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Abstract

Mathematics is an essential part of learning for all children especially in their early childhood stage. Besides that, a good and firm grounding in mathematics is also an important skill that can be applied in daily life. Therefore, children will start to learn numeracy in the first stage of learning mathematics because it can help them to improve their skills like problem solving, critical thinking and form the building blocks for higher math concept levels. The main difficulty is that children need something that can attract their attention and obviously they want something which is funny and enjoyable. The main purpose of having this project is to design an electronic-based educational game board that can teach kindergarten kids basic numbers through games using Arduino. This game board will be able to help the teacher to teach kids basic numbers and as well as enumeration of big and small numbers. The architecture of the game board is using Arduino UNO as the microcontroller that translates the code to electronic components execution. Moreover, this project is a new attempt throughout all the semesters. This game board is developed with a combination of hardware and software. The questions will display on the I2C LCD and the kids need to place the correct answer card on the board. If the answer is correct, the yellow LED will turn on and if it is wrong, the red LED will turn on. The game board contains 10 counting questions. The I2C liquid crystal display (I2C LCD) will display the questions and the instruction will display on smart phone by using the MIT application. In addition, this project needs to be tested in kindergarten whether it is helpful or not for the teacher and the kids. An interview session will be done with the teachers to collect the data. After analyzing the data, a statistic will be done as a reference for the future improvement of this project.

Introduction

Math learning is most exciting for children when hands-on manipulatives are combined. The purpose of learning mathematics in school is to put pressure on the reasoning and formation of students' attitudes as well as put pressure on skills in the application of mathematics (Alhaddad, 2016). Manipulatives give children physical illustrations of the numbers and counting concepts. Today, children have started to become familiar with gadgets and digital games (Ridhwan, 2020). The introduction of the electronic-based educational game board is

an alternative to help the teachers to teach math in a fun and easy way so that the children can have additional opportunities to practice these skills yet it will increase their confidence when working with math and number concepts. The focus of this project will be mainly on development of an electronic-based educational game board for teaching kindergarten children basic number through game using Arduino. Moreover, this project also studies and compare between the effectiveness of learning basic numbers through game using electronic-based educational game board and with the manual teaching.

Games

Games can be classified into several and almost similar categories. The samplings are included with adventure games, simulation games, competition games, cooperation games, programming games, puzzle games, and business management games (Dempsey et al., 1993; Dewi & Verawati, 2022; Kula, 2021; Jacobs & Dempsey, 1993; Liu et al., 2022; Syafii, Kusnawan, & Syukroni, 2020). A game which can fit into more than one group is common in real life. Basically, it is very important for a game to be classified as an activity and it must contain few basic characteristics. Games may involve an element of chance or imaginary. Competition is included in a game, either with computer or others. Bright and Harvey, (1984), Dempsey et al., (1994) and Malone (1980) stated that games can be instructional or not, they can be interactive or not, and they can be computer-based or not. Referring to Lepper and Malone (1987), Malone (1980), Malone (1983), Malone and Lepper (1987) and Malouf (1988), quality games are fun, motivating, as well as propose the exact amount of challenge. Games which successfully help in learning process have the additional characteristic of enhancing skills or knowledge.

Benefits of Educational Games

The research of Dempsey, Lucassen, Gilley and Rasmussen (1993) proves that gaming in different methods can inspire and energizes learners. Other than that, it can also improve thinking and reasoning skills (Mayland, 1990; Rahimi, Shute, & Zhang, 2021; Rieber; Wood & Stewart, 1987; Toprak Yallihep, Akcay, & Kapici, 2021; Yasar & Kiyici, 2021; Ye et al., 2021). Games can also improve retention which is defined as ability to recall back facts and figures in memory. Research proved that games can demonstrate more retention over time. Students also responded that they have more interest game activities than conventional classroom instructions. Besides, gaming elements which contain challenge and curiosity able to increase motivation.

Improve Higher Order Thinking Skills

According to Oxford and Crookall (1988), organizational strategies such as paying attention, self-evaluating, and self-monitoring, affective strategies like self- encouragement and anxiety reduction, memory strategies which are imagery, grouping and structured review, and compensatory strategies like guessing meaning logically can be improved when learning through games. In fact, games which combine multimedia in education can enhance higher order thinking skills. Games can ease learning process through structured discovery and motivate students (Adipat et al., 2021; Kucher, 2021; Paulson &Burggraf, 1994).

Paper Submission Criteria

The game format should be motivating, challenging and contribute elements of fantasy as well as curiosity (Malone, 1983). According to Lepper and Malone (1987), activities that which can attract interest of user will make them willing to spend more time on it and produce a better quality of learning. Besides, user can practice more when they spend longer time on the task that has interest on it. Gaming elements that contain challenge and curiosity can increase interest and motivation of user.

Effects of Practice and Feedback

Computer-based educational games always designed in a tool and practice format. Good design computer games are useful for consistent practice. On the other hand, games also required some interesting contents so that user will not be lost interest as well as motivation. Designer and developer should design the games that can fulfils different type of users. They will also consider the behaviorism of the users and produce almost error-proof practice. Besides that, they will design some practice experiences that enable the user to learn from mistakes when they misunderstand the learning content. Feedback can be indicated by text, sound or graphics. It is a vital element of practice because it allows user to evaluate their learning progress.

Methodology

The methodology of this project has mainly two part which is the hardware development and the software development. The control unit central for the whole system of the project is using Arduino UNO. Besides, the Radio-Frequency Identification (RFID) card and reader used as the mechanical work to perform game.

