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Game Application as Teaching Tool to Assist Mastering Installation of Three-Phase Motor Control Topic: Expert Perception

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Abstract: The learning and teaching process using conventional methods might cause students to be unable to highlight their true potential. Besides, it can be more difficult for teachers to choose the types of games that suit the curriculum and students' needs. Hence, this study aims to develop a game application as a teaching assistant tool for a three-phase direct online starter topic in Electrical Technology Malaysian Vocational Certificate subject for Vocational College students using the Android platform. Learning materials and games are developed using multimedia and interactive elements to attract students to be active in using the learning medium based on game applications as 21st-century learning tools. The development purpose of the game application is to give early exposure to students to the installation of three-phase motor control before going through the laboratory session. The behaviorism learning theory and Game Development Life Cycle (GDLC) model were implemented in the game application development in this research. The researcher used Unity 3D software is online software such as Canva and Microsoft PowerPoint design tools interactively to make a game-based learning application for the three-phase motor control installation subject. Based on the analysis of the findings, the experts agreed that the functionality of this three-phase Motor Control game application can be used well and is suitable to be used as a teaching aid. In addition, these research results can be used by teachers to increase students' interest and further make the learning process more interesting to improve student understanding.

Keywords: Game-based learning, game application, teaching tool, Three-Phase Motor Control, vocational education

1. Introduction

In this modern age, technological advances have multiplied; it facilitates a system's process and improves product quality and quantity. Technology also speeds up the workflow process (Beer & Mulder, 2020). The mastery of information technology and knowledge can influence the design of new methods and ways to deliver information and knowledge to the community and the students who learn it (Johnson, Jacovina, Russell & Soto, 2016), making technology a necessity to help facilitate daily life. As stated in Malaysia Education Blueprint 2013-2025, along with the advancement of technology, the country's education system has also changed towards 21st-century education, which aligns with the digital transformation vision of the Malaysian Education Development Plan (Ministry of Education Malaysia 2013).

The use of technology can provide space and opportunities for students to explore the natural world or simulations with applications that have been designed and with online technology. The students can communicate in real-time with

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their peers, and learning will be more interactive (Hsiao, Chang, Lin & Hu, 2014). Students also spend a lot of their time using their smartphones. Based on data released in 2018 by the Malaysian Communications and Multimedia Commission (MCMC), smartphone users under the age of 20 are 93.5%, while 95.5% are full-time students (Malaysian Communications and Multimedia Commission, 2019). Young people, known as Generation Y, are more skilled in using smartphones than those who have reached an older age (Yu & Sussman, 2020; Busch et al., 2021). Therefore, educators and researchers in the field of education can highlight online game applications in line with the development of technology that has no boundaries (Beer & Mulder, 2020). Game-based learning is a suitable way to improve problem-solving skills in learning (Adipat et al., 2021). Game-based learning also improves student achievement and provides fun during the learning process (Licorish, Owen, Daniel & George, 2018).

21st-century learning is more inclined towards the use of teaching aids that are built using platforms such as phone applications, quizzes, and game-based learning (Yadav & Oyelere, 2021). The students are trained to think creatively and critically while guided by teachers. In the 21st Century Education Framework, students must apply components with various learning skills to be mastered. The components consist of Life and Career Skills, Learning and Innovation Skills (4C's- Critical Thinking, Communication, Collaborative, and Creativity), and media and Information Technology Skills. These skills are applied in the teaching and learning process to ensure that students can compete at the global level in line with the National Education Philosophy.

Game-based learning is the latest approach to applying innovation and digital technology elements in teaching and learning (Camuñas-García, Cáceres-Reche & Cambil-Hernández, 2022). There are two types of game-based learning: digital and non-digital games. Digital games are more of an option in enhancing curriculum education to maintain current focus and knowledge (Kaimara, Fokides, Oikonomou & Deliyannis, 2021). Digital games are also used as a platform to stimulate and encourage students to participate more actively in class if the learning process becomes more exciting and fun (Zirawaga, Olusanya & Maduku, 2017).

