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# ANALYZING FACTORS OF GUI SIMULATION AS LEARNING MEDIA TOWARD STUDENTS' LEARNING OUTCOMES

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**Abstract**

The use of simulation tools has been widely used to learn something. Simulation tools have the advantage of imitating a process similar to the actual situation. But there are only a few researches that examine the students' engagement in using simulation tools in the learning process so that it affects the student learning outcomes. This research aims to analyze the factors of Graphical User Interface (GUI) simulation as learning media for learning signal coding techniques. The Partial Least Square – Structural Equation Modeling (PLS-SEM) method was used to investigate the impact and the relationship of factors of GUI simulation such as Easiness of Use (EU), Media Attractiveness (MA), and Learning Content (LC) toward Learning Outcome (LO). The results showed that the learning content factor gave a large and significant contribution toward learning outcomes, while easiness of use and media attractiveness made a small contribution to the learning outcome.

***Keywords –*** Simulation, Learning media, PLS-SEM, Learning outcome.

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## 1. Introduction

Utilizing simulation has been used in the fields of engineering. Simulation has a role to be able to illustrate the work process of a system. The simulation procedure is to provide input to a simulated system then observe the simulation process and measure the simulation output as a response to the input that has been given. Simulation has the capability of imitating situations and conditions according to real circumstances. The advantage of imitating conditions in real circumstances, the user of the simulation can be engaged in problems that are similar to the actual situation.

Comparing with real situations, simulation has fewer risks than implementing the problem directly in the real condition. To solve the problem in real conditions, it needs a high-cost condition, extensive effort, and long-time implementation. Therefore, simulation is needed as a performance evaluation technique. Simulation has the capability of its speed, cost-effectiveness, ease of implementation or use, flexibility, repeatability, and scalability (Sharif & Sadeghi-Niaraki, 2017). The easiness of use, simplicity, and excellence of simulation is also revealed by (Jakkhupan, Arch-int & Li, 2011) which stated that companies can use simulation with its easiness of use to understand the practical implications of the technology, meanwhile, research academics use a simulation to learn and explain the new transfigure process without taking a long-time consumption and a high-cost consumption. Through the learning content of simulation, the simulation users can practice making the right decision from several alternative solutions available from the simulation scenario. Every decision taken will have a certain impact on the system that has been simulated (Buditjahjanto & Miyauchi, 2011). In line with that Adams and Singh (2018) indicated that some simulation tools with their learning content could be applied to evaluate decisions or behaviors to better supply information to decision-makers toward the potential impacts of their decisions.

Simulations have been used in studying and solving problems virtually before facing the problem in real situations. Wolkerstorfer, Schweighofer, Wegleiter, Statovci, Schwaiger and Lackner (2016) used simulation with its learning content to estimate the low operational costs of smart grid communications in the low-voltage grid. In this grid system, there are some unpredictable phenomena of power-line channels such as frequency selectivity, narrowband noise sources, observable impulsive, and time-variance. Therefore, simulation utilization can help these problems. Hereafter, to learn supply chain firms, Jakkhupan et al. (2011) used simulations with its learning content to study and illustrate the latest remodeled process and to evaluate the impact of technology in practical implications.

Simulation as one type of learning media has an important role in the teaching and learning process in a class with its attractiveness. This is because simulation can help students to better understand the material provided. Bravo, Redondo, Ortega and Verdejo (2006) stated that the use of simulation with its attractiveness can be used in class for teaching purposes because simulation has the advantage of being able to support collaborative learning processes. Simulation can be used for the teaching and learning process by adapting simulation into an educational simulation tool by infusing learning materials and problems into the simulation. As research conducted by García-Díaz, Salcedo-Sanz, Portilla-Figueras and Núñez-Clemente (2009) stated that a simulation tool for education can be embedded learning content on how to learn characteristics of GSM technology, such as the simulation of calls, handoffs, and traffic. So the students can simulate the characteristics of network coverage for different scenarios simulating a small, medium, and large city. Zamora-Cárdenas, Pizano-Martínez, Lozano-García, Gutiérrez-Martínez and Cisneros-Magaña (2018), Žarković and Stojković (2015), and Altintas (2011) used a practical educational tool to learn state estimation of electric power systems. Shankar (2016) stated the media attractiveness of simulations in the learning process of wireless fading channels can enable student participation in class. Meanwhile, to study Techniques of Chaos-Based Digital Modulation, Oğraş and Türk (2013) used software simulation in Modelling and Simulation.

