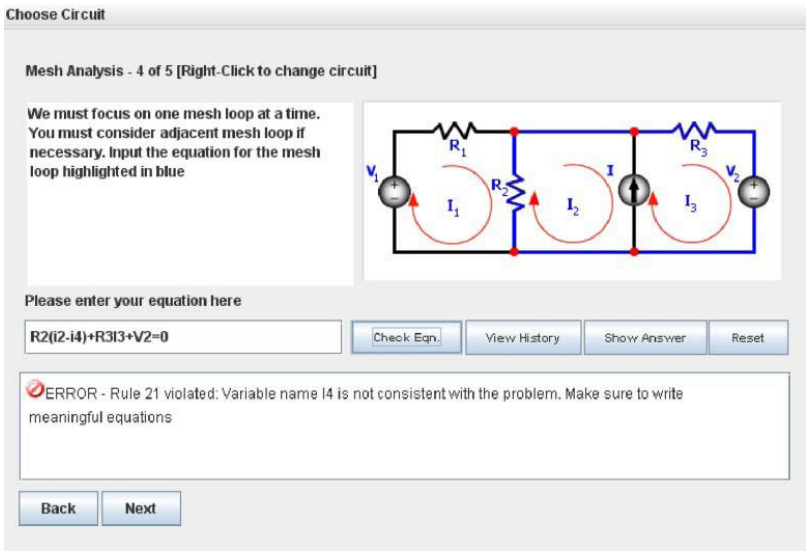

Figure 4. *eTutor* error message example.

If the equation is wrong, *eTutor* will provide information about the nature of the error as illustrated in Fig. 4. Another feature in the *eTutor* tool is that it provides multiple step instructions. The *step instruction box* will look for a better explanation of the problem if the step is missed. Each step contains its own personalized multiple step instructions in case the equation was missed because of lack of understanding regarding what to do or how to approach the problem.

After the 5th failed attempt, *eTutor* will ask if you would like to see the answer as shown in Fig. 5.

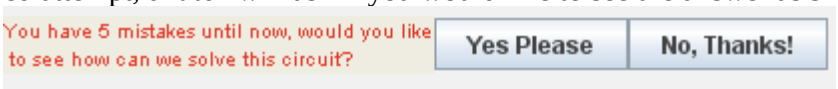

Figure 5. *eTutor* approches the user after the 5th failed attempt.

This message will appear at the bottom of the *eTutor* screen in case the user decides to stop trying and reveal the answer. However, by clicking at the 'Show Answer' button, the user will be able enable to peek at the correct answer at any time.

After the users finish solving the problem, they can interact with the circuit by inputting their own numerical values. This feature is handled by the *equation solver* that controls the circuit numerical solutions [4].

IV. Equation Accuracy

The Tutor-Me Module is designed to take the user's inputted equations, analyze them, expand them, and chop them into terms that would be easy to compare against the correct terms. The code is designed to make a term by term comparison and display the adequate error message. In the comparison, several errors are accounted for such as: "wrong sign", "wrong term", "too many terms", "missing a term". By giving these specific error messages, the users would be able to detect the exact areas they are having issues with. For example, if a "wrong sign message" is given, the user might want to check on the assumed current directions or voltage polarities. Furthermore, after imputing the wrong term for five times or more, the user will be given the option of viewing the correct answer.

In order to create the adequate code that would compare the user's equations against the correct equations for a given circuit, the flow chart displayed in Fig. 6 has been created. As the flow chart explains, the program starts by checking the number of terms of the inserted equation and gives the corresponding error message if that number does not equal the correct equation's number of terms. The following step is checking for legitimacy of the terms' signs and then the validity of those terms.

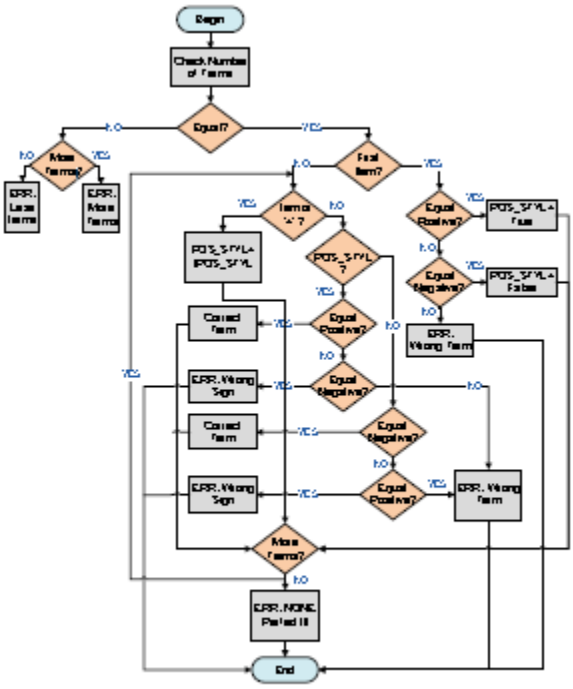

Figure 6. Block diagram for equation decision flow

eneral way that makes adding more problems to the website very quick and easy. A problem could be added by adding a new case to the tutor.java file. The case calls out the new circuit's parameters and equations.

V. Experimental Results

A survey for the Beta version of the *eTutor* was conducted for students of different majors from the Principle in Electrical Engineering (EGN 3373) class at the University of Central Florida, and results were analyzed to measure the students' feedback about the Tutor-Me Module. 77.8% of the students believe that the *eTutor* is a good tool for improving the understanding of the concepts in the class, while 18.5% think that the *eTutor* tool was not the only reason behind the understanding of the concepts but the Module is good and user friendly, and 3.7% reported that the tool was not effective for them. Fig. 7 reports the survey results. Most answers came positive, and the students expressed their willingness to use this tool for all their courses.

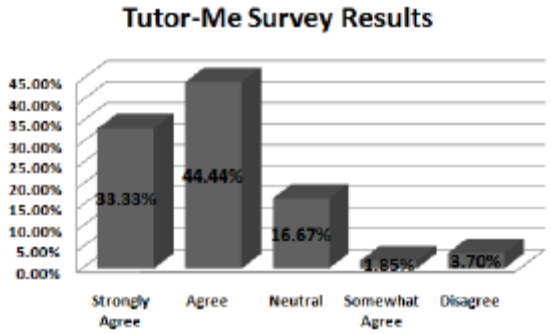

Figure 7. Survey results

VI. Conclusion

The MeLearning project will take a major leap in engineering education and will facilitate learning at a pace specific to the learner without the constraints of a fixed time span – semester or quarter, currently specified in our curricula. This paper, addresses the TechEBook Tutor-Me Module in particular. It presents a new electronic, interactive and adaptive method to maximize the students learning experience, in their self learning process and increase their understanding in any given topic. The main purpose of the *eTutor* technique is to provide a well defined step-by-step interactive problem solving that will help in testing the user understanding of key concepts in each main section presented by the TechEBook. The overall assessment of the class, who tried the *eTutor*, resulted in an average score of 77.8% for students who believed that the *eTutor* technique was beneficial and 3.7% for non effectiveness of the tool, the rest were neutral. Most students welcomed the new tool, which reflected the importance of these on-line modules.

VII. References

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