

Original Research Paper

## Computer-Assisted Teaching and Learning of Electronic Circuit on Student's Motivation, Achievement and Cognitive Load

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**Abstract:** This paper aims to see the effectiveness of computerized simulation with electronic circuits on students' motivation, achievement and cognitive load. This study uses mechanical electronic circuit simulation as a teaching aid and facilitator for students studying Design and Technology subjects. The objective of this study is to evaluate the effect of using simulation on students' motivation, achievement and cognitive load. This study is also to discuss the development of Simulation and laboratory worksheets for LiveWire software that will be developed for the Design & Technology subject for second-year students at the high school level. The method presented using LiveWire is a systematic work step in exploring the use of simulation for electronic circuits. This electronic circuit simulation is able to give students the ability to read, interpret and transfer wiring circuits to schematic circuits. This LiveWire simulation is also suitable and able to improve the construction of meaningful knowledge for students. Assessment is done through post-tests, Instructional Material Motivation Scale (IMMS) questions and the NASA Task Load Index cognitive load test. The results of this study show that electronic circuit simulation has a positive effect on students' motivation, achievement and cognitive load.

**Keywords:** Design and Technology, LiveWire, Simulation.



## 1. Introduction

Development of LiveWire Simulation as well as laboratory worksheets for LiveWire developed for Design & Technology subjects. The evaluation process of the LiveWire kit and the laboratory worksheets developed involving the evaluation of usability and user satisfaction are also discussed. The selection of an appropriate instructional design model is very important in providing a framework that can help someone carry out the task of designing and developing learning support tools more systematically [1].

The main goal of this study is to see the effectiveness of using LiveWire on students' achievement, motivation and cognitive load. Simulation-assisted learning is one of the most effective and popular technology-assisted teaching and learning methodologies nowadays. There are various examples of its use, such as in the field of aircraft handling, medical field, urban development planning and so on. Simulation-assisted learning can be implemented in various aspects, including in the field of education. One of the main issues in the current learning process is the difficulty students have in accepting, and responding to the learning process. Conventional learning that is centred on the teacher seems to be detrimental to students, especially students who lack knowledge. Students may be saturated in education and lack the motivation to learn [2].

The ARCS learning model is a form of a problem-solving approach to planning a motivational and learning environment in promoting and maintaining student motivation to learn [3]. A more dynamic learning environment by using appropriate teaching aids is more likely to provide motivation to students [3]. Cognitive load is capable of curbing the learning process and indirectly student achievement performance will decrease. The use of simulation in the teaching and learning process has the ability to attract students' attention and interest in learning. In fact, the performance of students who received a simulation-assisted delivery strategy was seen to be better than those who only received a face-to-face one.

Therefore, to ensure that the Malaysian education system continues to be relevant in a rapidly developing world, a combination of innovation and creativity in the education system and through concerted efforts and changes on all sides, the ever-changing challenges of the 21st century can be overcome [4]. Therefore, this study was carried out to identify the effect of computerized electronic circuit simulation on the performance, motivation and motivation of students in RBT subjects in secondary schools to facilitate students to read, interpret and transfer wiring circuits to schematic circuits that are able to contribute to skilled personnel in the field of technology. This study has five main objectives which are [5]:

- 1) Analyzing performance on achievement tests among students with different existing knowledge before learning using electronic design simulation.
- 2) Analyzing performance on achievement tests among students with different existing knowledge after the following learning using electronic design simulation.
- 3) Researching the difference in motivation levels among students with different existing knowledge before learning using electronic design simulation.
- 4) Researching the difference in motivation levels among students with different existing knowledge after the following learning using electronic design simulation.
- 5) Identify the effect of cognitive load that is a mediator to student achievement and simulation design

## 2. Literature Review

Livewire is an electronic simulation that is used to plan and analyze and can demonstrate the functions or principles of electronic networks. The computer simulation is a tool that can be used to improve high-level thinking [6]. The computer simulation design can improve high-level thinking skills. The Life Skills subject that is now replaced by the Design and Technology subject has the title of Electronic Design referring to the Form 2 Chapter 2 textbook [7].

