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Three-Dımensıonal Anımatıon-Based Rubık's Cube Algorıthm Tutorıal Vıdeo Wıth Mdlc Method

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Abstract
Society often identify rubik's cube as a "game for smart people" because it seems too complex and the needing to remember the algorithm just like remembering math equations so people don't want to try playing rubik's cube. To attract someone's interest in learning rubik's algorithm, we need a media that is easy to understand and easy steps to follow by showing both visual and audio. Tutorial video of rubik's algorithm based in three dimentional character can portrait the real scrambled cube and every algorithm is shown so everyone that watch the video can follow it easily and also sharpen thinking skill. Tutorial video of rubik's algorithm based in three dimentional character is made by using MDLC method that stands for Multimedia Development Cycle that consist of 6 elemens which is concept, design, material collecting, assembly, testing, and distribution. There are several independent variables that can affect students in showing interest in studying which is : Performance Expectancy, Effort Expectancy, Social Influence, Facilitating Conditions, Learning Value, and Hedonic Motivation also students interest that will be marked as dependent variable that will be refered as Behavior Intention. Based on the analitic result, independent variables that affects positively to dependent variable are Performance Expectancy, Effort Expectancy, Social Influence, meanwhile Facilitating Conditions, Learning Value, and Hedonic Motivation affects negatively to Behavior Intention.

Keywords:
Rubik's cube, Three dimentional animation, MDLC, Study, Rubik's cube interest

Introduction
Rubik's Cube is a puzzle game created in 1974 that can sharpen brain logic (Gunawan et al., 2018). A Rubik's Cube has six sides, each with a different color, and each side has 9 squares. This game is very popular and even has a world championship organized by the World Cube Association with the fastest record being 3.47 seconds in 2022. The challenge with Rubik's

Cube is finding a solution to complete all 6 colored sides with the minimal number of steps. In doing so, Rubik's Cube can enhance one's logical thinking and creativity in finding the most minimal steps to solve it (Hidayah et al., 2020) . People often identify Rubik's Cube as a "smart person's game" because it appears difficult and requires memorizing formulas similar to mathematical equations, causing many to hesitate trying to play Rubik's Cube. In reality, the key to playing the Rubik's Cube lies in the intention to learn, reflexes, and muscle memory in our fingers (Agung et al., 2019).

To capture someone's interest in learning the Rubik's Cube algorithm, it requires a medium that is easy to understand and easy to follow with visual and audio elements (Caesaria et al., 2020). One of the learning mediums believed to be easily understood, easy to follow, and present visual and audio components is a three-dimensional-based video tutorial (Anggelina & Trisnadoli, 2020). Three-dimensional-based Rubik's Cube algorithm video tutorials can project a scrambled Rubik's Cube just like the one owned by the viewer, and each algorithm can be displayed so that the viewer can easily follow the algorithm, simultaneously sharpening the viewer's logic (Syahputra, 2022).

The three-dimensional-based Rubik's Cube algorithm video tutorial is created using the MDLC method, or Multimedia Development Cycle. This method consists of 6 sequential stages: concept, design, material collecting, assembly, testing, and distribution. The MDLC method is typically used for creating games, mobile applications, learning apps, 2D animations, and 3D animated films (Novayani & Eka Budiansyah, 2022). The researchers designed this study titled 'Three-Dimensional Animation-Based Rubik's Cube Algorithm Tutorial with MDLC Method' with the hope that the video can be beneficial on online media platforms as a source of information and attract the public's interest in quickly learning how to play Rubik's Cube, especially for beginners.

Literature Review

This research is conducted with reference to a previous study on the topic of three-dimensional animation by Caesaria et al. (2020). The goal of that research was to produce a 3D-based magnetic field learning media that is easy to understand. The method used in designing the animation video is Design and Development Research (DDR). The analysis method employed in this research utilizes a quantitative approach. The results of this study include a 3D animation learning video based on Blender software on the topic of magnetic fields, which received a very feasible assessment from subject matter experts and media experts.

The research by Novayani et al. (2022) focused on creating three-dimensional animation using the Multimedia Development Life Cycle (MDLC) method. This research aimed to produce a 3D animated film depicting the historical story of the Siak Malay Kingdom using the MDLC method and pose-to-pose techniques and to assess its effectiveness in providing information. The researchers conducted pre-tests and post-tests before and after students watched the animated film. The results showed that students who watched the animation performed better in the post-test than those who read literature about the history of the Siak Malay Kingdom.

