Problem Solving Method Based On E-Learning System For Engineering Education

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ABSTRACT

Encouraging engineering students to handle advanced technology with multimedia, as well as motivate them to have the skills of solving the problem, are the missions of the teacher in preparing students for a modern professional career. This research proposes a scenario of problem solving in basic electrical circuits based on an e-learning system to assess students' skills in solving the problem through the use of the e-learning system. Through cooperation between the teacher and the students and among the students themselves, the proposed scenario indicates a high acceptability from the students to acquire cognitive skills; the students present more motivation to use advanced technology during instruction.

Keywords: Problem Solving; E-Learning

INTRODUCTION

E-learning provides advanced techniques that help satisfy the continuing need for the teacher to attractand maximize the students' cognitive skills, as well as increase the motivation of engineering students towards their lessons. In addition, e-learning tools may be used to evaluate teacher efficacy and the instructional method from the students' point of view and help to motivate teachers (Ballera, Lukandu, & Radwan, 2013; Gupta, 2002; Rashid &Ventura-Medina, 2012; Stojcevski, n.d.) Problem solving is an important technique in the delivery of an engineering curriculum. It is an efficient method that gives the teacher the capability to explore students' ability to analyze and synthesize various situations to solve possible problems facing them or the ability of the students required by the teacher to solve problems according to preceded information. Problem solving also gives the teacher the insight to improve educational outcomes (Breakey, Levin, Miller, & Hentges, 2008). The problem solving method easily allows for group work among students and trains them to accept the opinions of other students in the same group; it provides students with new attitudes and the spirit of competition, as well as the skills to find the solution to a problem that they may face in the future with respect to saving time and cost (Adams, Kaczmarczyk, Picton, & Demian, 2007).

Based on the pre-built e-learning system (Khazaal, Abbas, Abdulridha, Karam, &Aglan, 2014) and its features, abilities, and facilities, a scenario for a problem in basic electrical circuits has been proposed to be solved by the students, using one of the strategies of problem solving in order to develop the skills of the students, as well as motivate them and familiarize them with the e-learning system.

MOTIVATION

Problem solving methodology is one of the strategies followed by many institutions to reinforce learners' ability of to develop the skill of analyzing and synthesizing various situations and acquire the experience to investigate the best strategy to obtain the solution to the problems facing them in a short time at low cost.

Many strategies for problem solving have been proposed. Most of these strategies have common general steps that can be followed to solve the problem, such as(TeachEngineering.org, n. d. ; Citehr.com, n. d.):

1. Identify the problem.
2. Think about how to obtain the result.
3. Think about possible solutions.
4. Choose the best solution.
5. Implement the solution.
6. Evaluate the results and make necessary changes if needed.

Figure 1 indicates the problem-solving strategy flow.

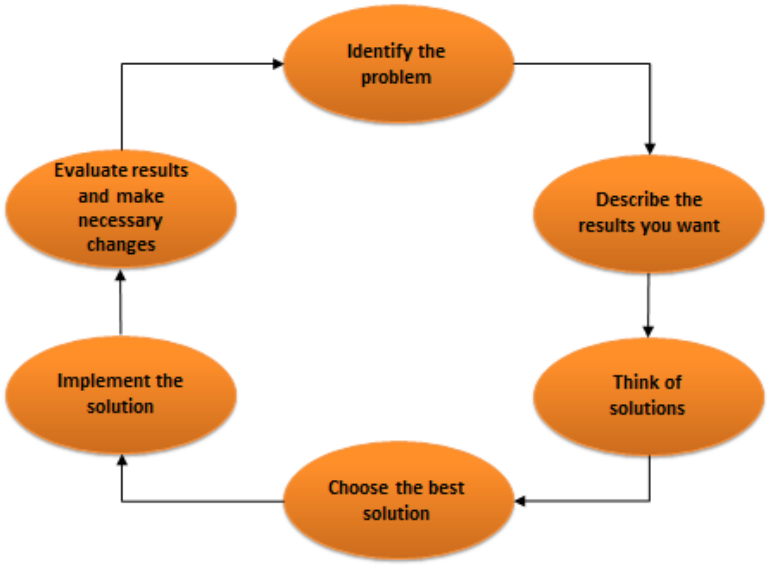


Figure 1. Problem-Solving Strategy

By following these steps, the students solve the problem using their skills through gathering the information previously presented and processing it to reach the solution.

METHOD

In this research a sample of 160 students individually solved a problem in basic electrical circuits according to lectures previously presented on the e-learning system, which covered topics on the basics of electrical net analysis. This problem was presented on the e-learning system. The students were enrolled in a course titled "Fundamental of Electrical Circuits (or Networks) Analysis". The teacher (researcher) asking the students about the participation in this experiment describing the importance of it to them in assessing themselves abilities' (self-assessment) as well as to assess their acceptance to use e-learning system as one of the significant method of presenting subjects in education process also they informed that the results of this experiment will be used to evaluate it. According to this the students agreed to be in this experiment.

