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Development of Scratch Applications for Virtual Smart Homes in Teaching Electronic Components in Electronic Design for Design and Tech Subjects

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Abstract: This study aims to develop teaching aids through the Scratch application for the subtopic of parts found in microcontrollers in the context of electronic components based on ADDIE theory. The Scratch application development method for a virtual smart home as a teaching aid for electronic components in electronic design for the subject of Design and Technology, using the ADDIE model design method and the design of this study is a qualitative study using the interview method. A total of 10 experts in the fields of Design and Technology and Technical and Vocational were involved as respondents to this study. Through interviews with experts, the majority of experts, 9 out of 10 experts, agree that the use of the Scratch application can help students better understand the subtopics of the parts found in microcontrollers and aspects of developing a Scratch application for a virtual smart home that consists of graphics, a total of 8 people experts from 10 satisfied experts. The main implication of the study is that the lack of applications that can be detected gives rise to improvements to strengthen the usability of the Scratch application for these electronic components more effectively as a teaching aid.

Keywords: Teaching aids, electronic components, Scratch application, design and technology

1. Introduction

Design and Technology (RBT) is a subject based on skills, creativity and technology that is exposed to students from primary school to secondary level. For lower secondary level includes first, second and third-grade students. Design and Technology (RBT) is a new subject that replaces Life Skills Integrated (KHB). When there is a transition of subjects and a new context, the teachers at KHB are still less creative in imparting knowledge, including technology projects or practical workshops. Therefore, students need help understanding concepts and applying skills taught by the teacher. Concerning that, teachers need to master their knowledge and RBT skills and use teaching aids (BBM) that are suitable for ensuring students can master Design and Technology subjects (Md Harun, 2014).

Design and Technology is a subject that requires theory and practice. Therefore, teachers must be creative in conveying concepts clearly to students and giving pointers to teach about practice regarding a lesson topic. The preparation of materials or teaching aids needs to be systematic and able to help teachers and students achieve PdPc objectives and be accepted and suitable for students (Abd Samad et al., 2018). Learning objectives will be achieved if the teacher implements curriculum policies using knowledge and skills specializing in RBT to achieve the outlined goals (Mahadi et al., 2021). RBT teachers need to use tools or teaching aids that are more technological and effective to make the Teaching, Learning Process and Facilitation (PdPc) effective as a core measure of student success (Paolini, 2015).

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The application of technology in PdPc students and the use of effective teaching aids or materials has a positive effect on giving birth to relevant youth in this age of modernization where the level or quality of education is good, authentic youth who are viable and have the strength to face digital challenges.

Technology in the education sector is growing with the times, including the needs, wishes and effectiveness of the PdPc to produce a capable generation. Furthermore, some studies say that students' productive behaviour increases when they learn to use technology (Chen et al., 2017). Accordingly, game software, such as the Scratch application, is very efficient for use in PdPc. In developed countries like Japan, they have applied Scratch applications in technology and education. According to Yamamori and Yoshihara (2016), he has used the Scratch application inside learning. As a result, students succeed in technology-related subjects, such as drawing figures, creating projects, etc.

Next, the Scratch application can create an image of a virtual smart home featuring microcontroller components. A virtual smart home is a home that has tools or safety components and facilities for the well-being of the home, and this situation is illustrated in animation and graphics. According to Strengers and Nicholls (2017), level services that are digitally connected to the occupants refer to the provision of smart home technology devices. Accordingly, electronic design exists in connection and cooperation with smart home devices due to using electronic components such as fuses, temperature sensors, etc.

Teaching, Learning Process and Facilitation (PdPc) applied in this study is game-based learning and interactive teaching. Game-based learning has various categories, designs and principles. For example, the development pattern of educational games on the Internet platform has principles of understanding, problem-solving and student empowerment (Coleman & Money, 2020). Game learning is an example of video games and simulators that can achieve effectiveness in e-learning as much as 90% compared to traditional learning, which is only 30% (Dimitra et al., 2020).