The stated learning objectives are as follows:

- 1) State the meaning of microcontroller and microprocessor
- 2) Explain the parts found in a microcontroller
- 3) Produce electronic circuit design sketches.
- 4) Build a simulation circuit that works with special software.
- 5) Connect the input circuit and output circuit to the microcontroller.
- 6) Write simple programming based on connecting the input circuit and output circuit.
- 7) Test and evaluate the functionality of electronic circuits.
- 8) Propose improvements to electronic circuit design.

Based on the following learning standards, students can get a real picture of how an electronic circuit works with the use of simulation. This aspect equips students with basic life skills that work to be applied in everyday life. Teachers who are competent in teaching have knowledge in delivering the content of teaching in the classroom in an organized and systematic manner. This element of knowledge can be measured through a teacher's skill in using various teaching strategies when teaching in the classroom or workshop [8].

In general, the integration of students with these simulation and technical facilities as teaching aids can make the learning and facilitation process more interesting. The use of computers in teaching and learning not only helps teachers achieve their pedagogical objectives but also gives students the opportunity to try new ways of learning. This is because the Design and Technology subject is a newly introduced subject that gives students the opportunity to combine design and technology skills by thinking creatively to produce something to meet their needs as technology changes [9].

The use of computers in reading learning shows significant effectiveness compared to traditional reading learning. The use of software in learning to read also successfully improved the students' reading skills significantly. The findings of this study also have implications for students, teachers and reading learning strategies. The students at low academic achievement levels usually need various combinations of mediums in their learning such as moving visuals, animation, text, music and graphics, where all these mediums are found in simulations that can be found in computer assisted learning [10].

### 3. Methodology

This study uses a quantitative approach to test the research objectives that have been outlined. Quantitative research is to determine measurements objectively to produce data in the form of numbers and analyzed using statistics. The quantitative research approach is based on the measurement and the search for relationships or associations between the variables used in the study. Quantitative research comes in six types, which are commonly used in the field of education. Among them are experimental studies, quasi-experiments, causal comparisons, correlations, regressions and surveys [11].

For this study, the type of research design used is regression and also quasi-experimental. This study involved a sample of secondary school students who took RBT subjects in four selected schools. The variables involved in this study are dependent variables, independent variables, and mediator variables. The level of student motivation is measured by using the IMMS questionnaire while the cognitive load test of students is measured by using the NASA Task Load Index or known as NASA TLX. Student achievement will be taken into account through a post-test to see the ability of students' cognitive load after using LiveWire Simulation in learning activities [12]. Figure 1 shown the design research flows.