The teacher used the e-learning system to present lectures and communicate with the students through the messaging function. In this manner the teacher and the students can have discussions through the system so that students can receive continuous feedback during the solution process to help them obtain the solution. Students are also able to communicate with each other through the system, further enhancing their educational experience.

The following figures display the system with some modules that are used by the teachers and students.

Figure 2 presents the system architecture, which is composed of three layers: User interface layer, Middle layer, and Server layer. The user interface layer has three modules: User interface module, Teacher module, and

Student module. Each of these modules has sub-modules that have an integral role to support the missions of the users of the system.

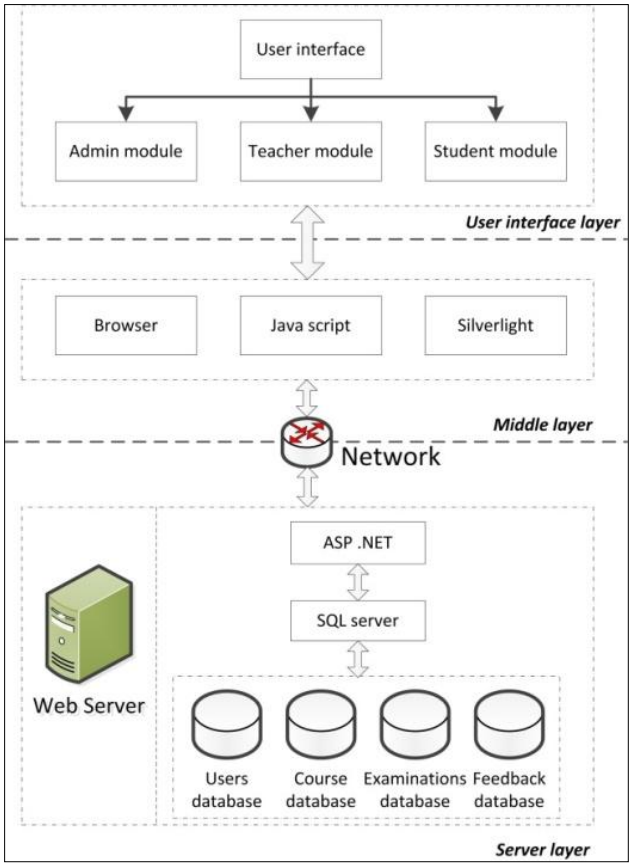


Figure 2. E-Learning System Architecture

In Figure 3 the teacher's today lecture sub-module is presented. This sub-module is used by the teacher to upload the lectures, which are then presented to the students.

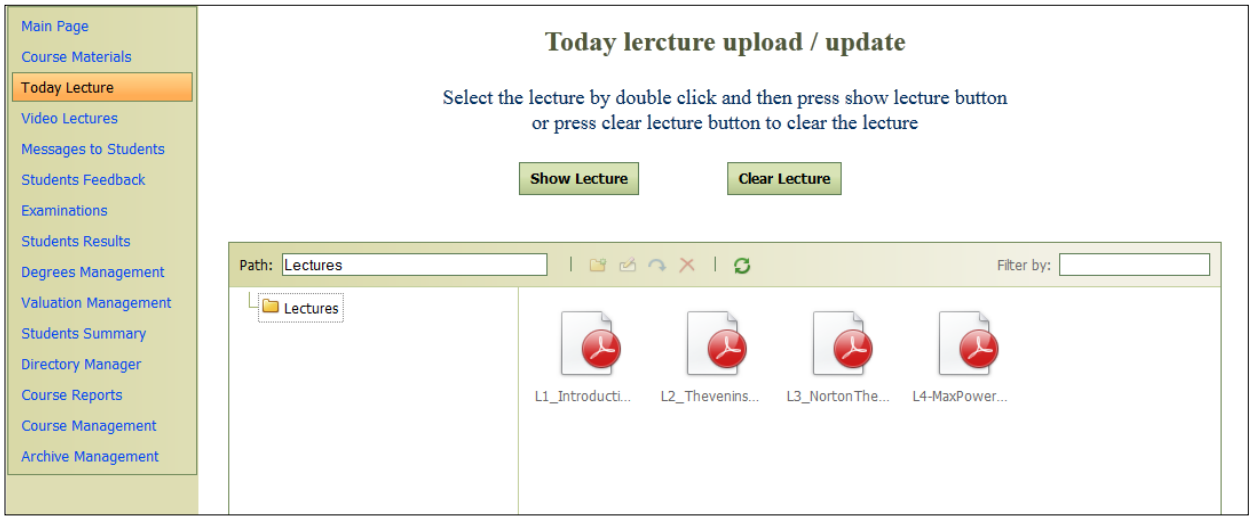


Figure 3. Teacher's Today Lecture Sub-Module

Figure 4 represents the sub-module that is used by the teacher to submit messages to the students. By this module the teacher can choose any students and send to them the same message or a variety of messages.