Riyanto et al.'s (2019) research focused on teaching genetics, specifically protein synthesis. The objective was to determine the improvement in cognitive learning outcomes by using Aurora 3D Animation Maker as a media tool in the Genetics course for Biology Education students at IKIP Budi Utomo Malang. The research employed a qualitative approach, and the

type of study was Classroom Action Research (CAR). The findings indicated that the application of Aurora 3D Animation Maker as a media tool could enhance the cognitive learning outcomes of Biology Education students, with cognitive learning results achieving classical completeness from 71% to 88%.

Anggelina et al. (2020) conducted research analyzing the effectiveness of a three-dimensional animated film's message about the dangers of smoking for active teenage and adult smokers. The aim was to convey the message about the dangers of smoking through an audio-visual medium, namely a 3D animated film titled "Danger of Smoking." The research method used was descriptive quantitative. The results indicated that the three-dimensional animated film was successfully created as an alternative health socialization medium regarding the dangers of smoking for active teenage and adult smokers. It effectively conveyed the message about the dangers of smoking to the majority of respondents and had a more significant impact on active teenage smokers.

Table 1. Main Jurnals

No	Author(s)	Publish Year	Summary
1	Caesaria et al.	2020	The results of this research include a 3D animation learning video based on Blender software on the topic of magnetic fields, with an assessment of suitability deemed highly appropriate by subject matter experts and media experts.
2	Novayani et al.	2022	The researcher employed the MDLC method to create a 3D animated video about the history of the Siak Malay Kingdom.
3	Riyanto et al.	2019	This study utilized a qualitative approach in the form of a survey to assess the effectiveness of a three-dimensional animated video in delivering genetic material.
4	Anggelina et al.	2020	From this research, it was found that a three-dimensional animated film was successfully created as an alternative health socialization medium about the dangers of smoking for active teenage and adult smokers.

The author conducted this research by developing a three-dimensional-based Rubik's Cube algorithm video tutorial, which was then evaluated by its audience using a quantitative approach. The development of the three-dimensional animated Rubik's Cube algorithm video tutorial followed the approach taken by Caesaria et al. (2020). The algorithmic content was based on the research by Hidayah et al. (2020). This Rubik's Cube algorithm video tutorial was developed using the MDLC method, similar to the study by Novayani et al. (2022). Data collection in this research was done through a questionnaire, similar to the study by Riyanto et al. (2019), and it was measured by the audience using a quantitative approach. The analysis was conducted using multiple regression analysis methods, as in the study by Caesaria et al. (2020). The respondents for the questionnaire were students from Universitas Internasional Batam, selected using stratified proportional random sampling, with a total of 342 respondents.

Research Methods

1. Research Flow

Here is a flowchart illustrating the steps in the research titled "Three-Dimensional Animation-Based Rubik's Cube Algorithm Tutorial with MDLC Method" to ensure a systematic progression toward the intended goals.

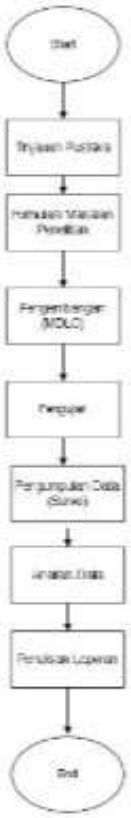

Figure 1. Research Flow.

Figure 1 illustrates the flow of this research from beginning to end, starting with a literature review. In the literature review section, the researcher summarizes all relevant collections of previous research used as references in this study. The researcher evaluates and clarifies previous studies related to this research. The second stage involves formulating the research problem, encompassing all the issues this study addresses (Riyanto & Susilawati, 2019).

2. Problem Description

People often identify Rubik's Cube as a 'game for smart people' because it appears complex and requires memorization of formulas, similar to mathematical equations, leading many individuals to hesitate to try playing Rubik's Cube. In reality, the key to playing the Rubik's Cube lies in the intention to learn, reflexes, and muscle memory in our fingers (Gunawan et al., 2018).

Due to this issue, the researcher aims to create a three-dimensional animation-based Rubik's Cube algorithm tutorial video. The developmental phase in this research involves using the Multimedia Development Cycle (MDLC) method, consisting of 6 sequential stages: concept,

design, material collecting, assembly, testing, and distribution. The researcher hopes that the existence of this tutorial video will increase the community's interest in learning to play Rubik's Cube. The research will be measured through a survey conducted among individuals who have watched the three-dimensional-based Rubik's Cube algorithm tutorial video.