Observation and awareness of the importance of visualization, verbalization and auditory within the PdPc. Design subject Learning Design and Technology (RBT) should be fun and apply technology in PdPc so that students get input from the teacher's interesting method or pedagogy. According to Buntat and Mohamed (2010), teachers must be more creative in diversifying effective explanation methods for students. If the teacher's teaching is based solely on text or verbal, then students are slow, or it is difficult to understand the input because no visualization illustrates the explanation teacher.

Textbooks are the main teaching materials teachers use. Still, various resources or other teaching materials can be used, namely tools or materials that help teach interactively to attract students' interest and make it easier for students to understand. However, Raman et al. (2019) found that teachers only use textbooks in the Teaching and Learning Process (PDP). Usually, students only learn theory based on textbooks. According to Arip et al. (2013), teachers use chalk-and-talk pedagogy or teaching methods conventional make students lose focus. It is supported by Ismail et al. (2021), who think students feel bored with the teacher's constant guidance. Therefore, teachers need to be flexible in using various pedagogies during PdPc, such as the game approach, and provide a student-centred learning space to explore knowledge self-knowledge through applications or games.

A study on the development of a Scratch application for a virtual smart home as an aid in teaching the functionality of electronic components in electronic design for the subject of Design and Technology is a facilitator used by RBT teachers to make the process of teaching and learning more effective. Scratch includes elements of code construction, patterns coding, programming activities and other programming content to create a set of algorithm instructions in a project (Moreno-León et al., 2015). This study aims to increase the understanding of second-year students in electronic design for RBT at school after developing an application that helps PdPc be more effective. The research objective is for PdPc facilitation, such as identifying how the Scratch application can help students better understand the parts in a microcontroller, especially electronic components and developing Scratch applications for virtual smart homes.

2. Literature Review

This section gives an overview of the concept of Scratch application development for home virtual intelligence as a teaching tool for the functionality of microcontroller components. In the room, this literature review also highlights relevant theories and comparisons of previous studies against Scratch applications, using microcontrollers and smart homes to improve my application.

According to Ilias et al. (2013), he said that student focus can be achieved during teaching and learning using teaching aids by teachers. In addition, materials help teach and provide the atmosphere and process of PdPc is more interesting and effective, and students' input becomes clear and easy to understand (Jusmiana et al., 2020). Teaching aids such as game-based learning software Scratch, Kodu, Adventure Author, and others involve problem-based learning techniques where students apply knowledge to solve problems given and are motivated (Wijnia et al., 2011). Next, according to Meister (2018), game-based learning supports student-centred learning, balanced learning between classrooms and classes, and increases the efficiency of student learning. Prensky (2003) has introduced digital game learning, which combines the domain of education and games for the fun of learning, encouraging new skills and knowledge (Sin et al., 2013).

Microcontroller components introduced and stimulated using the Scratch application can help students see a clear picture through computers, tablets or smartphones. The use of computers in PdPc is very helpful in improving student understanding. It is supported by Al Musawi et al. (2016), who said that learning is more effective using technology such

as computers than traditional learning, known as conventional learning, using whiteboards and books. Scratch is an application that includes visualization, auditory and verbal, where users such as teachers and students can design games, story animations and others. According to Sunarti and Rusilowati (2020), users perform or design a project on this Scratch application platform by operating blocks and other features provided within Scratch.

This study uses the ADDIE model and Scratch application development for smart homes. This virtual game is suitable for using Piaget's theory because it emphasizes learning while playing. Piaget 1951 argued that children's active learning involves objects around them while communicating and playing (Khairuddin & Mailok, 2020). Therefore, Scratch applications can help the PdPc through animation stories and so on according to the student's level. Several studies have found that students are now more inclined to learn using technology because it is more interesting and facilitates understanding and acceptance of the PdPc process. In addition, the Scratch application allows students to access this application at any time and repeat sections, which is difficult to understand according to the student's level of understanding.