Based on that description above, so the obtained research gap is as follows: only a few types of research investigate the students' engagement in using computer simulation in the learning process so that it affects the student learning outcomes. Most of the researches related to computer simulation still discuss the usefulness of the computer simulation to solve the problem at hand and still has not discussed the supporting factors that exist in the usage of computer simulation that is perceived by the students in the learning process. This research gap becomes the basis to conduct this research.

The objective of the research is to analyze the factors of Graphical User Interface (GUI) simulation that applied as learning media in learning material of signal coding techniques. The factors of GUI simulation such as Easiness of Use (EU), Media Attractiveness (MA), and Learning Content (LC) and, Learning Outcome (LO). The definition of each factor of the GUI simulation is as follows: Easiness of Use (EU) is the easiness to operate GUI simulation, Media Attractiveness (MA) is the display attractiveness of GUI simulation which includes the availability of information, the presentation of images and tables, Learning Content (LC) is the availability and the completeness of the learning materials studied and the interactiveness of the GUI simulation and, Learning Outcome (LO) is the result of student learning after using GUI simulation. GUI acts as an interface between the user and the computer to ease the user in operating a computer application. The GUI simulation can visualize the process of signal coding techniques. By using GUI simulation, the students can observe and understand the process of signal coding techniques in the learning process. Students can interact with the GUI simulation by providing input in the form of analog or digital signals and then observe the response in the form of output signals coming out of the results of the simulation process.

Furthermore, to analyze the model, this research used The Partial Least Square – Structural Equation Modeling (PLS-SEM) to test the validation and reliability of the outer model and to measure and evaluate the impact of each latent variable of the inner model. The Partial Least Square – Structural Equation Modeling (PLS-SEM) is a method of structural equation modeling that presents estimating complex cause-effect relationship models for latent variables. The research hypotheses include: The factor of easiness of use has a positive effect on learning outcome; The factor of media attractiveness has a positive effect on learning outcome; The factor of learning content has a positive effect on learning outcome.

## 2. Literature Review

### 2.1. Modeling

Modeling a system is needed to describe the condition or state of the problem observed by the user. The use of the model can provide many benefits for users before implementing the system in the real state. Modeling makes it easy for researchers to make models affordable because they provide constraints and assumptions made (Kong, Shi, Yu, Liu & Xia, 2019). By using modeling, the reliability of a communication network can be known and measured. Because modeling provides convenience in determining what parameters can be used in the calculation of reliability that affects the communication network (Ahmad, Hasan, Pervez & Qadir, 2017; Cogoni, Busonera, Anedda & Zanetti, 2017). In line with that modeling can help to improve the reliability of a computer communication network in order more reliable. The model in the manifestation of a simulated mobile agent network can make it easier to help in detecting network problems and fix them so that network reliability is increased (Daoud & Mahmoud, 2008).

Villalba and Zambonelli (2011) stated that modeling the computational elements of agents in the pervasive service framework and their interactions with ecosystems is to provide parameters for their character by getting inspiration from ecological systems. Meanwhile, according to Dezfouli, Radi, Razak, Hwee-Pink and Bakar (2015) that modeling to design and implement low-power wireless communication is needed. Because through modeling with the use of parameters in building a low-power wireless communication, the essentials of accurate modeling and evaluation of low-power wireless communications can be established. According to Ibáñez, García-Rueda, Maroto and Delgado-Kloos (2013), a model can use in the learning process. By regulating interactions, the model is used to arrange collaborative learning activities and also used in the scaffolding of learning workflows. A simulation tool was developed for the model to support and establish collaborative learning modules.

### 2.2. Graphical User Interface (GUI) Simulation

Simulation can be manifested in computer applications known as a computer simulations. The development of computer simulations has been growing rapidly following the needs of its users. Therefore, the types of computer simulations or simulators being developed are also increasing. Each simulation is developed according to the problems faced by its users. Bhor, Angappan and Sivalingam (2016) used OpenDSS for power systems and OMNET for ++ communication networks simulation. Nagarjuna, Lakshmi and Nehru (2019) used LabVIEW software to build a system model to study frequency division multiplexing. Abuelmaatti, Abuelma'atti, Thayne and Beaumont, (2010) used Simulink to study complex modulation schemes such as QPSK. Meanwhile, Avallone & Di Stasi (2016) used WiMesh, a software tool that is used to learn multi-radio wireless mesh networks. MATLAB is another computer programming that is often used for simulation. Álvarez-Gálvez (2017) applied it to study high-speed backscatter based on an HS-Miller modulated subcarrier and Zungeru, Ang and Seng (2012) employed it to learn routing modeling application simulation environment.