3. Development

In this research, the researcher employs the MDLC method, or Multimedia Development Life Cycle, to create a three-dimensional-based Rubik's Cube algorithm tutorial video. The MDLC method consists of six sequential stages: concept, design, material collecting, assembly, testing, and distribution (Amalia Yunia Rahmawati, 2020). The MDLC method is typically used for creating games, mobile applications, learning apps, 2D animations, and 3D animation (Novayani & Eka Budiansyah, 2022). The sequence of MDLC stages is illustrated in Figure 2.

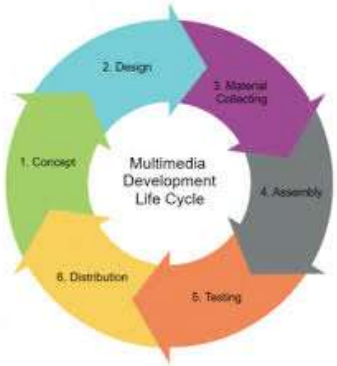

Figure 2. MDLC Steps.

1. Concept

Designing a three-dimensional-based Rubik's Cube algorithm tutorial video to generate interest among the community in learning Rubik's Cube.

2. Design

Planning the concept and form to be created in the form of a storyboard to ensure an organized process for animation and video creation.

3. Material Collecting

Collecting materials such as textures, background music, sound effects, visual effects, and others that can enhance the atmosphere of the tutorial video to prevent it from feeling monotonous and boring.

4. Assembly

In this stage, the researcher creates three-dimensional animation using Autodesk Maya 2020 and edits the video using Adobe Premiere Pro 2020. The researcher also composes the narration, background music, sound effects, visual effects, and other elements into the tutorial video.

5. Testing

Testing is conducted using the alpha testing method. With alpha testing, the researcher assesses whether there are any errors in the creation process. This stage compares the results with the expected outcomes by creating a table to test those criteria.

6. Distribution

The completed video will be distributed through Steven Marlin's YouTube account.

4. Research Model

According to Dima Dajani, an animation can influence students' learning interest if it meets the independent variables as follows: Performance Expectancy, meaning the three-dimensional animation performance must be engaging; Effort Expectancy, indicating the three-dimensional animation must be easy to understand; Social Influence, requiring the student environment to support the development of three-dimensional animation; Facilitating Conditions, requiring students to have adequate facilities to watch three-dimensional animation; Learning Value, meaning students must be able to learn using three-dimensional animation independently; and Hedonic Motivation, stating that three-dimensional animation must be appealing and enjoyable for students. A student's learning interest, expressed as Behavior Intention, is the dependent variable (Dajani & Abu Hegleh, 2019).

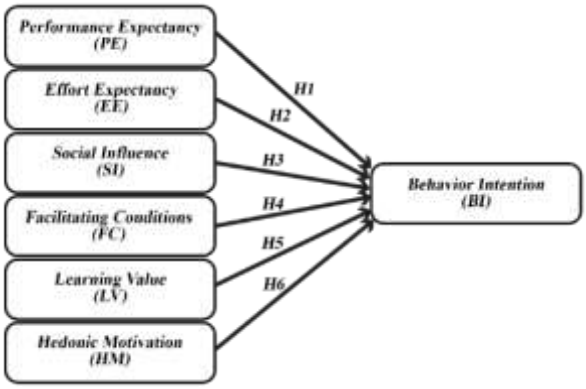

Figure 3. Research Model.

From the research model in Figure 3, there are six formulated hypotheses to be discussed in this study:

H1a: Performance Expectancy positively influences Behavior Intention.
H10: Performance Expectancy negatively influences Behavior Intention.
H2a: Effort Expectancy positively influences Behavior Intention.
H20: Effort Expectancy negatively influences Behavior Intention.
H3a: Social Influence positively influences Behavior Intention.
H30: Social Influence negatively influences Behavior Intention.
H4a: Facilitating Conditions positively influences Behavior Intention.
H40: Facilitating Conditions negatively influences Behavior Intention.
H5a: Learning Value positively influences Behavior Intention.
H50: Learning Value negatively influences Behavior Intention.
H6a: Hedonic Motivation positively influences Behavior Intention.
H60: Hedonic Motivation negatively influences Behavior Intention.

5. Sampling Method

Data will be collected quantitatively using the stratified proportional random sampling method. The researcher will distribute questionnaires to students at Universitas Internasional Batam, targeting 342 respondents from students who can play Rubik's Cube and those who cannot. Respondents will also be divided into three major groups: students in the 1st semester,

3rd semester, and 5th semester, with the number of respondents per semester randomly selected (Jimmy & Cristiansen, 2022).