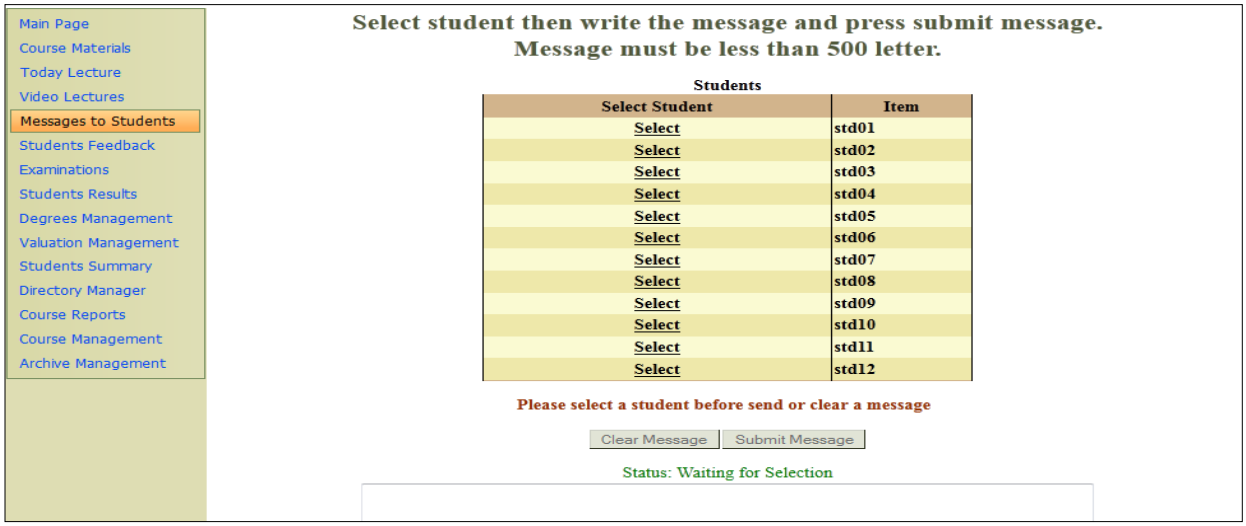


Figure 4. Teacher's Messages To Students Sub-Module

Figure 5 presents the sub-module that displays to the teacher the feedback messages that come from the students.

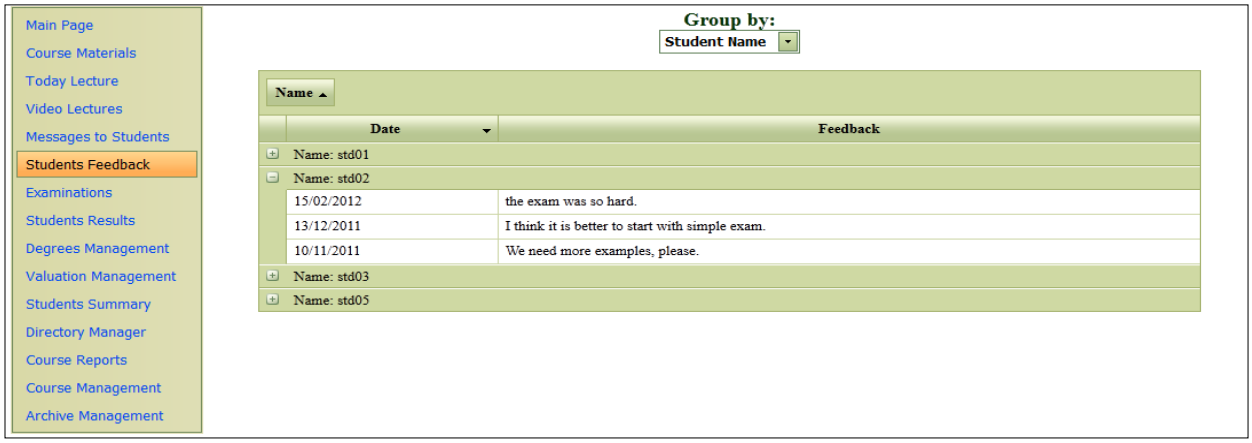


Figure 5. Teacher's Student Feedback Sub-Module

The sub-module presented in Figure 6 displays the messages that come from the teacher to students; it is called the students' teacher messages sub-module.