Simulation in the field of engineering has been applied to solving a problem that arises in the learning process. The learning process by utilizing Graphical User Interface (GUI) simulations can enhance student learning for educational purposes. Simulation can contribute to improving students' understanding of the phenomena that occur in a system (Oğraş & Türk, 2013; Buditjahjanto, Nurlaela, Ekohariadi & Riduwan, 2017). For educational purposes, simulation has the capability of an easy-to-use and user-friendly visual instruction tool. Zamora-Cárdenas et al. (2018) used a practical educational tool for state estimation of electric power systems. This simulation tool helps students to enhance learning, understanding and saving the time of implementation and development of laboratory experiments. According to Del Barrio, Manzano, Maroto, Villarín, Pagán, Zapater et al. (2019) that the use of simulations to study communication theory can help improve student understanding compared to using a traditional equation-based environment. This is also supported by Altintas (2011) related to the use of GUI MATLAB, which is used for teaching and learning power electronics courses, can behave as a front-end interface. This GUI simulation can be used as useful learning media or as a virtual laboratory. After the learning that uses GUI simulation is done, the students give a positive response to power electronics courses. This designates that the utilization of GUI simulation is very helpful for learning the subject of power electronics.

## 3. Method

This research used MATLAB programming for establishing Graphical User Interface (GUI) simulation to learn the signal coding technique. MATLAB was chosen because it has a development facility in the form of a GUI so that it can facilitate the planning and making of the simulation tool as learning media, especially in the form of simulation interactions. MATLAB also has advantages in terms of mathematics. It is very suitable for use in the development of learning media in the form of simulation for signal coding technique material in the data communication course in the department of electrical engineering, The State University of Surabaya-Indonesia. Figure 1 shows the display results of using the MATLAB GUI to simulate the PCM signal.

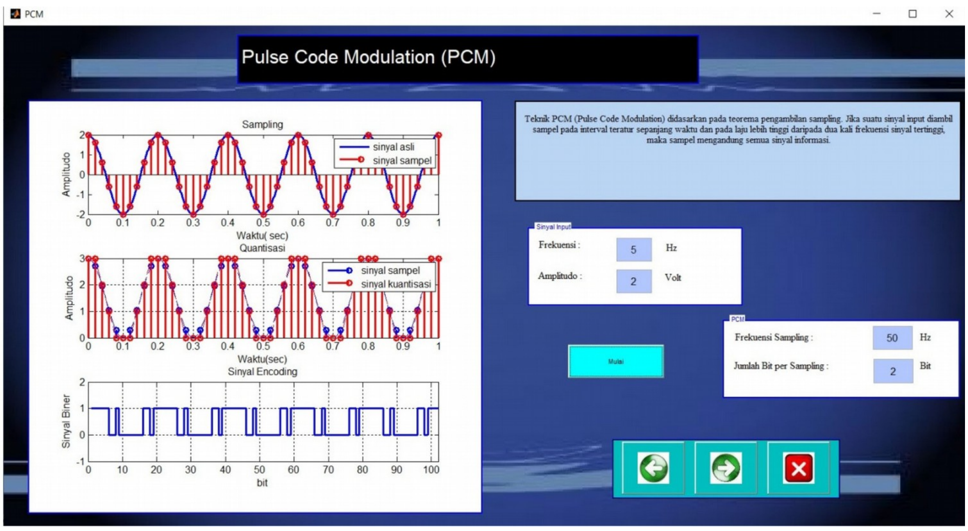


Figure 1. PCM signal simulation

### 3.1. Procedure

The procedure of this research consisted of two stages: the modeling stage and the analysis stage. At the modeling stage, constructs or latent variables are determined to evaluate the model of utilizing signal coding technique simulation. The construct consists of 4 constructs, namely: Easiness of Use (EU), Media Attractiveness (MA), Learning Content (LC), and Learning Outcome (LO). The modeling stage models the relationship between the constructs of the EU, the MA, and the LC to the LO in the use of signal coding technique simulations. The model prediction for the signal coding technique simulation is shown in Figure 2.