6. Data Analysis Method

Using the research model and data collection techniques described above, the researcher will analyze the respondent data using the multiple regression data analysis method. In the analysis process, the researcher will utilize the IBM SPSS application to test data validity, data reliability, classical assumption tests, and regression tests to verify the accuracy of the collected data. The analysis aims to determine whether the three-dimensional-based Rubik's Cube algorithm tutorial video positively impacts students at Universitas Internasional Batam.

Results and Discussion

1. Storyboard

The storyboard used as an initial design for the smooth creation process of the three-dimensional-based Rubik's Cube algorithm tutorial video is as follows:

Table 1. Storyboard.

Sketsa Adegan	Durasi (detik)	Keterangan adegan
	30	Penjelasan orientasi pada rubik
	10	Penjelasan step 1 yaitu membuat "tambah" pada sisi putih
	10	step 2 : menyamakan sisi berwarna dengan center yang benar
	30	step 3 : memasukkan corner pada layer pertama dengan algoritma dari tiga kemungkinan berikut
	20	step 4 : memasukkan edge pada layer ke 2 dengan algoritma dari dua kemungkinan berikut
	20	step 5 : membuat "tambah pada sisi kuning dengan algoritma dari dua kemungkinan berikut
	20	step 6 : memperbaiki edge yang tertukar berdasarkan warna dari centernya dengan algoritma dari dua kemungkinan berikut
	20	step 7 : memperbaiki lokasi dari setiap corner
	30	step 8 : memperbaiki corner twist dengan algoritma dari tiga kemungkinan berikut

2. 3D Modeling

In this research, 3D Modeling utilizes the Autodesk MAYA 2022 application. The modeling begins by creating a black-colored cube that is then beveled 20 times. The boxes inside the bevel are given different colors for each side, starting from white, yellow, red, orange, blue, and green. The cube is duplicated 27 times to form the Rubik's Cube and is given a controller in the form of a sphere parented to each cube.

Figure 1 Three-Dimensional Rubik's Modeling.

3. Video Creation

a. Introduction Scene: Rubik's Orientation.

The video introduces the parts of the Rubik's Cube, namely the center, edge, and corner. It is followed by an orientation introduction of the Rubik's Cube, consisting of 12 movements: R, R', L, L', U, U', D, D', F, F', B, B'. This scene lasts for 30 seconds.

Figure 2 Opening Scene.

b. First Layer Solution Scene.

The scene involves solving the first layer, which consists of three stages: completing the "cross" in white, adjusting the colored side with the correct center, and inserting corners in the first layer. This scene lasts for 50 seconds.

Figure 3 Layer 1 Solution Scen**e.**

c. Second Layer Solution Scene.

This scene involves solving the second layer, which includes one stage: inserting edges in the second layer. The scene lasts for 20 seconds.

Figure 4 Layer 2 Solution Scene.

d. Last Layer Solution Scene.

The scene involves solving the third layer, comprising four stages: creating the "cross" in yellow, fixing swapped edges, correcting the position of each corner, and fixing corner twists. This scene lasts for 90 seconds.

Figure 5 Initial Stage of Layer 3 Solution Scene.

Figure 6 Final Stage of Layer 3 Solution Scene.

e. Ending Scene.

In this scene, the Rubik's Cube moves to the center, and the text "Thank You For Watching" appears using a fade-in effect. This scene lasts for 5 seconds.

Figure 7 Ending Scene.

4. Data Analysis

The questionnaire was distributed to students at Universitas Internasional Batam across all academic years, and the total number of respondents who filled out the questionnaire was 368 students. The data ready for testing amounted to 348, with 262 students unable to play Rubik's Cube and 81 students capable of playing Rubik's Cube. The researcher will employ the multiple regression analysis method.

a. Validity and Reliability Test:

The Reliability Test shows that the variables Performance Expectancy, Effort Expectancy, Social Influence, Facilitating Conditions, Learning Value, Hedonic Motivation, and Behavior Intention have Cronbach's Alpha scores above 0.6. Hence, all variables are reliable.

b. Classical Assumption Test:

- Normality Test Result:

The P-P plot normality test results are shown in Figure 8. The points on the graph represent respondents, and the straight diagonal line is the standard data distribution line. The points generated by the researcher's analysis are not far from the diagonal line, indicating a normal or randomly scattered data distribution.