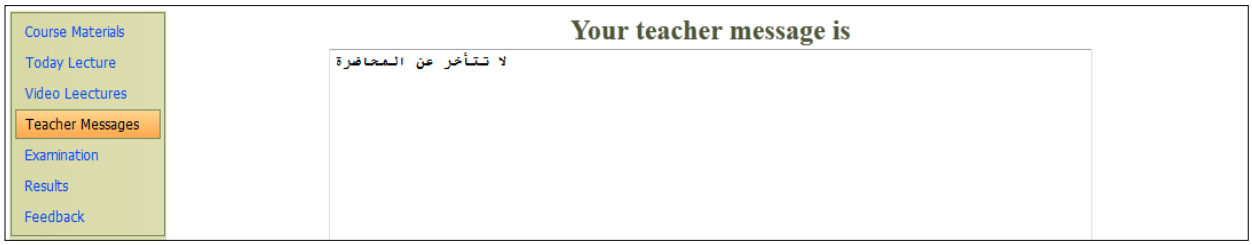


Figure 6. Students' Teacher Message Sub-Module

By the sub-module presented in Figure 7, the students can download and display the video lectures that have been uploaded by the teacher.

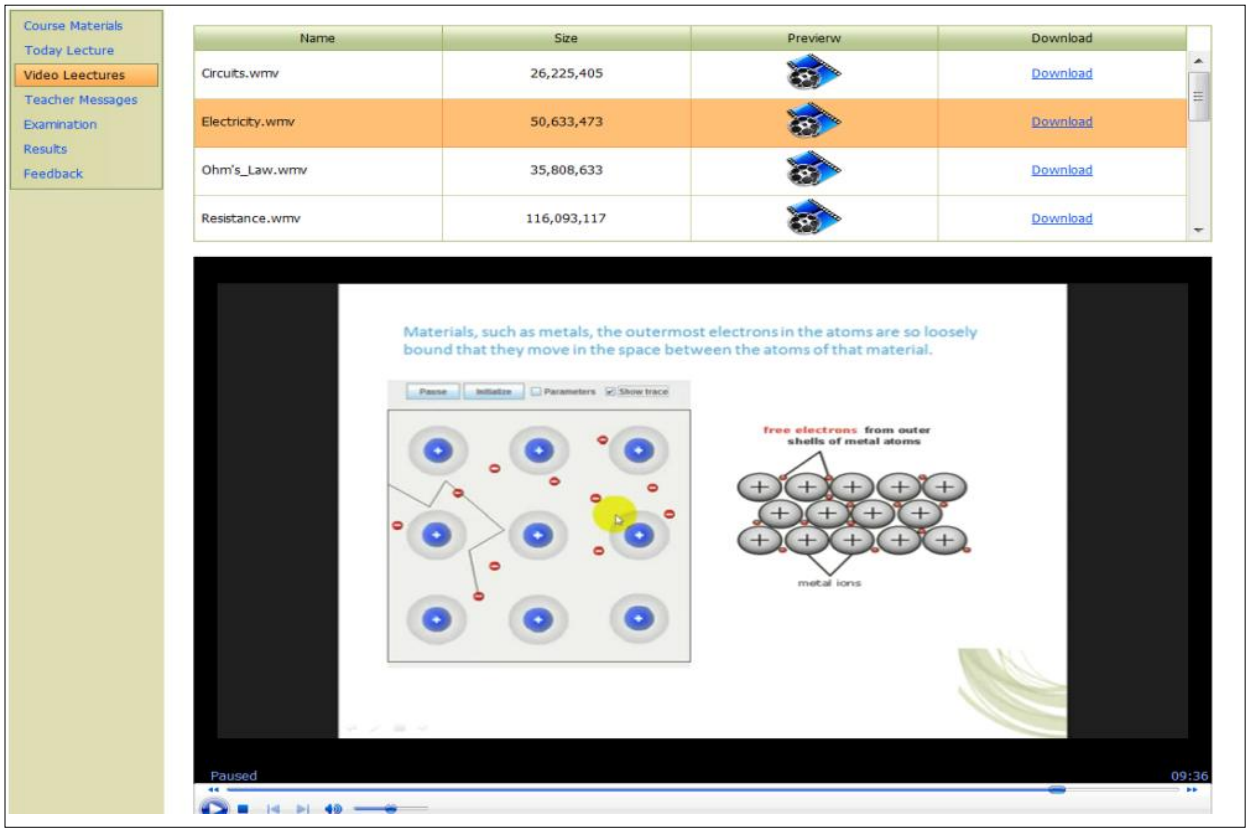


Figure 7. Students' Video Lecture Sub-Module

Using the sub-module presented in Figure 8, the students can send their messages to the teacher as feedback messages.