The recent Covid-19 pandemic has significantly influenced the socio-economy and the field of education worldwide (Rasul et al., 2021). The spread of the Covid-19 epidemic has caused the teaching system in various educational institutions to be disrupted (Pokhrel & Chhetri, 2021). Face-to-face classes were postponed to ensure the safety of students, lecturers, and the surrounding community, and even caused fear among students of the effects of the Covid-19 epidemic (Jalongo, 2021). Thus, formal learning activities are affected due to the order to close educational institutions, either at the school level or institutions of higher learning (Sarmiento, Sarmiento & Tolentino, 2021). Accordingly, online learning is delivered through the internet using a computer or smartphone (Maatuk et al., 2022).

The learning and teaching process uses conventional methods by only listening and recording and is teacher-centered. That may cause students not to be able to highlight their true potential. Besides, it can be more difficult for teachers to choose the types of games that suit the curriculum and students' needs—the ability of instructors to do online teaching methods and challenging to teach practical subjects. For example, motor control online due to learning activities affected following the order to close educational institutions. Therefore, this study aims to develop a game application as a teaching assistant tool for a three-phase direct online starter topic in Electrical Technology Malaysian Vocational Certificate subject for Vocational College students using the Android platform.

2. Methodology

The behaviorism learning theory and Game Development Life Cycle (GDLC) model, were implemented in the game application development in this research. Games Development Life Cycle (GDLC) model consists of six (6) phases in developing game applications as a guide, but the researcher used the fifth (5) phase. The researcher used Unity 3D software is online software such as Canva and Microsoft PowerPoint design tools interactively to make a game-based learning application for the three-phase motor control installation subject. The functionality is examined to be considered and find the troubleshooting so that the developed software as a tool for teaching game-based software to find troubleshooting. The researcher has selected three experts consisting of a Vocational College teacher and two lecturers from Universiti Tun Hussein Onn Malaysia (UTHM) in the testing phase. The experts in this research have a role to examined the content and test the functionality of this game application for student use. Questionnaires were given to experts to provide evaluations, comments, and insights after testing the functionality of the three-Phase Motor Control game application. The data results were analyzed descriptively using frequency and percentage.

2.1 Design Modelling

The development of game applications using the Games Development Life Cycle (GDLC) model in this research consists of the fifth (5) phase. Internal testing focuses on developing content to be tested by a Vocational College teacher who teaches the subject of three-phase motor control and gets feedback. Moreover, the selected materials are also the main asset of developing this game application through the website. The selected assets included in the Unity Software and the programming language will use Microsoft Visual Studio IDE.

The purpose of the GDLC model used in game application development is to apply an interactive approach to enabling flexible access to change during game development. Moreover, it can also determine the quality characteristics at each stage of the prototype to follow the sequence to maintain the quality of the final product. Table 1 shows five (5) phases in the GDLC model.

Table 1- Five phases in the GDLC model

Phase	Phase Name	Statement
Phase 1	Initiation	Create a concept about the game you want to make.
Phase 2	Pre-production	Design the layout, genre game, gameplay, storyline, and music.
Phase 3	Production	Focus on assets and coding.
Phase 4	Testing	Testing the game internally before Beta Version.
Phase 5	Beta	Testing process to outsiders before being released to the market.

2.2 The Design Scheduling

Procedures for developing a game application based on the GDLC model are required until phase 5, the Beta version. The research is limited to the testing phase. Data from three (3) experts were collected to see how practical this game application is for students.

Table 2 - Work Schedule

Phase	Phase Name	Statement
Phase 1	Initiation	Create concept game application of Direct Online Starter 3 Phase
Phase 2	Pre-production	Create the storyboards of the game application that consists of assets (motor control three-phase asset) to identify the flow of the game application.
Phase 3	Production	Create the motor control three-phase asset in Unity 3D software and programming language by using Microsoft Visual Studio IDE
Phase 4	Testing	Testing the game application internally to get improvement before Beta Version.
Phase 5	Beta	Testing game application to the three experts that had been choosing to get feedback tested.

