Development of Colour and Shape Learning Device for Kindergarten Students

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ABSTRACT
Early childhood education plays a very basic role in the sense of developing human capital. For students in kindergarten (5-6 years), the ability to discern colours and geometric shape is essential for children's development. Students in kindergarten should think about colours and geometrical shape. It is necessary to create colour and shape learning media for kindergarten students. The Research and Development (R&D) method is applied as development model for this learning media. Using the Arduino, TCS3200 colour sensor, DFPlayer, and colour card, the learning media was created. In this media development, there are ten cards for the colours grey, blue, brown, light green, dark green, black, red, pink, orange, and purple. In the development of this media, there are ten cards to shape images in the form of a trapezoid, star, oval, square, triangle, rectangle, circle, kite, pentagon, and heart. The testing of the device has shown that the accuracy of the colour and shape recognition device is 97 percent, which can be defined as a very good result. The device for colour and shape learning is applied at Elbaith Rif'a Islamic Happy School. By using this media, the student reaction was very positive about studying colour and shape.

Keywords: *Colour Learning Device, Shape Learning Device, Kindergarten Student, Arduino*

1. INTRODUCTION

In the context of preparing human resources, early childhood education, as expressed by Santoso (2006), holds a very fundamental position [1]. The experience of early childhood education can have a lasting influence so that it will become the basis for children's education at a later age [2]. Early childhood education is carried out as an effort to assist children in increasing their potential according to the talents and interests of each child, as mandated in the Child Protection Law Number 23 of 2002 Article 9 states that "Every child has the right to receive teaching in the context of personal development and level of intelligence according to his interests and talents [3].

The preschool years mark a period of vast psychological advancement, with the initial presentation of many psychological capabilities that will need to be perfected into young adulthood [4]. Any child born has talent, imaginative ability, and social patterns that are valuable assets for deciding the future of children [5]. Based on the results of research, about 50% of adult intelligence capabilities have occurred when the child was 4 years old [6].

In early childhood, the use of electronic devices, enabled with internet connectivity, has been widespread in the everyday lives of western society. There are numerous explanations why parents use devices to encourage young children to use them. While it has advantages, it is evident that internet access actually has detrimental impacts on young children's growth and development processes [7]. Paediatricians should be mindful of both the positive and the side effects of electronic devices and, based on the age of children, offer recommendations to families [8]. The Canadian Paediatric Society emphasized that children aged 0-2 should not be exposed to technology at all. Children aged 3-5 years are limited to using technology to only one hour per day [9].

For youth, colour is a very powerful aspect. In the classroom setting, early childhood education and care centres offer young children with opportunities to discover, develop, reflect, practice, and understand [10]. The emotional responses of children to vivid colours have become more optimistic with age [11]. Consistent and accurate colour naming appears to grow paradoxically late in children despite the numerous typical environmental characteristics, since even young

children differentiate and classify colours well. Colour is a popular aspect of the world of the kid, and children are mindful of colour as a distinct realm, know colour words, and respond with colour names to colour questions [12]. The capacity of Kindergarten student (5-6 years) to differentiate geometric shapes is crucial for the growth of children [13]. The perception of shape and space among children is a matter of living in a world where they begin to learn and develop conceptions of shape and space as soon as they can move themselves [14].

Based on the discussion above, it is important to develop a colour and shape learning media for kindergarten students. The media should not be implemented by using a smartphone due to the side effect of this devices.

2. METHOD

The development model applied in this learning media is to use the Research and Development (R&D) method. Sugiyono (2012) explains that Research and Development is a research method used to produce certain products along with testing the effectiveness of these products [15]. Meanwhile, Borg & Gall explained that Research and Development is a research method used to develop or validate products used in education and learning [16]. Based on these two opinions, it can be concluded that Research and Development is a research method used in developing a product so that the results of the validity and effectiveness of the product that have been developed will be obtained.

In development research using the Research and Development method, there are 10 stages that must be passed, including: (1) potential and problems, (2) data collection, (3) product design, (4) design validation, (5) design revision, (6) product testing, (7) product revision, (8) usage trial, (9) product revision, and (10) final product.

2.1. Collecting the Potential and Problems

This stage is used by the team to collect the information that will be used in the development of learning media, starting from collecting the requirement, developing the designs, and how to implement the devices. This development activity is carried out by cooperating with a partner, namely Kindergarten of Elbaith Rif'a Islamic Happy School, located in Kedungkandang Village, Kedungkandang District, Malang City.