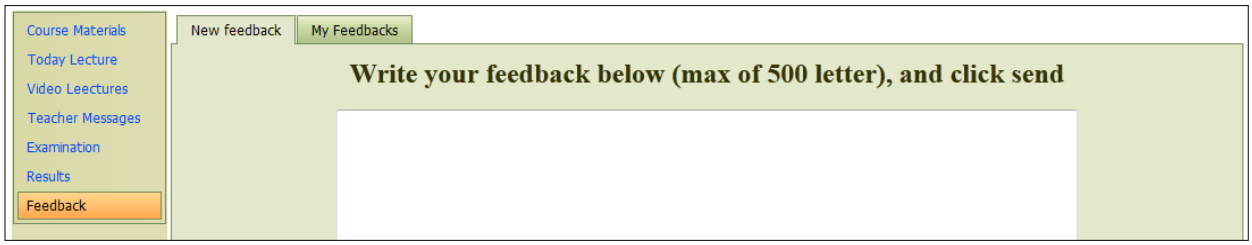


Figure 8. Students' Teacher Feedback Sub-Module

Figure 9 represents the sub-module that students use to display the requested examinations; the same sub-module is used to upload their answers to the teacher.

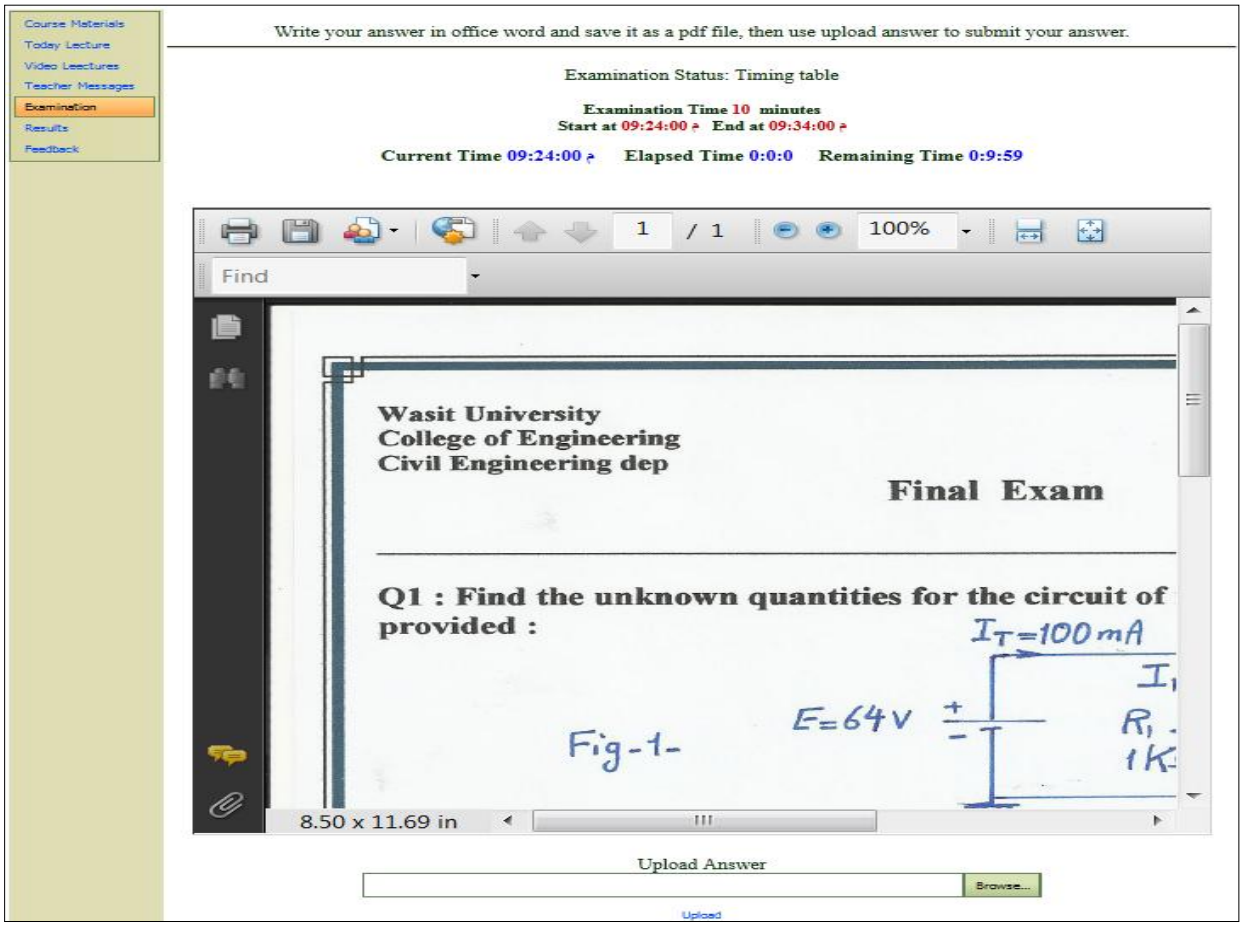
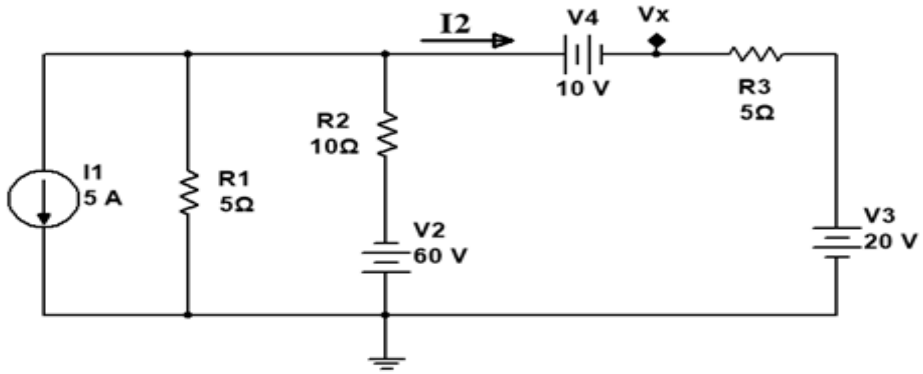