2.3 Development Instrument and Evaluation Feedback

The development instrument that has been used is questionnaires that require expert evaluation. The expert evaluation questionnaire contains four (4) sections, expert demographics, technical product section, product content design section, and expert comments and suggestions for product improvement.

3. Findings

The activities that have been carried out are testing and evaluating the application to measure the functionality and suitability of this application for Vocational College students who take the Malaysian Vocational Certificate in Electrical Technology. The developer has selected three experts consisting of Vocational College teachers to check the content and functionality of the game application for use by students and two lecturers from University Tun Hussein Onn Malaysia (UTHM) to test the functionality of this game application. Questionnaires were given to experts to be given evaluation, comments, and views after testing the functionality of the Three-Phase Motor Control game application.

3.1 Phase 1: A Concept about the Motor Control Game Application

The game that was developed is a three-phase motor control game application. This game framework has different types of installations and levels. Users can choose the type of installation: level one is a quiz question, level two is the installation of the control circuit, and level three is the main circuit installation. Each stage according to the procedure performed in the three-phase motor control installation.

3.2 Phase 2: Design the Motor Control Game Application

The tools used are pictures of pilot lights, control motors, and connection cables found on the Canva and Youtube websites. The tools selected in Unity software is a digital game development software. The software is through Microsoft Visual Studio IDE for Programming language. The researcher used Unity 3D software shown in Figure 1, to design and compile the interface and programming language.