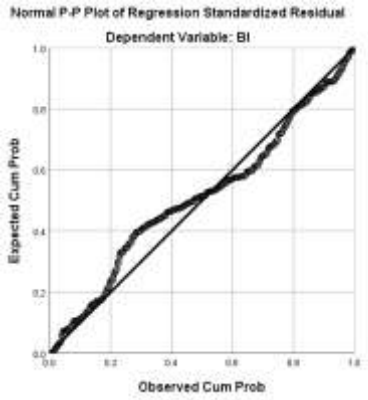

Figure 8 Normality Test Result.

- Heteroskedasticity Test Result:
The scatter plot graph of questionnaire respondents is displayed in Figure 9. The points on the scatter plot do not form a specific pattern, and the points are scattered above and below zero. Thus, it can be concluded that heteroskedasticity assumptions are visually irregularly dispersed.

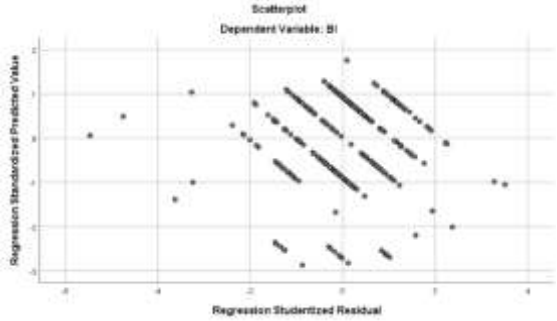

Figure 9 Heteroskedasticity Test Result.

- Autocorrelation Test Result:
In this study, the Durbin-Watson method is used for autocorrelation testing. The Durbin-Watson test yielded a value of 1.980. Based on the DW table, the value (du) to be compared with the data for 348 respondents is 1.8306. To be free from autocorrelation, the DW number must meet the condition (4 - du) > 1.8306. If we input the (du) obtained from this study into the equation, it results in 4 minus 1.980, producing 2.02, which is greater than 1.8306. Therefore, this study is declared free from autocorrelation.

Table 9 Durbin-Watson Test Result.

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.750[a]	.563	.555	.48746	1.980

a. Predictors: (Constant), HM, EE, SI, FC, LV, PE

b. Dependent Variable: BI

c. Regression Analysis Result:
- R Square Test Result:
The R square test result is indicated in Table 10. The adjusted R square value is 0.555, meaning that independent variables (Performance Expectancy, Effort Expectancy, Social Influence, Facilitating Conditions, Learning Value, and Hedonic Motivation) can explain the dependent

variable (Behavior Intention) by 55.5%, while the remaining 44.5% is explained by other factors not within the model. With the presence of Performance Expectancy, Effort Expectancy, Social Influence, Facilitating Conditions, Learning Value, and Hedonic Motivation, a student is likely to change Behavior Intention to learn Rubik's Cube algorithms through 3D animation-based video tutorials.

Table 10 R Square Test Result.

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.750[a]	.563	.555	.48746	1.980

a. Predictors: (Constant), HM, EE, SI, FC, LV, PE

b. Dependent Variable: BI

- F Test Result:

The significance value of F in Table 11 is < 0.001, amounting to 0.000. Therefore, it can be concluded that Performance Expectancy, Effort Expectancy, Social Influence, Facilitating Conditions, Learning Value, and Hedonic Motivation significantly influence Behavior Intention.

Table 11 F Test Result.

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	104.203	6	17.367	73.088	.000[b]
	Residual	81.029	341	.238		
	Total	185.232	347			

a. Dependent Variable: BI

b. Predictors: (Constant), HM, EE, SI, FC, LV, PE

- t Test Result:

A variable is said to influence the dependent variable if the significance in Table 12 is smaller than 0.005. Thus, it can be concluded that:

Performance Expectancy Test Result: Performance Expectancy has a significance level of 0.001 < 0.05; thus, H1o is rejected, and H1a is accepted, meaning Performance Expectancy positively influences Behavior Intention.

Effort Expectancy Test Result: Effort Expectancy has a significance level of 0.004 < 0.05; thus, H2o is rejected, and H2a is accepted, indicating Effort Expectancy positively influences Behavior Intention.

Social Influence Test Result: Social Influence has a significance level of 0.004 < 0.05; thus, H3o is rejected, and H3a is accepted, suggesting Social Influence positively influences Behavior Intention.

Facilitating Conditions Test Result: Facilitating Conditions have a significance level of 0.446 > 0.05; thus, H4o is accepted, and H4a is rejected, implying Facilitating Conditions negatively influence Behavior Intention.