There are very few educational learning tools at Elbaith Rif'a Islamic Happy School, so teachers have to create and provide tools for learning. So that the concept of interactive play group children's education is no longer a guideline for implementation. Teachers do not take advantage of the items around them for supporting learning facilities. APE depends on finished goods which of course need to be expensive. Even though Elbaith Rif'a Islamic Happy School is not profit oriented so that the fulfillment of APE's needs for learning is very minimal. In general, the problems that exist in this program are how to make and use electronic tools to learn colors and shapes for students of Elbaith Rif'a Islamic Happy Schoolas an effort to provide interactive learning media without having to use a smartphone.

2.2 Design of the Product

An overview of the science and technology solutions offered is shown in the following block diagram:

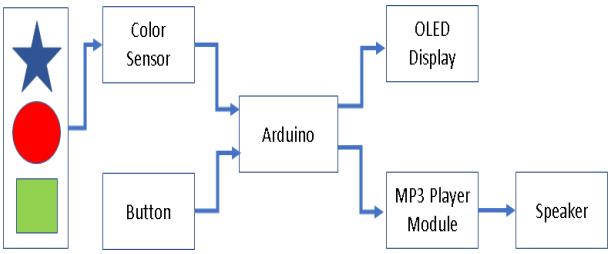

Figure 1 The block diagram of the product.

The TCS230 colour sensor is a colour sensor that is often used in microcontroller applications for the detection of an object or the colour of the object. Arduino Nano is a series of microcontrollers that uses ATmega328 so that it can process information and process data from sensors and other devices like a small computer. DFPlayer is an MP3 player module for Arduino which has a small size and its output can be directly attached to the speaker. The button is used to choose the menu which the device will operate.

This device is used by inserting a card into the slot available on the front of the device. The card used has a special design measuring 5 cm x 10 cm. All the backs of the cards are given a certain colour, while on the front of the cards there is a shape drawing of the same colour as the back of the card. When the user inserts the card, the colour sensor will detect the colour from the back of the card being inputted and send data to Arduino. The data from the sensor will be processed by Arduino according to the program that has been made to determine the colour and shape based on the colour of the back of the card. The Arduino will send a command to DFPlayer connected to a mini amplifier to output a sound indicating the colour or shape of the card. The colour of the back page, shape, and the colour of the shape of each card is shown on the Table 1.

Table 1. Colour and Shape Design of the Card

No.	Colour on the back page	Shape	Colour of the Shape
1	Grey	trapezoid	Grey
2	blue	star	blue
3	brown	oval	brown
4	light green	square	light green
5	dark green	triangle	dark green
6	black	rectangle	black
7	red	circle	red
8	pink	kite	pink
9	orange	Pentagon	orange
10	purple	heart	purple

On the front of the device, there are four buttons that function to select the menu that these devices can use. The menu is learning to recognize colours, learning to recognize shapes, quiz to recognize colours, and quiz to recognize shapes. When the user selects the learning to recognize colours menu, the user will be asked to enter any card and the device will say the colour of the card. The structure of the menu of the software used in this device is shown in the following figure.

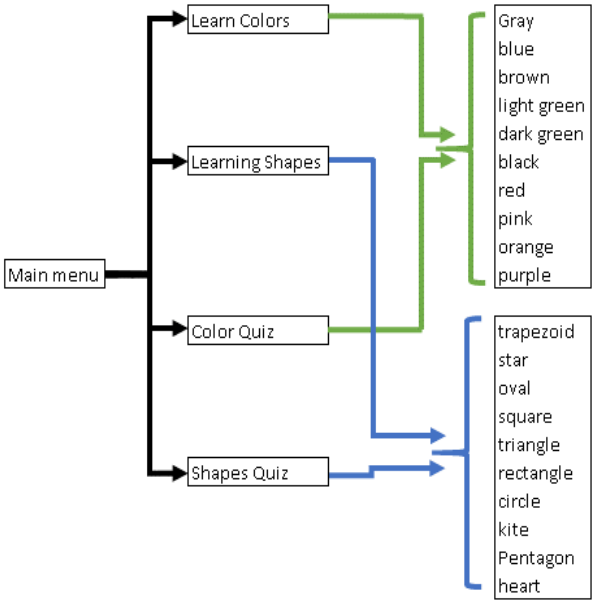

Figure 2 The Structure of The Menu.