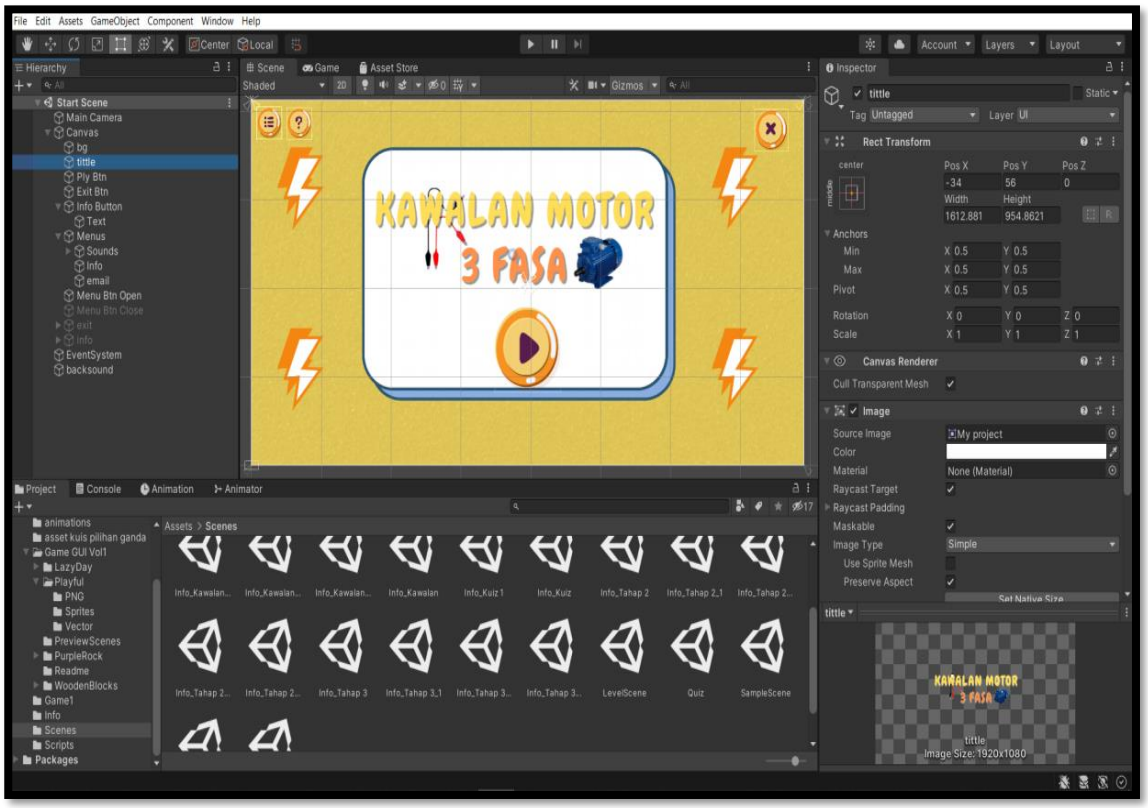


Fig. 1 - Unity 3D Software Interface

3.3 Phase 3: Focus on Assets and Coding

The Programming used in Unity 3D software is C# which uses Microsoft Visual Studio software to make interactive buttons that can switch from one interface to another when the button is pressed. Programming language used to design the games: quizzes, control circuit assembly, and main circuit assembly. The following is the programming language used in some interfaces and games to perform the functions on the interactive buttons.

```
1   using System.Collections;
2   using System.Collections.Generic;
3   using UnityEngine;
4   using UnityEngine.SceneManagement;
5
6   public class startmenu : MonoBehaviour
7   {
8       public void exit()
9       {
10          Application.Quit();
11      }
12
13      public void LoadScene(string sceneName) {
14          SceneManager.LoadScene(sceneName);
15      }
16
17      public void mailto(string mail) {
18          Application.OpenURL("mailto:"+mail);
19      }
20
21      public void sound_volume(float volume) {
22          PlayerPrefs.SetFloat("volume",volume);
23      }
24
25  }
```