The EU, MA, LC, and LO are constructs that cannot yet be measured because they are latent. Therefore, they need several indicators to describe these latent variables. Furthermore, for the indicators that have been made can be measured, it needs an instrument in the form of a questioner that uses a Likert scale in its measurement. Table 1 shows the latent variables with their constituent indicators.

The analyzing stage consists of two sub-steps, which are the measurement model and the evaluation of structural models. The measurement model evaluates indicators, latent variables, and relationships between indicators and latent variables.

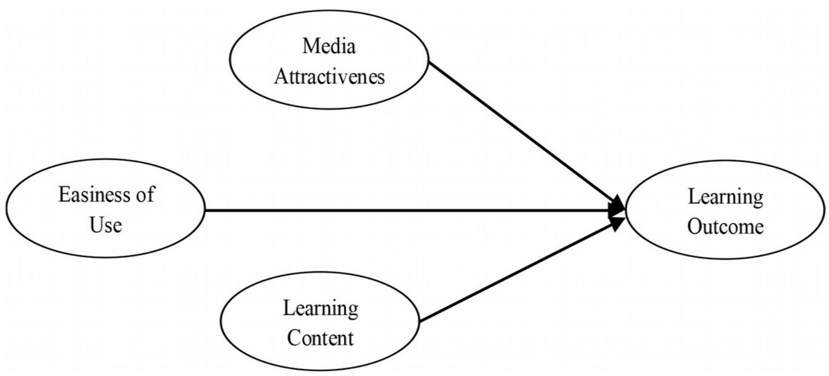


Figure 2. Modeling of utilizing signal coding technique based on GUI Simulation

| **Construct/Latent Variable** | **Indicator** |
|---|---|
| Easiness of Use (EU) | The instructions are clear (EU1) |
| | Language is easy to understand (EU2) |
| | Ease of operation (EU3) |
| | Ease of entering data inputs and displaying results (EU4) |
| Media Attractiveness (MA) | The information presented is readable (MA1) |
| | The order of images and text are interrelated (MA2) |
| | The images are clear (MA3) |
| | The descriptions of pictures and tables are clear (MA4) |
| | The script is easy to understand (MA5) |
| | Font size is proportional and legible (MA6) |
| | The teaching material have considered economic aspects (MA7) |
| Learning Content (LC) | The entered data matches with the coding results (LC1) |
| | The results of the encoding signal are a match and clear (LC2) |
| | Support the implementation of teaching and learning activities (LC3) |
| | Facilitate students in learning signal coding techniques (LC4) |
| | Suitability of the media with learning material (LC5) |
| | The truthness level of the material concept in teaching material (LC6) |
| | The learning material contents match the curriculum (LC7) |
| | Information in teaching materials is sufficed (LC8) |
| | The assignments from material learning encourage student activity (LC9) |
| | Worksheets on learning materials match learning media (LC 10) |
| Learning Outcome (LO) | Learning Outcome Result |

Table 1. Latent variable and its indicator

The evaluation of the measurement model consists of convergent validity measurement and indicator reliability measurement. The convergent validity parameter is a loading factor with a valid condition if it is greater than 0.7 and the Average Variance Extracted (AVE) parameter with a valid condition if it is greater than 0.5. Next, the indicator reliability parameter is Cronbach's Alpha with a reliable condition if it is greater than 0.7. In the evaluation step of the structural model evaluate latent variables and relationships between latent variables. The evaluation measurement calculates the coefficient of determination ($R^2$), path coefficient (β), and hypothesis analysis (t-test).

### 3.2. Participants

The research participants are 30 undergraduate students of electrical engineering at The State University of Surabaya-Indonesia. All research participants followed the course of data communication.

### 3.3. Instruments

The research data were collected through questionnaires to get student responses. Questionnaires were created according to the indicators of each GUI simulation latent variable. The questionnaires were given to students after they have finished learning all the material on the signal coding technique using a GUI simulation. Meanwhile, the students' learning outcomes were obtained from the students' exam results related to the signal coding technique material that students have learned using GUI simulation. Some instruments are developed to measure the latent variables. The developed instruments are based on indicators that describe each of the latent variables. In the model, all latent variable indicators are measured using a 5-point Likert scale. Because this research develops a predictive model, thus this research used the Partial Least Square – Structural Equation Modeling (PLS-SEM) method to analyze the models. According to Komiak and Benbasat (2006), one of the advantages of the PLS-SEM method is capable of analyzing predictive models even with small data. The other advantage of the PLS-SEM is capable of analyzing all of the paths in one analysis (Hair, Hult, Ringle & Sarstedt, 2014).