When the user selects the learning to recognize shapes menu, the user will be asked to enter any card and the device will mention the image of the shape on the card. When the user selects the colour recognition quiz menu, the user will be asked to enter a card whose colour has been mentioned by the device. If the user inserts a card with the correct colour, the device will make a "you are correct" sound, otherwise the device will make a retry sound. When the user selects the shape recognition quiz menu, the user will be asked to insert a card whose shape has been mentioned by the device. If the user inserts a card with the same shape image, the device will make a "you are correct" sound, otherwise the device will make a retry sound. On the quiz menu, the colour and shape that mentioned by the device is randomly chosen.

3. RESULT AND DISCUSSION

The sensor used to detect colour is the TCS3200 sensor, which is connected to a microcontroller in the form of an Arduino Nano. The menu mode is selected using a push button whose results are displayed using an OLED display. The voice used in this tool is recorded using google voice. The sound is stored on micro SD memory so that it can be played back via DFPlayer. There are 4 main menu modes, namely recognizing colours, recognizing shapes, colour quizzes, and shape quizzes. The developed device is shown on Figure 3.

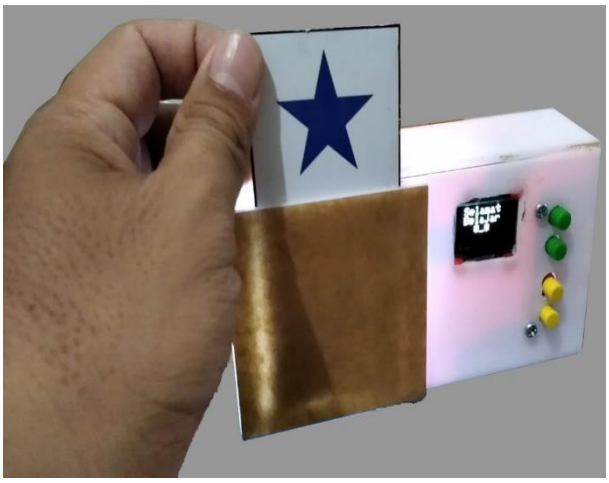

Figure 3 The Developed Device.

The cards used in this tool are made using printed paper with certain colours and images. Each card has the size of 5 cm x 10 cm. The card size is designed not too big enough to train children's fine motor skills. The back side of each card is filled with a certain colour, while the front side of the card has a shape with a colour same as the colour of the back side. The card design is shown on the Figure 4.

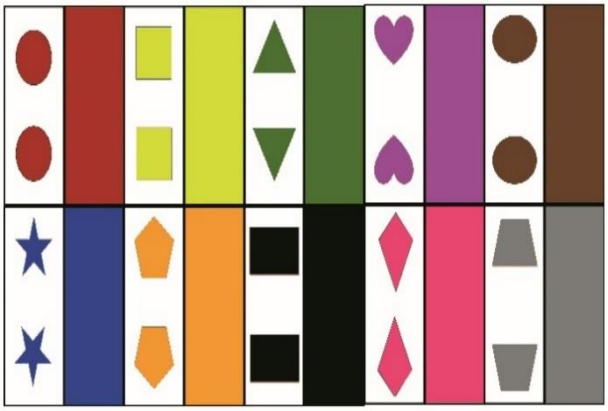

Figure 4 The Design of the Card for the Developed Device.

3.1 Device Testing

Device testing is done by testing each part of the device. The most important test in device testing is the colour sensor test because the working success of the colour sensor will determine whether the device can function properly or not. This test is done by inserting a card and reading the sensor readings. The test for each card was carried out 50 times. From the test results, the average and standard deviation of the colour sensor readings were calculated. The mean and standard deviation of the colour sensor readings are shown in Table 2.