Fig. 2 - Programming of the main menu button

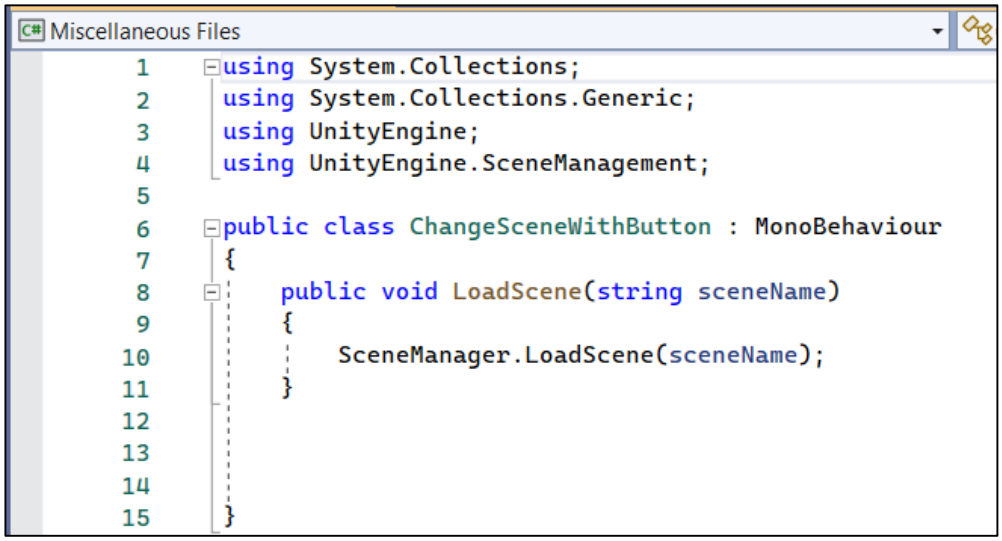


Fig 3 - Programming of interface switching buttons

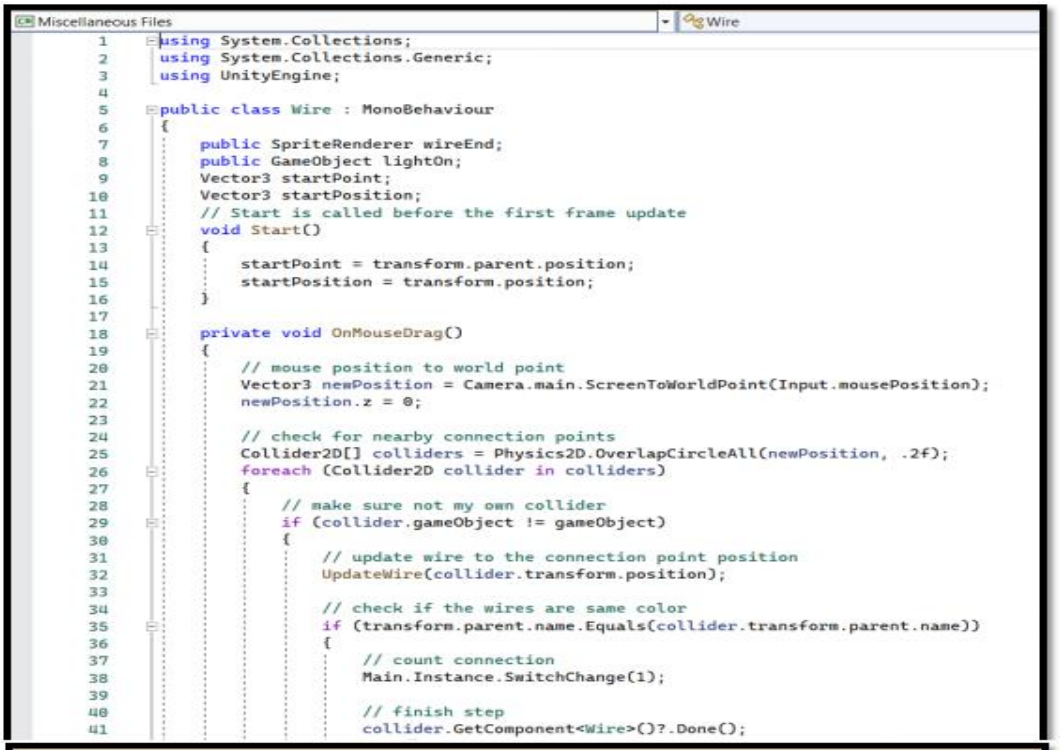
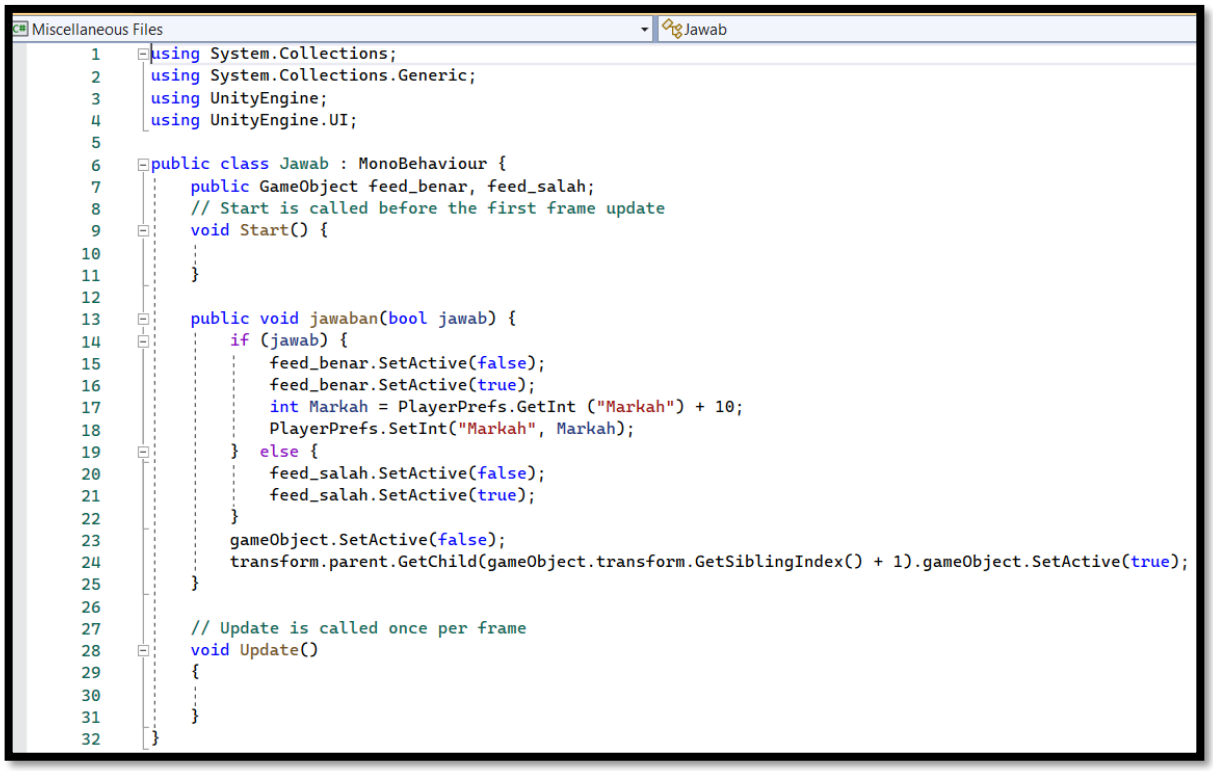