Figure 9. Students' Examinations Sub-Module

THE PROBLEM SCENARIO

The problem provided to the students is shown in Figure 10 below:



Find I_2&V_x in the above

ORIGINAL CIRCUIT DIAGRAM

Figure 10. Original Circuit Problem

The problem was sent to 160 students through the system in order to answer it individually to measure and assess their capabilities, attitudes and thinking skills for such problems. There are three possible scenarios to solve this circuit problem as shown below.

Scenario 1: Using Source Transformation

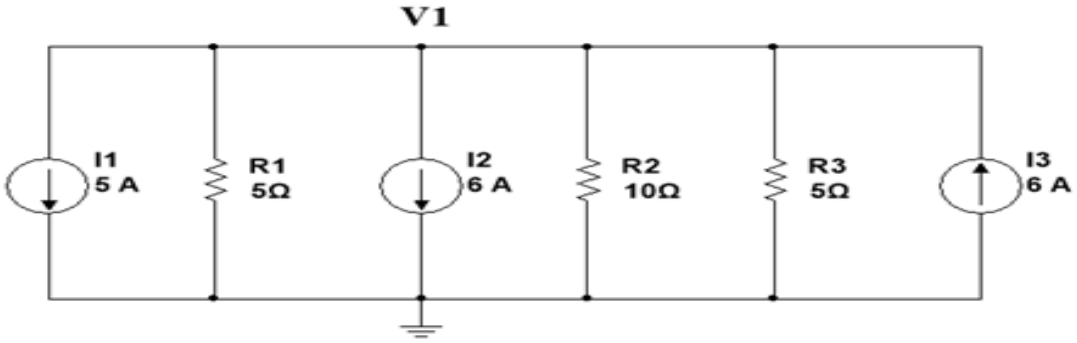


Figure 11. Conversion Of Voltage Sources To Current Sources

By converting the voltage sources into current sources as shown in Figure 11,voltage 1 (V1) is obtained.

$$I_T = -I_1 - I_2 + I_3 = -5A - 6A + 6A = -5A$$

$$R_T = R_1 // R_2 // R_3 = \frac{1}{\frac{1}{5\Omega} + \frac{1}{10\Omega} + \frac{1}{5\Omega}} = 2\Omega$$

$$\therefore V_1 = I_T R_T = -5A \times 2\Omega = -10\ V$$

This is then used in the original circuit to obtain current I_3 as shown in Figure 12.