Table 2. The Result of Colour Sensor Testing

#	Colour	Mean			Standard Deviation		
		C_R	C_G	C_B	C_R	C_G	C_B
1	Grey	790	712	892	3.57	3.03	3.99
2	Blue	649	640	1019	1.26	1.02	1.17
3	Brown	704	555	671	1.89	1.66	2.01
4	Light Green	1482	1310	986	5.44	4.49	3.58
5	Dark Green	647	655	718	1.28	1.35	1.52
6	Black	563	512	628	2.36	2.25	2.54
7	Red	1044	585	734	3.02	2.20	2.66
8	Pink	1545	660	926	10.11	4.20	6.09
9	Orange	1702	885	908	60.31	3.07	2.83
10	Purple	910	640	1012	1.94	1.53	2.14

The colour sensor test results show that the colour sensor gives an average reading of the red, green, and blue colour spectrum that varies between grey, blue, brown, light green, dark green, black, red, pink, orange, and purple. The highest reading of the red spectrum is produced by orange, and the lowest is produced by black. The highest green colour spectrum readings are produced by light green, and the lowest is produced by black. The highest reading of the blue spectrum is produced by blue, and the lowest is produced by black. The average range of sensor readings is 512 to 1702. The highest standard deviation of the sensor readings is obtained from the red spectrum when the sensor reads orange with a value of 60.31. This standard deviation value is still much smaller than the sensor reading value, so it can be said that the sensor can work stably and can produce the appropriate output.

Testing of all parts of the device is done by testing the performance of the device for the learning menu to recognize colours and learning to recognize shapes. The quiz menu to recognize colours and recognize shapes was not tested because it was a development of the learning menu to recognize colours and learn to recognize shapes. Testing the learning menu to recognize colours and learning to recognize shapes is done by inserting each card into the sensor slot then listening to the sound produced whether it matches the colour or shape shown by the card. Tests for each card were carried out 10 times for colours and 10 times for shapes. The exact number of performance results is then calculated to determine the accuracy of sensor readings and system performance. The results of overall device testing that has been conducted is shown on Table 3.

Table 3. The Result of Overall Device Testing

#	Color	Shape	Accuracy
1	Gray	trapezoid	100.00%
2	blue	star	100.00%
3	brown	oval	100.00%
4	light green	square	95.00%
5	dark green	triangle	100.00%
6	black	rectangle	100.00%
7	red	circle	100.00%
8	pink	kite	90.00%
9	orange	Pentagon	85.00%
10	purple	heart	100.00%
Average			97.00%

The results of the overall device testing that were carried out showed that the resulting accuracy was 97%. The lowest accuracy is obtained in the test for the orange colour or the pentagon shape with an accuracy of 85%. This result is because the sensor readings for the orange colour give unstable results where the orange colour provides a fairly high standard deviation for the red spectrum. The pink (kite shape) and light green (square shape) colours still produce some read errors and provide 90% and 95% accuracy. Another colour or shape gives a stable reading. From the overall tool testing carried out, it can be concluded that the tool runs according to the design and all components work normally.

3.2 Product Implementation

This implementation activity is carried out in the form of a dissemination activity on the use of the tools that will be given to the kindergarten. This training activity is carried out using the lecture, question and answer method, and practice. The lecture method is carried out to provide an understanding of the theory and concept of the working principle of the tool. The question and answer method aim to increase understanding of the benefits of the tool and its working principles. While the practical method is carried out to practice the operation of the tool. The product implementation process is shown on the Figure 5.

The results of this implementation activity show that students are very enthusiastic about trying out the tools that have been developed. Of the 16 students at Elbaith Rif'a Islamic Happy School who participated in this implementation activity, all of them wanted to go forward to try out the tools that had been developed. These students learn to recognize colours and shapes by trying the learning menu to recognize colours and learning to recognize shapes. After trying the menu several times,

students can try the quiz on recognizing colours and the quiz on recognizing shapes. The results of trying the quiz menu recognizing colours and the quiz recognizing shapes, all students can choose the right card according to the questions given by the device.

Figure 4. The Product Implementation Process

4. CONCLUSION

As a conceptual model for these learning tools, the Research and Development (R&D) approach is applied. The learning media was developed using the Arduino, TCS3200 colour sensor, DFPlayer, and colour card. There are ten cards for the colours grey, blue, brown, light green, dark green, black, red, pink, orange, and purple in this colour learning device. There are ten cards for forming images in the shape of a trapezoid, star, oval, cube, triangle, rectangle, circle, kite, pentagon, and heart in the creation of this learning media. Unit testing has shown that the accuracy of the system for colour and shape recognition is 97 percent, which can be described as a really good score. Colour and shape learning media were applied at Elbaith Rif'a Islamic Happy School. The student feedback was very optimistic about learning colour and form by the use of this learning media.

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