Therefore, the path analysis of PLS-SEM was used to analyze the relationship between independent variables (EU, MA, and LC) toward dependent variables (LO). Moreover, PLS-SEM can work efficiently with complex models and small sample sizes (Rezaei & Ghodsi, 2014). As mentioned before that our research only used 30 participants (small sample sizes).

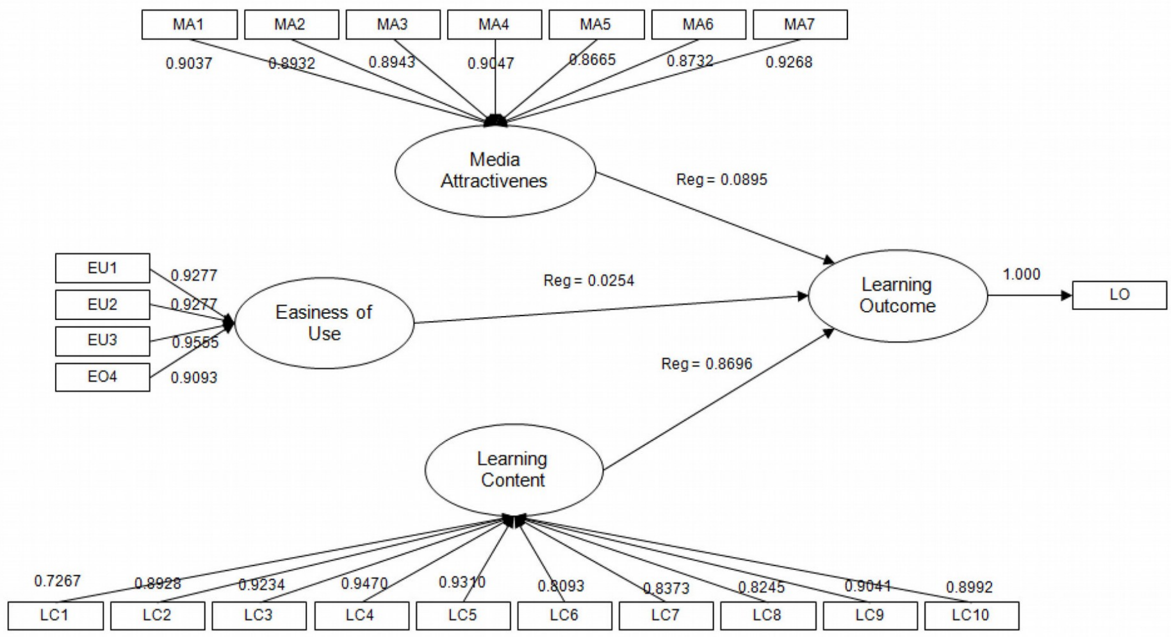


Figure 3. Result of modeling of utilizing signal coding technique based on GUI simulation

# 4. Result

## 4.1. Simulation Results

To analyze research data, statistical software XLSTAT was used. XLSTAT was used to determine the relationship between inter latent variables and the relationship between latent variables and their indicators. Figure 3 indicates the running results of XLSTAT from the modeling of the signal coding technique with their latent variables. In the measurement model which was the validity and reliability test of the model. The results of XLSTAT showed that the loading factor values for all indicators in the Easiness of Use (EU), Media Attractiveness (MA), and Learning Content (LC) construct were greater than 0.70. This showed that all of the loading factors have fulfilled the condition of validity. Table 2 shows the loading factor value for the indicator in each construct. Meanwhile, the AVE values of all constructs were greater than 0.50 as seen in Table 3. It shows that all of the AVE values have fulfilled the condition of validity.