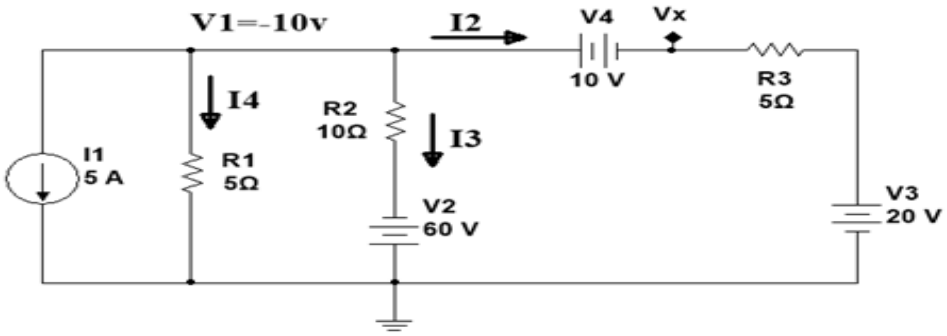


Figure 12. Equivalent Circuit To That Shown In Figure 11

$$I_4 = \frac{V_1}{R_1} = \frac{-10V}{5\Omega} = -2A$$

$$I_3 = \frac{V_1 + V_2}{R_2} = \frac{-10V + 60V}{10\Omega} = 5A$$

Then applying Kirchhoff's Current Law(KCL)(i.e. In any electrical network, the algebraic sum of the currents meeting at a point(or junction) is zero) at node V_1 gives:

$$I_1 + I_2 + I_3 + I_4 = 0$$
$$5A + I_2 + 5A - 2A = 0$$
$$\therefore I_2 = -8A$$
$$V_x = V_1 - V_4 = -10V - 10V = -20V$$

Scenario 2: Using Branch-Current Method

By converting the current source into voltage source, the voltages in loops 1 and 2 are obtained as shown in Figure 13.

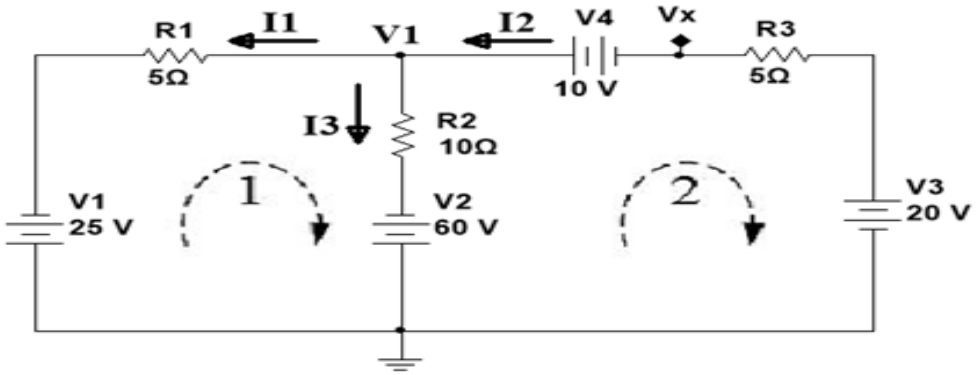


Figure 13. Equivalent Circuit To That Shown In Figure 11

$$Loop\ 1: -25V + 5I_1 - 10I_3 + 60V = 0 \xrightarrow{yields} 5I_1 - 10I_3 = -35V \quad (1)$$

$$Loop\ 2: -60V + 10I_3 - 10V + 5I_2 - 20V = 0 \xrightarrow{yields} 5I_2 + 10I_3 = 90V \quad (2)$$

Next, applying KCL at node V1 gives:

$$I_1 + I_3 = I_2 \xrightarrow{yields} I_1 - I_2 + I_3 = 0 \quad (3)$$

Now solving these three equations for I2, V_x is obtained.

$$\frac{\begin{bmatrix} 5 & -35 & -10 \\ 0 & 90 & 10 \\ 1 & 0 & 1 \end{bmatrix}}{\begin{bmatrix} 5 & 0 & -10 \\ 0 & 5 & 10 \\ 1 & -1 & 1 \end{bmatrix}} = \frac{1000}{125} = 8A$$

$$V_x = V_1 - V_{R_3} = 20V - (I_2 R_3) = 20V - (8A \times 5\Omega) = -20V$$

Scenario 3: Using Mesh Analysis Method

By converting the current source, the circuit diagram in Figure 14 is obtained.