3. Methodology

Researchers conducted a study at a national secondary school in Selangor Darul Ehsan, and two teachers were selected as respondents. The study was also conducted in a public university in Perak Darul Takzim, and eight experts were selected as respondents for the validity of the usability of the Scratch application in helping RBT students in level two and above understand the parts found in the microcontroller, especially the components electronics. Based on Table 1 shows the profile of respondents who have been selected and have experience and different service periods. The study uses a qualitative approach through a structured interview method, and the researcher prepares an interview protocol.

This interview is to obtain information from experts face-to-face or communicate verbally. Rachmawati (2017) said that the interview was detailed communication carried out by the interviewer according to the guidelines. All communication dialogues are important for the input of this study from the respondents so that the researcher gets clear information about the usability of the Scratch application for electronic components. All data obtained from the interview session will be typed and coded to facilitate the researcher to analyze the information from the interview results to obtain validity. The method of analysis used for this interview is the analysis of content.

Table 1: Respondents profile

Position	Field	Experience
Teacher	Design and technology	10 years
Teacher	Design and technology	15 years
Lecturer	Game developer	20 years
Lecturer	Technical and vocational	33 years
Lecturer	Technical and vocational	7 years
Lecturer	Technical and vocational	10 years
Vocational training officer	Technical and vocational	8 years
Lecturer	Technical and vocational	14 years
Lecturer	Technical and vocational	5 years
Lecturer	Technical and vocational	15 years

3.1 Scratch Application Development

Scratch application development method for virtual smart home as a teaching aid electronic components in electronic design for the subject of Design and Technology, using the ADDIE model design method and the design of this study is a qualitative study. This selection occurs due to several influencing factors, such as the user factor, which is the teacher design and technology subjects and concerned students who focus on concepts application. Through this research approach, the development of Scratch applications for virtual smart homes as teaching aids electronic components can be identified through a questionnaire validity. Then, the researcher made five phases: analysis, design, development, implementation and evaluation. In addition, it is necessary to know about the goal software, software objectives, target group, software content, pedagogical approach and software usage strategy.

3.2 ADDIE Development Model

3.2.1 Analysis

This phase is important to ensure the teaching aids (BBM) that want to be developed can achieve the goals outlined in the study's objectives. Among the things that need to be taken into account in the analysis phase are the purpose of the instructional application developed, the user of the application focused, and the platform that wants to be used to develop this BBM. In this analysis, the researcher performed an analysis related to the problems faced by students and the platform or a suitable type of learning game, the Scratch application. The time taken to do draft planning such as storyboard, pictures and other materials for developing this application is a month.

3.2.2 Design

This phase includes the appearance of form, approach, structure, learning theory and technology, which is used in developing teaching aids (BBM), which is the Scratch application. In this phase, the researcher designs the Scratch application after completing the draft idea or storyboard. Design the BBM storyboard form of this Scratch application, including story ideas, animations, audio, text and other necessary aspects. When the storyboard is ready, and you get the picture desired and appropriate to the learning subtopic, then the design of this application idea is successfully designed. Furthermore, these teaching aids are designed to achieve the objective of helping students better understand electronic components. Accordingly, compiling content and multimedia elements must be appropriate and relevant to the Standard Document Lesson Curriculum (DSKP) and only a few words and other elements because students tend to easily understand simple things. Next, there are several aspects in the design of this Scratch application, namely storyboard design, element design multimedia and interface design. Interface design is an element that can visible, like pictures, charts or animations used to make the interface are interesting and easy to understand (Nordin & Singh, 2016). According to Nordin and Singh (2016), design elements in the e-learning interface consist of images, layout, typography, navigation and colour. Next, the design of the main menu interface related to the display of learning titles, manual user and start of the game.

3.2.3 Development

The third phase in the ADDIE model is the development phase. This phase is related development of the Scratch application, a teaching aid application with graphics, animation, audio and others in the existing software. In this phase, too, content development. The content of the Scratch application needs to be seen as appropriate according to the student's problem. Auxiliary materials This tutorial is developed using the Scratch platform.