The simulation results show as seen in Table 3 that the values of Cronbach's Alpha are greater than 0.7. So, the values of Cronbach's Alpha have fulfilled the reliability condition. As all conditions for validity and reliability have been fulfilled, so in this stage, the model of utilizing signal coding technique based on GUI simulation is valid and reliable.

| Factors | Easiness of Use | Media Attractiveness | Learning Content | Learning Outcome |
|---|---|---|---|---|
| EU1 | **0.9277** | 0.9268 | 0.8860 | 0.8693 |
| EU2 | **0.9277** | 0.9268 | 0.8860 | 0.8693 |
| EU3 | **0.9555** | 0.8950 | 0.9082 | 0.8953 |
| EO4 | **0.9093** | 0.8547 | 0.8537 | 0.8521 |
| MA1 | 0.8410 | **0.9037** | 0.8636 | 0.8476 |
| MA2 | 0.9153 | **0.8932** | 0.8551 | 0.8378 |
| MA3 | 0.8960 | **0.8943** | 0.8452 | 0.8387 |
| MA4 | 0.9212 | **0.9047** | 0.8592 | 0.8485 |
| MA5 | 0.7772 | **0.8665** | 0.8314 | 0.8127 |
| MA6 | 0.8600 | **0.8732** | 0.8430 | 0.8189 |
| MA7 | 0.9277 | **0.9268** | 0.8860 | 0.8693 |
| LC1 | 0.7979 | 0.7909 | **0.7267** | 0.7111 |
| LC2 | 0.9392 | 0.8819 | **0.8928** | 0.8736 |
| LC3 | 0.9502 | 0.8995 | **0.9234** | 0.9035 |
| LC4 | 0.9494 | 0.9267 | **0.9470** | 0.9267 |
| LC5 | 0.9534 | 0.9042 | **0.9310** | 0.9110 |
| LC6 | 0.8482 | 0.8444 | **0.8093** | 0.7919 |
| LC7 | 0.8841 | 0.8736 | **0.8373** | 0.8193 |
| LC8 | 0.8771 | 0.8890 | **0.8245** | 0.8068 |
| LC9 | 0.8255 | 0.8920 | **0.9041** | 0.8847 |
| LC10 | 0.9395 | 0.8840 | **0.8992** | 0.8799 |
| LO | 0.9370 | 0.9379 | 0.9785 | **1.0000** |

Table 2. Loading Factor of Signal Coding Technique simulation model

| Construct | AVE | Cronbach’s Alpha |
|---|---|---|
| Easiness of Use | 0.8653 | 0.9502 |
| Media Attractiveness | 0.8007 | 0.9697 |
| Learning Content | 0.7603 | 0.9812 |

Table 3. The AVE & Cronbach’s Alpha of Signal Coding Technique simulation model

The step of the evaluation of structural models was to evaluate the path coefficient, the coefficient of determination, and hypothesis analysis. Table 4 shows the simulation results of the developed model which consists of the path coefficient, standard error, t-value of each latent variable. From simulation result of path coefficient can be formulated the equation model as follows:

$$LO = 0.02544 * EU + 0.08948 * MA + 0.86956 * LC$$

The equation model shows that all the path coefficients value are positive, but only the path coefficient value of LC is close to 1 so that it can be said to make a significant contribution to LO compared to EU and MA where the values of path coefficient are too small.

Table 5 indicates the coefficient of determination ($R^2$) of the Model. It is known that Learning Outcome is significantly determined by the three exogenous variables (EU, MA & LC) with the value of $R^2$ are 0.9586. This means that the three exogenous variables capable to explain 95% of the variance in learning outcomes.

Furthermore, the results of this simulation were used to answer the research hypotheses. From Table 6, it can be shown that H1 was not supported. Because the simulation results showed the path coefficient value of the EU only 0.0254 that indicated it has a low contribution to the LO and also the t-value was 0.1580 lower than the critical t-value at 1.65 for a significance level of 10%. So it is with H2 was not supported. Since the simulation results showed the path coefficient value of the MA only 0.0895 that indicated it has a low contribution toward the LO and also the t-value was 0.5654 lower than the critical t-value at 1.65 for a significance level of 10%. From the simulation, only H3 was supported. Because the simulation results showed the path coefficient value of the LC at 0.8696 that indicated it has a high contribution against the LO and the t-value was 6.2654 higher than the critical t-value at 2.58 for a significance level of 1%. From the three hypotheses, only H3 is supported.

| Latent variable | Value | Standard error | t | Pr > \|t\| | $f^2$ |
|---|---|---|---|---|---|
| Easiness of Use | 0.0254 | 0.1610 | 0.1580 | 0.8757 | 0.0010 |
| Media Attractiveness | 0.0895 | 0.1583 | 0.5654 | 0.5767 | 0.0123 |
| Learning Content | 0.8696 | 0.1388 | 6.2654 | 0.0000 | 1.5098 |