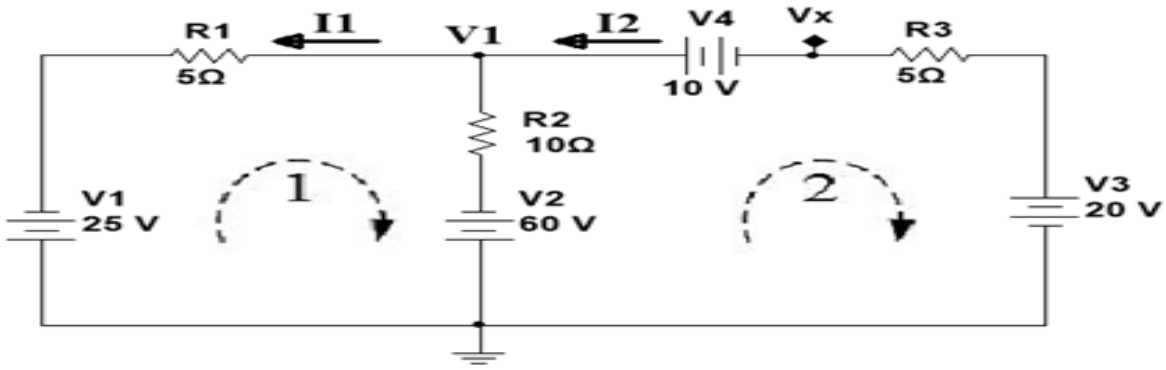


Figure 14. Equivalent Circuit To That Shown In Figure 11

$$Loop\ 1: 15I_1 - 10I_2 = 35V \quad (1)$$

$$Loop\ 2: -10I_1 + 15I_2 = -90V \quad (2)$$

Now solving these two equations for I_2gives:

$$\frac{\begin{bmatrix} 15 & 35 \\ -10 & -90 \end{bmatrix}}{\begin{bmatrix} 15 & -10 \\ -10 & 15 \end{bmatrix}} = \frac{-1000}{125} = -8$$

$$V_x = V_1 - V_{R_3} = 20V - (8A \times 5\Omega) = -20V$$

RESULTS

From the collected answers it was determined that 7.5 % of the students (12 students)failed to find the correct solution. The remainder of the students used the presented scenarios in the following percentages:

- Scenario No. 1: 22.5 % (36 students)
- Scenario No. 2: 31.25 % (50 students)
- Scenario No. 3: 38.75 % (62 students)

The reason why the students who did not obtain the right answer were unable to complete the problem is not known; however, because the instructor is able to identify these students very quickly through the use of electronic grading within the e-learning system, and communicate in a very timely manner, these students can be offered remediation to help increase their skills.

The second highest number of students used the second scenario to solve the problem; however, these students also should be reminded that an easier method is available, which is scenario #3. The teacher can now group the students in four groups according to their previous solution method and instruct them on the other possible solutions. The e-learning system provides an efficient way for the instructor to personalize instruction.

As the groups of students now must solve the problem as a group, they also have three solution scenarios to study. The groups follow the steps of the problem solving strategy:

Write down the problem with its requirements.

1. Write down all the laws and the methods for analyzing the electrical circuits and networks that were previously fed to them by the teacher through the lectures, which may help them to maintain the required results.
2. Extract the exact laws and methods related to targeted problem.
3. Students then discuss the possible scenarios amongst themselves and should be able to conclude to choose scenario No. 3 since it is the shortest method.
4. Re-implementing the scenario gives the required results.
5. The groups evaluate the results and submit them to the instructor.

To assess the acceptance and the satisfaction of the use of the problem solving method through the e-learning system, a Likert-type questionnaire was administered to the students. The level of satisfaction in this questionnaire is represented by the mean opinion score (MOS); the maximum possible is 5 (very great satisfaction) and the minimum is 1 (very low satisfaction).. The results of the questionnaire are depicted and tabulated in Table 1. The results indicate that there is satisfaction and the method is acceptable among the majority of the students.

CONCLUSIONS

In this study a problem-solving strategy was presented to the students through an e-learning system in order to teach them the problem-solving skills necessary for a circuit problem and to familiarize the students with the e-learning system. Students initially worked as individuals and then were placed in groups, based on their initial response to the problem, to further understand the problem and possible strategies for its solution. When the problem had been solved by the students individually, the results indicated that a small group of students had trouble solving the problem; however, the e-learning system easily enables the professor to identify these students and remediate them. Other students solved the problem correctly, but did not necessarily use the most efficient method to do so.

On the other hand, when the students worked in a team, better results were obtained, which is the same goal of the problem-solving method. So in order to implement the problem-solving method, individuals should be encouraged to work in groups in order to achieve better results. Group discussion provides an opportunity for students to share their opinions and learn strategies from one another. It also prepares students for the world of work, where they will often be expected to work in teams. Students also demonstrate appropriate skills in using the system

when they feel they are free to communicate with the teacher by using the alternative feedback messages. The students' satisfaction and acceptance of the use of the problem-solving method with the e-learning system was assessed through the use of a questionnaire. The results of the questionnaire indicate that students are highly satisfied with the problem-solving method and the e-learning format.

AUTHOR INFORMATION

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APPENDIX

Table 1. Questionnaire Results

Items	Degrees					MOS
	Very Large	Large	Medium	Little	Very Little	
The e-learning system is friendly to use.	86	60	8	4	2	4.693333
Problem-solving method is easy to execute and managed by the e-learning system.	85	63	7	3	2	4.706667
The use of e-learning system with method of problem solving facilitates discussions among students.	89	61	6	3	1	4.76
The use of the e-learning system reduces embarrassment for students during the altering of information between them.	82	67	4	5	2	4.68