3.2.4 Implementation

The fourth phase in the ADDIE model is the implementation phase. This phase shows problems that will occur or exist during the implementation of the Scratch application. Researchers found that if the screen is small and shows coding blocks, the risk occurs when the stressed coding block is large, which can cause the coding block to be deleted or wrong enter coding input, making the game not run as desired. Therefore, the use of this game needs to use a large screen display to avoid problems the said. When the Scratch application for this electronic component is ready and successfully played or used, the researcher downloads the file to enable the Scratch application to play without the internet. In connection with that, the researcher made a QR code and prepared a link to be shared with Design and Technology teachers to make it easy to use as material.

3.2.5 Evaluation

The fifth phase in the ADDIE model is the evaluation phase. This phase acquires validity from experts in games, technical and vocational fields as well as Design teachers and Technologies involved in developing Scratch applications for teaching aids. Purpose this evaluation phase is done so that the objective of developing teaching aids is achieved, and the researcher can make improvements if necessary according to the expert's opinion on the development of Scratch applications for virtual smart homes as teaching aids for components electronics in electronic design for the subject of Design and Technology.

3.3 Instrument of Study

The research instrument used for developing this Scratch application is the qualitative method, which is the validity of the interview. The researcher interviewed 10 experts who related to the research topic to obtain validation and applicability in achieving research objectives. The interview conducted by the researcher is a type of structured interview. Structured interviews use questions related to content and the design of research products, namely interfaces, graphics and others.

4. Results

In-depth data analysis is obtained from the results of interviews with respondents. Researchers use qualitative methods as a research instrument by conducting interviews structured to collect true input about the study from respondents. Ten respondents were interviewed face-to-face to obtain information about the Scratch application development study.

A total of ten experts who were involved as respondents in this study were interviewed face to face. The first to fourth respondents were interviewed on 5 June 2023 (Monday) at 8.30 am, 10.23 am, 2.00 pm, and 4.50 pm. The fifth to eighth respondents were interviewed on 7 June 2023 (Wednesday) at 9.00 am, 10.45 am, 2.35 pm, and 5.15 pm. The ninth and tenth respondents were interviewed on 9 June 2023 (Friday) at 3.15 afternoon and 5.00 pm. On average, this interview session takes 20 to 30 minutes. This interview session went smoothly because the interview questions had been sent a week in advance for respondents ready to validate and evaluate the teaching aids the researcher developed, the Scratch application. The questions asked of the respondents in the interview session are as follows: 1) can you tell me a

little bit about your background such as personal information, career and education? 2) does the content information in the Scratch application for this electronic component coincide with the textbook syllabus and Curriculum Standard Document and Assessment (DSKP) for the subject of Design and Technology in the second year? 3) is the use of sentences and questions found in the Scratch application game this easy to understand? 4) are the graphics and multimedia elements in the Scratch application interesting? 5) is this Scratch game easy to use and has a good storyline? and 6) what are your comments or suggestions for improvement, if there are any, to make the Scratch application for electronic components better than many?

Based on the question, the respondent states the answer. Then, the researcher analyzes the feedback given by each respondent using analytical methods, content, and coding systems to make it easier for researchers to identify important information which is required in the implementation of learning. Based on Table 2, code determination for questions. The second interview was conducted to identify the use of the Scratch application to help students better understand the parts found in a microcontroller, especially electronic components. Next Tables 3, 4, 5 and 6 show the determination of the code third, fourth, fifth and sixth questions to obtain validity from experts.

Table 2: The determination of the code for the second question is content information in the Scratch application for electronic components. This coincides with the textbook syllabus and documents standard curriculum and assessment (DSKP) for the subject of design form and technology second level

No.	Item	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10
1	The content of this game coincides with DSKP (2.4.2 Explaining the parts found in a microcontroller)	/	/	/	/		/	/	/	/	/
2	The content of this game is related to a textbook	/	/	/	/	/	/	/	/	/	/
3	There are representative electronic components input and output sections	/	/	/	/	/	/	/	/	/	/
4	The content entered is accurate and brief	/	/	/	/	/	/	/	/	/	/
5	This game provides examples of objects which use electronic components which are not found in textbooks as the addition of information	/	/	/	/		/	/	/	/	/
6	The whole game application is suitable to aid students understanding of electrical components	/	/	/	/	/	/	/	/	/	/

In this interview, respondents gave feedback on the use of sentences that were found in the Scratch application. Table 3 shows the questions given to the respondents to ensure that the use of sentences is easy to understand.