Table 4. Path coefficients of latent variables

| $R^2$ | F | Pr > F | $R^2$ | Standard error | Critical ratio (CR) |
|---|---|---|---|---|---|
| 0.9586 | 200.8561 | 0.0000 | 0.9618 | 0.0179 | 53.4395 |

Table 5. Coefficient Determination ($R^2$) of Model

| Hypothesis | Hypothesized Path | β values | t -value | Result |
|---|---|---|---|---|
| H1 | Easiness of Use → Learning Outcome | 0.0254 | 0.1580 | Not Supported |
| H2 | Media Attractiveness → Learning Outcome | 0.0895 | 0.5654 | Not Supported |
| H3 | Learning Content → Learning Outcome | 0.8696 | 6.2654* | Supported |

Table 6. Hypothesized Path

### 4.2. Discussion

This research used data with 30 students as participants. However, according to Rezaei and Ghodsi (2014) and Hair et al. (2014) that the Partial Least Square – Structural Equation Modeling (PLS-SEM) method proceeds efficiently with complicated models and small sample sizes. Therefore, this research data still can be analyzed and also contribute to its research results following the principles of the PLS-SEM method.

The modeling of utilizing signal coding techniques based on Graphical User Interface (GUI) simulation has fulfilled the requirement of validity and reliability. As mention before that, all loading factor values for all latent variables have achieved the validity requirements. This is following the research result of Hair et al. (2014) stated that the loading factor is declared valid if it has a value > 0.7. In Table 2 it can be seen that the lowest value of the loading factor is LC1 (The entered data matches with the coding results) of 0.7267 and the highest loading factor of EU3 (Ease of operation) which is 0.9555. So, it is with the values of AVE for the Easiness of Use (EU), Media Attractiveness (MA), and Learning Content (LC) have fulfilled the validity requirement. As stated by Fornell and Larcker (1981) the model is valid if the AVE value is greater than 0.50. Therefore, it shows that all indicators can work on the measurement model, so the validity of the outer model can be said to be valid. Cronbach's Alpha is one of the parameters to measure the reliability of a model. According to Hair et al. (2014) stated that the model is considered reliable if the value of Cronbach's Alpha is > 0.70. Meanwhile, the reliability test results in this study indicate that the Cronbach's Alpha value on all latent variables is greater than 0.70 as shown in Table 3. Therefore, the reliability of this model is reliable.

The variables that are used to analyze the structural model are path coefficient (β values) and coefficient of determination ($R^2$). The path coefficient of the LC shows a positive value with the highest β values of 0.8696 as shown in Figure 3. This value approaches the value of 1 which means that the relationship between the LC to the LO plays a major role. While the β values of the EU and the MA variables are 0.0254 and 0.08950 respectively. These values are too small to give a relationship toward the LO.

According to Weinfurt (1995) stated that the bigger of value $R^2$, the more the predictive power of the model can be developed. From Table 7 can be known that the biggest value of $R^2$ is the LC at 88.7587, then the $R^2$ value for the MA at 8.7546 and the EU at 2.4866. Based on the value of $R^2$, it indicates that the variance amount of LC contributes toward LO at 88.7587 % in this model. The MA variable contributes at 8.7546 % and the EU variable contributes at 2.4866 toward the LO variable. Figure 4 shows the impact and contribution of the variables to the Learning Outcome. Hair et al. (2014) stated if the $R^2$ value of endogenous latent variables is > 0.75, so it is categorized as substantial. Therefore, only the LC in this study provides the predictive power of the model that is developed in the substantial category meanwhile the MA and the EU only provide the weak category.