Fig. 4 - Programming for the circuit connection game



```
Miscellaneous Files                                    Jawab
1   using System.Collections;
2   using System.Collections.Generic;
3   using UnityEngine;
4   using UnityEngine.UI;
5
6   public class Jawab : MonoBehaviour {
7       public GameObject feed_benar, feed_salah;
8       // Start is called before the first frame update
9       void Start() {
10
11      }
12
13      public void jawaban(bool jawab) {
14          if (jawab) {
15              feed_benar.SetActive(false);
16              feed_benar.SetActive(true);
17              int Markah = PlayerPrefs.GetInt ("Markah") + 10;
18              PlayerPrefs.SetInt("Markah", Markah);
19          }  else {
20              feed_salah.SetActive(false);
21              feed_salah.SetActive(true);
22          }
23          gameObject.SetActive(false);
24          transform.parent.GetChild(gameObject.transform.GetSiblingIndex() + 1).gameObject.SetActive(true);
25      }
26
27      // Update is called once per frame
28      void Update()
29      {
30
31      }
32  }
```

Fig. 5 - Programming for quiz games

3.4 Phase 4: Testing the game internally before Beta Version

Once the production phase is finished the game application is tested in the internal testing phase. The internal testing performed: a trial test in the APK file, a review of the functionality of the programming language with the tools used, testing of the suitability of the interface in the game application, and a review of the smoothness of the exchange of one display screen to another. Internal testing before the Beta version is released to identify if any problems require returning to the improvement phase. This testing uses an Android-type smartphone to see the functionality of the game application developed. Overall, product design development can provide interactive and effective guidance through the content context to attract users when playing with this three Phase Motor Control game application.

3.5 Phase 5: Testing process to experts before being released to the market

Table 3, the technical product, showed technical issues faced when this game application was installed into the Android phone; Table 4, product content design, showed the suitability of the content developed with a Direct Online Starter for three-phase.

Table 3 - Technical product

Item	Statement	Frequency		Percentage
		Yes	No	(%)
1	This game application is easily installed on an "Android" type smartphone through a downloaded "APK" file.	1	2	33.33
2	The game application can be played without the need for an internet connection.	3	0	100
3	Display an interface that fits the screen size of the user's smartphone.	3	0	100
4	The buttons on the icons in the three-phase Motor Control game app can be used well without any problems.	3	0	100
5	The buttons provided in the three-phase Motor Control game application help the user reach the information display.	3	0	100
6	The buttons used in the three-phase Motor Control game application correspond to the interface design on each page.	2	1	66.67

On Item 1, two of three experts had a problem installing the game application on their android phones because their phones' security would not allow any unregistered software to be installed on the phone. In comparison, only one expert does not agree with item 6 because if students get a wrong answer, students cannot do the correction with the button.