Table 3: The determination of the code for the third question is the use of sentences and questions found in the game. Is this Scratch application easy to understand

No.	Item	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10
1	Clear text and font size	/	/	/	/	/	/	/	/	/	/
2	Sentences used in the game are clear	/	/	/	/	/	/	/	/	/	/
3	The use of sentences in the game is brief	/	/	/	/	/	/	/	/	/	/
4	The description of each available section in microcontrollers is clear and easy to understand	/	/	/	/	/	/	/	/	/	/
5	Instructions in the game are there	/	/	/	/		/	/	/	/	
6	Use of appropriate mind test questions	/	/	/	/	/	/	/	/	/	/

The fourth question is about the graphic and multimedia elements in the application Scratch this. Table 4 on the questions asked to the respondents to ensure the use of appropriate and interesting graphics. Creative graphics and multimedia can make students play and not get bored.

Table 5, which is the fifth question about this Scratch game, is easy to use and has a good storyline. The continuity of the storyline is very important so that students don't feel dizzy. The user-friendly application is also very effective to use as a subtopic BBM the parts found in the microcontroller.

Table 4: Is the code determination for question four graphic elements interesting, and is the multimedia in this Scratch application

No.	Item	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10
1	The graphic elements included are appropriate and attract	/	/		/	/	/	/	/		/
2	Use a lot of picture elements	/	/	/	/	/	/	/	/	/	/
3	Attractive navigation layout	/	/		/	/	/	/	/	/	/
4	Use of appropriate backgrounds	/	/	/	/	/	/		/	/	/
5	Use interesting and appropriate audio		/	/	/		/	/			
6	Smooth object animation (smooth)		/	/	/	/	/	/	/		/

Table 5: Code determination for the fifth question: is this Scratch game easy to use and has a good storyline

No.	Item	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10
1	The right game for every component of electronics	/	/	/	/		/	/	/	/	/
2	Appropriate storyline with electronic components	/	/	/	/		/		/	/	/
3	Simple and easy to use	/	/		/	/	/	/	/	/	/
4	There is a continuation of the story from the beginning game over		/	/	/		/	/	/	/	/
5	There are easy-to-use instructions players	/	/	/			/	/	/	/	/
6	Easy to control the game	/	/	/	/	/	/	/	/	/	/

Table 6 shows the sixth question about comments and suggestions for improvement that can be done on the Scratch application for this electronic component to ensure effective usability for teachers and students.

Table 6: Determining the code for the sixth question, what are the comment correspondence or improvement suggestions, if any, to make the application Scratch for this electronic component better from various angles

No.	Item	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10
1	Increase the variety of game types	/									
2	Time does not delay too long				/	/	/	/	/	/	/
3	Interesting and plentiful audio additions	/		/	/	/	/	/	/	/	/
4	Refine sentences and instructions					/	/				/
5	Enter English for terms engineering		/								
6	Use cheerful colors for interest							/			

Next, after the code was determined, the researcher began to analyze the interviews with show it using a bar chart. Fig. 1 shows the code analysis of respondents for the second question.