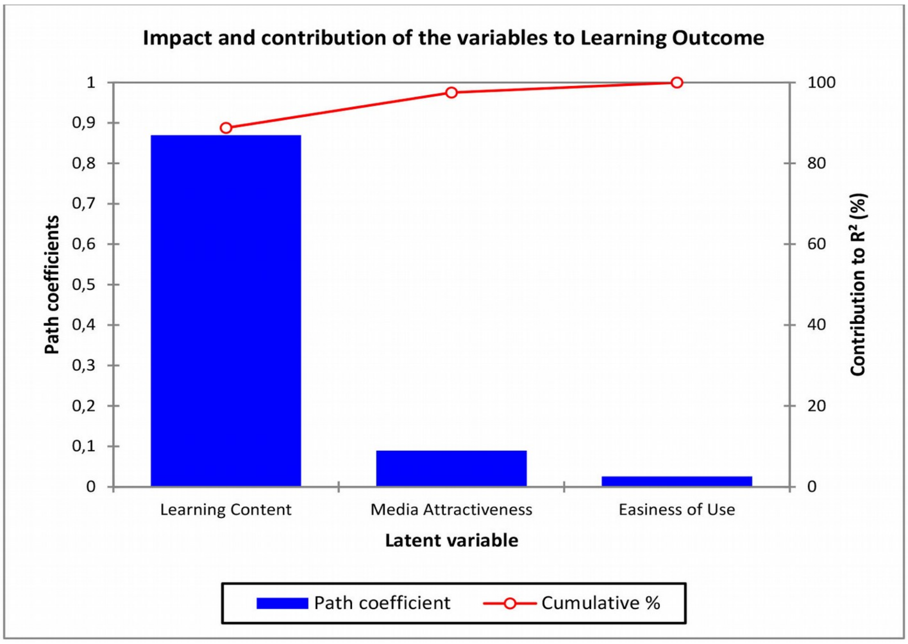


Figure 4. Impact and contribution of the variables to Learning Outcome

| | Learning Content | Media Attractiveness | Easiness of Use |
|---|---|---|---|
| Correlation | 0.9785 | 0.9379 | 0.9370 |
| Path coefficient | 0.8696 | 0.0895 | 0.0254 |
| Correlation * path coefficient | 0.8509 | 0.0839 | 0.0238 |
| Contribution to $R^2$ (%) | 88.7587 | 8.7546 | 2.4866 |
| Cumulative % | 88.7587 | 97.5134 | 100.0000 |

Table 7. Impact and contribution of the variables to Learning Outcome

Thus, the latent variable of the LC provides higher impact levels of the predictive model than other latent variables. It is following the utilizing of simulation based on GUI that embedded the signal coding technique material so that it can contribute considerably toward the students' understanding. Meanwhile, the EU and the MA only give low contributions in this utilizing of simulation based on GUI. Therefore, it needs more improvement for the EU and the MA in GUI simulation for future research.

The simulation result indicates that only H3 is supported when analyzed with the t-test. The t-test result showed at 6.2654 and with a significant value of 1%. This means that the LC has a high level of significance and has a large role in the LO. While the EU and the MA variables have a less significant effect because the value of the t-test is very small although positive. However, if the model is analyzed using the Goodness of Fit (GoF) index, as shown in Table 8. It indicates that the value of the outer model Goodness of Fit (GoF) is 0.9543 and the GoF inner model is 0.9973 where both GoFs show values that are close to 1, which means that the model is a good model that is close to the real system.

| | GoF | GoF (Bootstrap) | Standard error | Critical ratio (CR) |
|---|---|---|---|---|
| Absolute | 0.8723 | 0.8420 | 0.1009 | 8.6412 |
| Relative | 0.9518 | 0.9205 | 0.0923 | 10.3063 |
| Outer model | 0.9543 | 0.9193 | 0.0915 | 10.4254 |
| Inner model | 0.9973 | 1.0013 | 0.0124 | 80.5499 |

Table 8. The Goodness of fit index of model

## 5. Conclusion

The factors of GUI simulation such as Learning Content, Easiness of Use, and Media Attractiveness make a positive contribution to the learning outcome of students in learning signal coding techniques. However, only learning content provides the best and the most significant contribution compared to the easiness of use and media attractiveness. The results of running PLS-SEM show that learning content has the highest value of the path coefficient of the relationship toward the learning outcomes of students and then followed by the value of the path coefficient of the relationship from the Ease of Use and Media Attractiveness. Thus, Learning Content has the greatest influence on the learning outcomes of students compared to ease of use and media attractiveness. Likewise for the value of the coefficient of determination, learning content has the highest value when compared to the ease of use and media attractiveness. This shows that the learning content variability that can be explained by the learning outcome of student variability is very significant, while for Easiness of Use and Media Attractiveness, each of their contribution of variability is less significant. Furthermore, with a significance level of 10%, the results of the t-value calculation also show that learning content has a significant value. Meanwhile, Ease of Use and Media Attractiveness has a less significant t-value. This shows that Learning Content has a big effect on the learning outcome. Meanwhile, Ease of Use and Media Attractiveness shows the results of a small effect on the learning outcome.

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