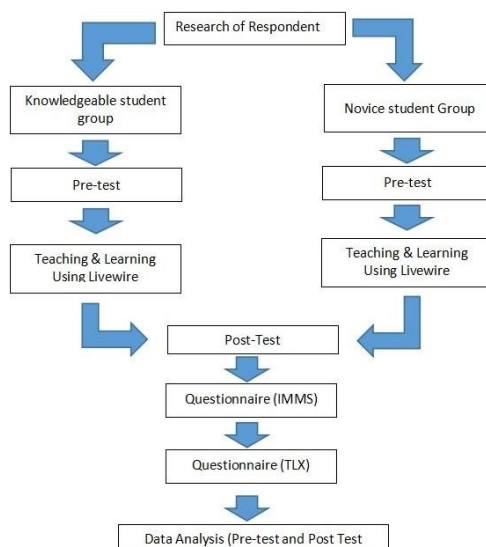


Figure 1. Research Design

Covariate analysis tests (ANCOVA) and Linear Regression were chosen as statistical analysis methods in this study. The selection of this technique is seen to be able to answer the research questions. ANCOVA is a combination of ANOVA, regression and linear correlation procedures [13]. ANCOVA was chosen because there are variables that are not involved in the study but have an effect on the sample and these variables need to be eliminated. For this study, the post-test score is the dependent variable (DV), while the pre-test score is a covariate in the analysis of variance and it is used to eliminate the comparison of achievement in the post-test) [14]. The use of covariates in ANCOVA also allows the researcher to control the error between groups and also Elimination of Confounds. Next, the Bonferonni method was chosen to identify which groups were significantly different. The use of regression analysis in this study was chosen to see the relationship between cognitive load and post-test students and whether it has a positive or negative relationship [15].

#### 4. Findings and Discussion

The results of Pre-test and Post-tests on the teaching and learning of computer-aided electronic circuits on students' motivation, achievement and cognitive load. Achievement is based on Pre-test scores and Post-tests that are conducted in writing. The Pre-test and the Post-test are the same in terms of content and number of questions. However, the preparation of the questions in the test is different. Both sets of questions contain two parts, namely part A and part B. Part A contains 10 fill-in-the- blank questions and Part B contains one essay question. Since all the basic conditions of the ANCOVA test were met, the ANCOVA analysis continued to see the differences between the groups of novice students who received various MIM strategies. Therefore, covariate effects must be statistically removed for subsequent evaluation. The effect of computerized electronic circuit simulation on students' motivation and thinking skills in design and technology subjects. The questionnaire used a Likert scale as shown in the Table 1. This questionnaire is the result of analysis through the postal test that has been done on respondents.

Table 1. Questionnaire used a Likert Scale

Scale	Description
1	Strongly Disagree
2	Disagree
3	Neutral
4	Agree
5	Strongly agree

Table 2. Respondets Feedback

No.	Item	Respondents Feedback					Mean
		Strongly Disagree	Disagree	Neutral	Agree	Strongly agree	
1	It is fun learning design and technology by using computerized circuit simulation.	0 0.0%	0 0.0%	0 0.0%	12 40%	18 60%	4.60
2	Computerized circuit simulation become a motivation to learn design and technology.	0 0.0%	0 0.0%	0 0.0%	17 56.7%	13 43.3%	4.43
3	The use of circuits can maintain interest.	0 0.0%	0 0.0%	2 6.7%	9 30.0%	19 63.3%	4.57
4	Interest in doing the exercises provided by the teacher in the worksheet.	0 0.0%	0 0.0%	0 0.0%	18 60.0%	12 40.0%	4.40
5	Learning becomes more interesting with the application of computerized circuit simulation	0 0.0%	0 0.0%	1 3.3%	5 16.7%	24 80.0%	4.77
Overall Average		0.0%	0.0%	2.0%	40.7%	57.3%	4.55

Table 2 shows positive feedback. All items are at a high level and this shows that respondents agree with the use of computerized electronic circuit simulation in design and technology subjects. Based on all the following items, the statement of learning becomes more interesting with the computerized electronic circuit simulation application having the highest mean of 4.77 followed by the statement of fun learning design and technology by using computerized circuit simulation of 4.60.

Table 3. Student's Cognitive Load Test

Source	Sum of Squares	Df	Mean of Squares	F	Sig.	Partial Eta Squared
Cognitif Load	7389.22	2	3694.61	34.22	0.00	0.19
	31313.12	290	107.97			

Table 3 shows the results of the student's cognitive load test. Students are tested using the Livewire Software method. Descriptive analysis of the mean value of cognitive load also shows that the learning strategy using LiveWire software provides better results than the learning strategy using traditional methods.

## 5. Conclusion

This LiveWire simulation is also suitable and able to improve the construction of meaningful knowledge for students. The results of this study show that electronic circuit simulation has a positive effect on students' motivation, achievement and cognitive load. There are five items used to know respondent feedback. All items are at a high level and this shows that respondents agree with the use of computerized electronic circuit simulation in design and technology subjects.

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