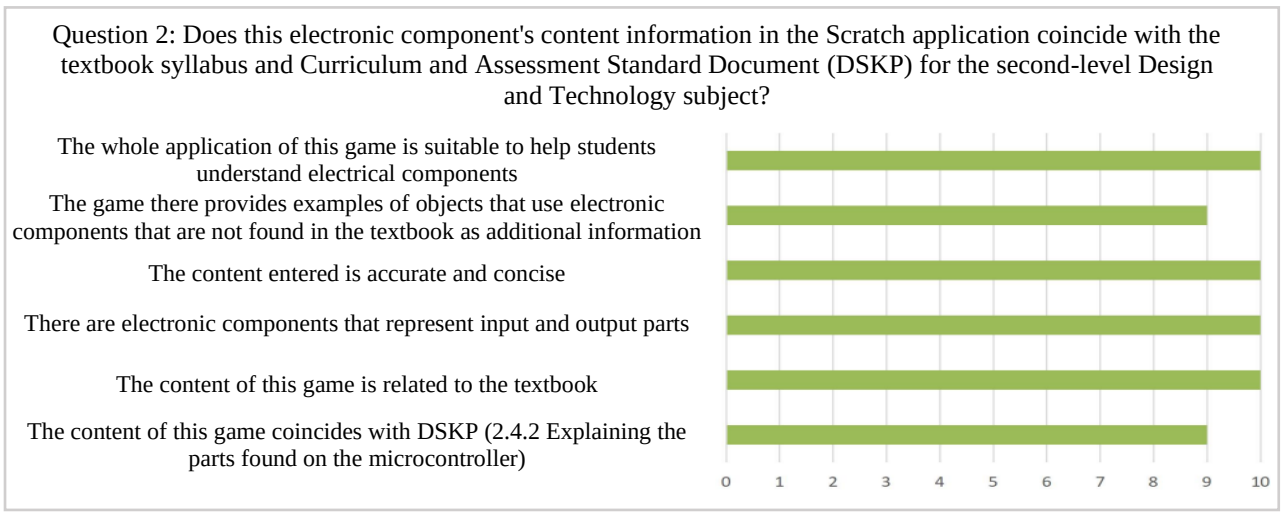

Fig. 1: Determination of the code for the second question: is there information on the content in the Scratch application of the component? This electronics coincides with the textbook syllabus and curriculum and assessment standard document (DSKP) for second year design and technology subject?

Fig. 2 is about using sentences and questions found in the game. This Scratch application is easy to understand. According to the researcher's input from the respondents, the majority agreed with the above statement because the researcher used simple sentences and solid content.

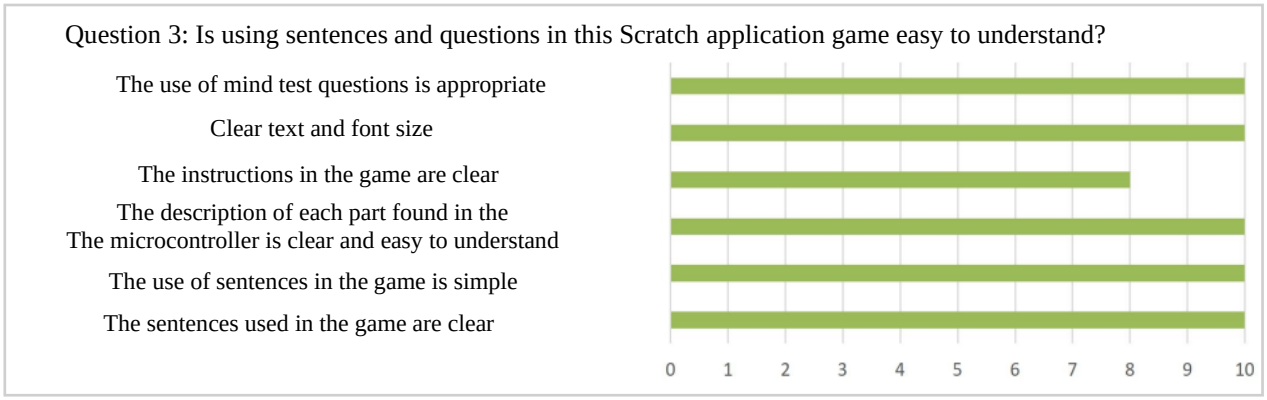

Fig. 2: Determination of the code for the third question is the use of sentences and questions found inside. Is this Scratch application game easy to understand?

Fig. 3 about graphic and multimedia elements in the Scratch application to look attractive. According to the results of the input received from the respondents consisting of ten people, they gave a lot of positive feedback on using these graphic elements that touch audio, animations, backgrounds, games and so on.