Table 4 - Product content design

Item	Statement	Frequency		Percentage
		Yes	No	(%)
1	The background interface design on the 3 Phase Motor Control game application appeals to users.	2	1	66.67
2	The content in this game can achieve the learning objectives	3	0	100
3	The content in the game is related to the title "3 Phase Motor Control Installation."	3	0	100
4	The examples in this game correspond to the learning content of 3 Phase Motor Control and 3 Phase Direct Online Starter.	3	0	100
5	The game instructions provided are easy to understand by the user.	3	0	100
6	The notes given on the 3 Phase Motor Control game application can be easily read.	2	1	66.67
7	The information in this 3-Phase Motor Control game application is accurate.	3	0	100
8	The content in this 3 Phase Motor Control application is well organized.	3	0	100
9	The content of this game application is compatible with learning needs as a teaching aid.	3	0	100
10	The content of this game application matches the cognitive level of the user.	3	0	100

On item 2, one of the experts disagreed about the background interface design of this game application. It can be improved by changing fonts and backgrounds to a more suitable theme. While on item 5, one of the experts disagreed about the notes provided. The notes can be more simplified and suitable for students to read.

Table 5 - Comments and suggestions from experts

No	Detail	Comments and Suggestion
1	The Expert 1	This application game would be better if there were games for other motor control circuits such as forward-reverse, Start-Delta, Auto-Transformer
2	The Expert 2	The content suitable for the motor control system syllabus Need to be improved in design and animation
3	The Expert 3	Need to add output after complete primary circuits such as pilot lamp lit and motor rotating animation

Based on the experts' evaluation, some suggestions are given by the experts for improving this game application for the future. The testing and evaluation process is essential to measure the quality and functionality of the product developed for the target user, which is Vocational College students. Table 5 shows comments and suggestions from experts.

4. Discussion

The researcher used Unity 3D software is online software such as Canva and Microsoft PowerPoint design tools interactively to make a game-based learning application for the three-phase motor control installation subject. The three-phase motor control installation syllabus serves as a guide for developers to produce a content design appropriate to the title used for students to learn how Direct Online Starter installation is finished when playing this Three-Phase Motor Control game application. These findings show that the experts agreed the game application can be played without the need for an internet connection and display an interface that fits the screen size of the user's smartphone. Besides, the buttons on the icons in the three-phase Motor Control game application can be used well without any problems and help the user reach the information display. Therefore, the findings can be concluded that the experts agreed that the functionality of this Three-Phase Motor Control game application can be used well and is suitable to be used as a teaching aid. This finding supports the research conducted by Satrio et al. (2021) found that integration game application for teaching aid provides an increased understanding of the student's learning outcomes.

Besides, these results are in line with the results of the study by Calderon and Ruiz (2015) that found the effectiveness of using educational games in the higher education environment shows that students accept new strategies to enrich the

student's learning experience. In addition, these research results can be used by teachers to increase students' interest and further make the learning process more interesting to improve student understanding. The results of this research support the findings of the study of Sun-Lin and Chiou (2019), Cheung and Ng (2021), Bulut, Samur, and Comert (2022), Pan et al. (2021) the use of games in teaching makes the learning process more interesting and makes the learning easy for students to understand. Besides, the motivation to understand something of students can be improved through educational games because they have fun while making sense of the learned content (Byusa, Kampire &Mwesigye, 2022). The experts in this research agreed that the content in this game can achieve the learning objectives related to the title "three-Phase Motor Control Installation." But it needs improvement in terms of the appropriate colors and fonts to increase curiosity and attract the user's attention to play this game application. While the proposed improvement that needs to finish by adding more circuits in the three-phase motor control installation: forward-reverse, start-delta, and auto-transformer makes the game application a new learning medium. In addition, the use of learning notes as a reference for users before starting the game makes the game application a preparation for students to do actual practice in the workshop.

5. Conclusion

The learning and teaching process that only uses conventional methods by only listening and recording and is teacher-centered causes students cannot highlight their true potential. The findings of this study have shown that a game application as a teaching aid was developed for the three-phase direct online starter topic in the Malaysian Vocational Certificate subject of Electrical Technology for Vocational College students using the Android platform. The results of this study hoped to help teachers improve students' understanding of the topic of three-phase direct online starters in the subject of Malaysian Vocational Certificate in Electrical Technology. In addition, these research findings can be used by teachers to increase students' interest and further make the learning process more interesting to improve student understanding.

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