Learning Value Test Result: Learning Value has a significance level of 0.103 > 0.05; thus, H5o is accepted, and H5a is rejected, meaning Learning Value negatively influences Behavior Intention.

Hedonic Motivation Test Result: Hedonic Motivation has a significance level of 0.294 > 0.05; thus, H6o is accepted, and H6a is rejected, indicating Hedonic Motivation negatively influences Behavior Intention.

Table 12 t Test Result.

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
		B	Std. Error	Beta	t	Sig.	Tolerance	VIF
1	(Constant)	.284	.162		1.468	.001		
	PE	.369	.098	.330	4.168	.001	.197	3.067
	EE	.052	.053	.000	.982	.004	.397	2.518
	SI	.184	.074	.160	2.478	.004	.284	3.518
	FC	.065	.089	.057	.783	.446	.230	4.348
	LV	.143	.088	.122	1.637	.103	.232	4.317
	HM	.097	.093	.085	1.050	.294	.194	5.157

a. Dependent Variable: BI

5. Discussion

a. Influence of Performance Expectancy on Behavior Intention:

Performance Expectancy has a significance level of 0.001 < 0.05; therefore, H1o is rejected, and H1a is accepted. This implies that the performance of the algorithm video positively influences students' interest in learning Rubik's Cube from the three-dimensional-based Rubik's algorithm tutorial video. Clear instructions and steps motivate students to delve deeper into Rubik's algorithm through three-dimensional animated videos. Both beginners and experienced Rubik's Cube players can develop and understand Rubik's algorithms, specifically designed for beginners.

b. Influence of Effort Expectancy on Behavior Intention:

Effort Expectancy has a significance level of 0.004 < 0.05; hence, H2o is rejected, and H2a is accepted. This means that students watching the three-dimensional-based Rubik's algorithm tutorial video do not need extra effort to understand Rubik's algorithm. The Rubik's algorithm is captured and animated exceptionally well and is easy to comprehend. Consequently, students' interest in learning Rubik's algorithm increases, positively impacting Behavior Intention.

c. Influence of Social Influence on Behavior Intention:

Social Influence has a significance level of 0.004 < 0.05; thus, H3o is rejected, and H3a is accepted. This suggests that the student's environment positively influences their interest in learning Rubik's Cube from the three-dimensional-based Rubik's algorithm tutorial video. Examples of the student's environment include peers learning Rubik's Cube through the three-dimensional-based algorithm tutorial video, close acquaintances believing they can quickly learn Rubik's algorithm through three-dimensional animated videos, and overall, the student's campus supports learning through animated videos.

d. Influence of Facilitating Conditions on Behavior Intention:

Facilitating Conditions have a significance level of 0.446 > 0.05; thus, H4o is accepted, and H4a is rejected. This indicates that the three-dimensional-based tutorial video facility conditions negatively influence students' interest in learning the Rubik's Cube from the three-dimensional-based Rubik's algorithm tutorial video. It is stated that students need to be more suitable for learning using three-dimensional animated videos.

e. Influence of Learning Value on Behavior Intention:

Learning Value has a significance level of 0.103 > 0.05; thus, H5o is accepted, and H5a is rejected. This implies that the learning value of the three-dimensional-based tutorial video

negatively influences students' interest in learning the Rubik's Cube from the three-dimensional-based Rubik's algorithm tutorial video. It is stated that students cannot manage their time independently for self-learning using three-dimensional animated videos.

f. Influence of Hedonic Motivation on Behavior Intention:

Hedonic Motivation has a significance level of 0.294 > 0.05; therefore, H6o is accepted, and H6a is rejected. This means that the learning motivation from the three-dimensional-based tutorial video negatively influences students' interest in learning the Rubik's Cube from the three-dimensional-based Rubik's algorithm tutorial video. It is stated that students do not feel tension, excitement, and enjoyment when watching three-dimensional animated videos.

Conclusions

Based on the analysis results in analyzing independent variables (Performance Expectancy, Effort Expectancy, Social Influence, Facilitating Conditions, Learning Value, and Hedonic Motivation) against the dependent variable (Behavior Intention), only Performance Expectancy, Effort Expectancy, and Social Influence positively influence Behavior Intention or the interest in learning the Rubik's Cube algorithm among students at the International University of Batam. Meanwhile, Facilitating Conditions, Learning Value, and Hedonic Motivation negatively influence the interest in learning the Rubik's Cube algorithm among students at the International University of Batam.

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