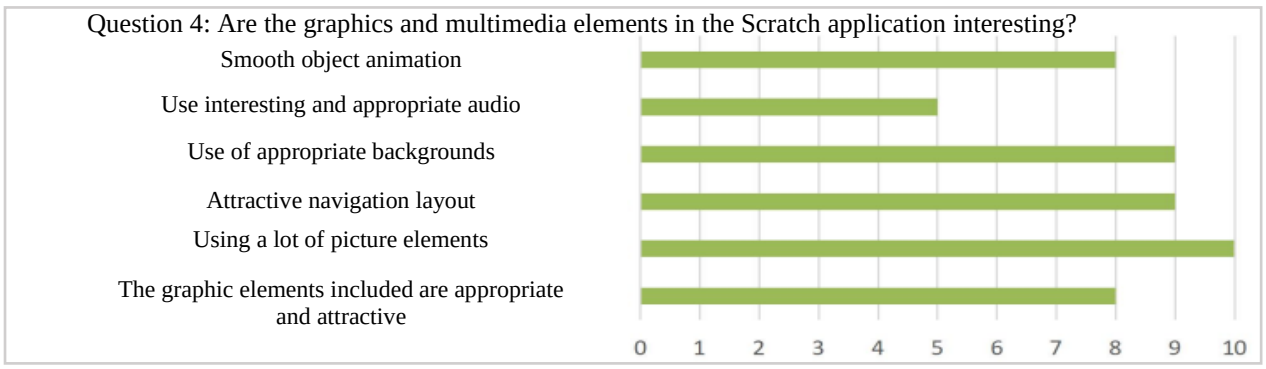

Fig. 3: Determination of the code for question four graphic and multimedia elements inside. Is this Scratch app interesting?

Fig. 4 about the use of Scratch and the story line. The researcher gets input from respondents that this Scratch application is easy to use and controls the game. In addition, the storyline that describes the virtual smart home equipped with electronic components is also suitable.

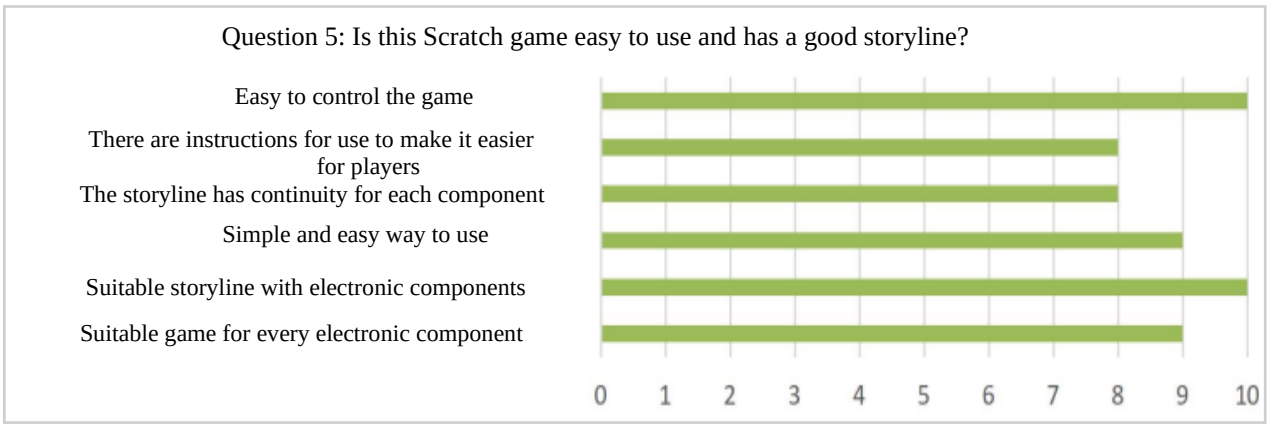

Fig. 4: Determination of the code for the fifth question: is this Scratch game easy to use and has a good storyline?

Finally, Fig. 5 about comments and suggestions for improvements that can be made to the development of Scratch applications for electronic components. Respondent feedback is positive by giving various encouraging ideas, and the majority touched on verse, graphics, and multimedia.

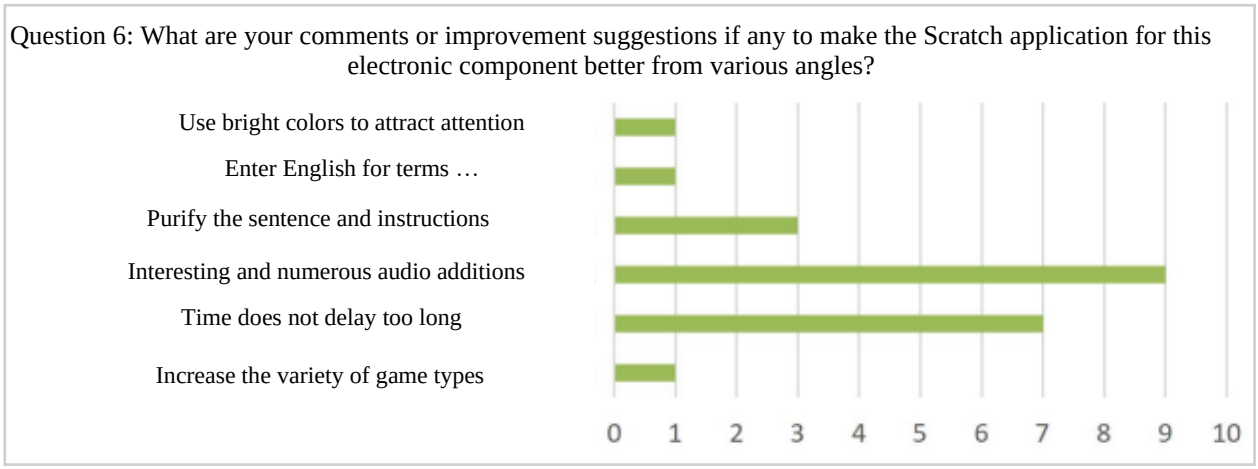

Fig. 5: Determination of the code for the sixth question correspondence comments or suggestions for improvement if is there to make a Scratch application of the component this electronics is better from many angles?

5. Discussion

Based on the results, applications created with Scratch are made available as teaching aids in the form of pre-existing software that includes graphics, animation, audio, and other features. After receiving the preliminary data from the needs analysis results, the study was conducted during the design stage (Laili, 2019). Following the analysis, the presentation was modified to better suit the students' skills, and the original product was created as an eye-catching teaching tool.

After the teaching materials are ready, they are validated by 10 experts. A number of aspect indicators are used to assess the feasibility of teaching materials. These include easy language use: researchers consider the form of teaching materials. Teaching materials are systematically arranged in language that students easily understand according to their knowledge and age, can be accessed anytime and anywhere, and can help them learn independently (independently) with minimal assistance or guidance from educators (Al Asy'Ari et al., 2021), appropriate graphic and multimedia use, and alignment with the textbook syllabus and Curriculum and Assessment Standard Document (DSKP) for the second-level Design and Technology subject. Overall, from the results of the interviews, the experts gave a positive response to the Scratch-based application that had been developed.

This demonstrates how digital technology improves learning environments and workflows in education in a number of ways. Furthermore, kids love digital technology a lot. But we also need to remember that in order for teachers to use digital tools in the classroom effectively, they need the backing of the school administration as well as the right training, technique (Havlaskova et al., 2021).

6. Conclusion

Finally, the development of Scratch applications for virtual smart homes as aids in teaching electronic components in electronic design for Design subjects and Technology has achieved the study's objective at the beginning of this study. Interviews were successfully conducted with ten respondents with a background in the field of game developers, RBT and technical and vocational teachers, making the findings of this study more meaningful and accurate with the content of this Scratch application. The scratch application development process is also done orderly and according to the timeline set by referring to the model ADDIE, applying game theory, learning theory such as Jean Piaget and other references used in developing the application and writing this thesis. ADDIE model selection is very appropriate and shows the success and success of this Scratch application, which allows this application to work well and can be used as an aid to teaching.

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