Hardware Development

The design of the educational game board consists of I2C LCD, RFID reader, red and yellow LEDs and Arduino. When the input signal from RFID card has been detected by RFID reader, Arduino will send the output signal to LCD to display answers and will turn on the LED.

Figure 1. Installation of Microwave Moisture Analyzer

Software Development

The software used to develop the program coding is Arduino IDE. The coding of the program ensures that the game run smoothly and display the outputs.

Results

Comparison between expected result and actual results based on different scenario

Table 1 shows that the scenario happens to the game board by seeing the comparison of the expected result and the actual result get after finishing the development of the Game Board for Teaching Kindergarten Kid Basic Number through Game using Arduino. It clearly shows that we achieved the result as expected and the game board are working as the objective. From Table 1, player can play the game board by answer the question that appear on the LCD by tapping the correct RFID card labelled with basic number to game board. The question of the game board can be set according to the level of education of the player. Where in this project our focus is for kindergarten kid to know and learn basic numbers in mathematics interestingly through game method.

Table 1. Comparison between Expected Result and Actual Results based on Different Scenario

No	Scenario	Expected Result	Actual Result
1	When the educational game board connected with the power source which is power bank.	The TFT LCD will display the main default menu.	The TFT LCD will display the main default menu: WELCOME TO COUNT HOW MANY A!  
2	After 5 seconds.	TFT will display the question.	TFT will display the question.  

3	When the user placed a correct answer card.	Yellow color LED will light up, LCD will display "You are correct" and proceed to next question.	Yellow color LED will light up, LCD will display "You are correct" and proceed to next question.  
4	When the second user placed a wrong answer card.	Red color LED will light up, LCD will display "You are wrong" and proceed to next question.	Red color LED will light up, LCD will display "You are wrong" and proceed to next question.  
5	When all the questions are answered.	TFT LCD will repeat the questions from the beginning.	TFT LCD will repeat the questions from the beginning.  

Result Analysis based on Survey Questions

This survey is done to collect data from 30 respondents to do further analysis regarding the educational kit. There are total 5 questions that needed to be answered. The respondents are kindergarten teachers from different kindergarten based in Kuala Lumpur. Teachers and kids are required to use the kit before answer the questions. The demonstration and trial time given to the respondent are 15 minutes to 30 minutes. This survey is done using Google form and the results are tabulated in pie chart and bar chart. The pictures below shown the questions that verified educational kit will help students to learn basic numbers in a more effective way compared to theoretical way.

Question 1: Do you agree that edutainment can apply in learning process?

Figure 2 represent a pie chart generated from responses for Question 1. The purpose of this question is to know whether the teachers agree that edutainment can apply in learning process or not. Based on the observation, there 87% of teachers agree with the statement, 11% disagree and 2% felt that maybe edutainment can be applied in learning process. Majority of the respondent is agreed with Question 1.

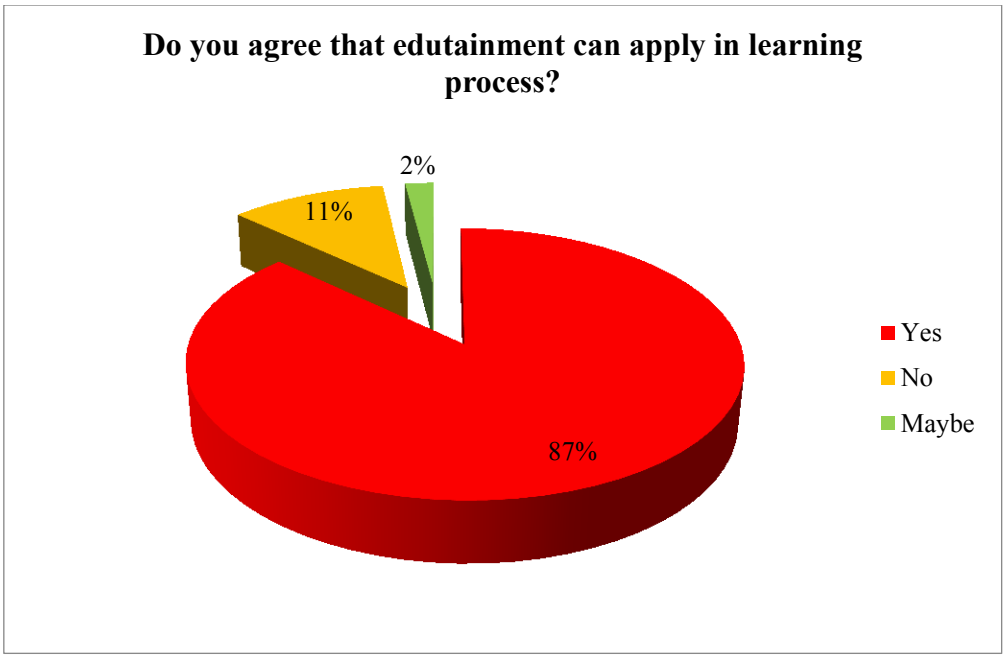


Figure 2. Responses for Question 1

Question 2: Do you feel that teaching kids to learn basic numbering with the manual way is effective?

Figure 3 represent a pie chart generated from responses for Question 2. After analyzed the results we collected, there are 57% of teachers agree with the statement while 43% of them felt that teaching kids to learn basic numbering with the manual way is not effective. Most of the respondent answered no for Question 2.

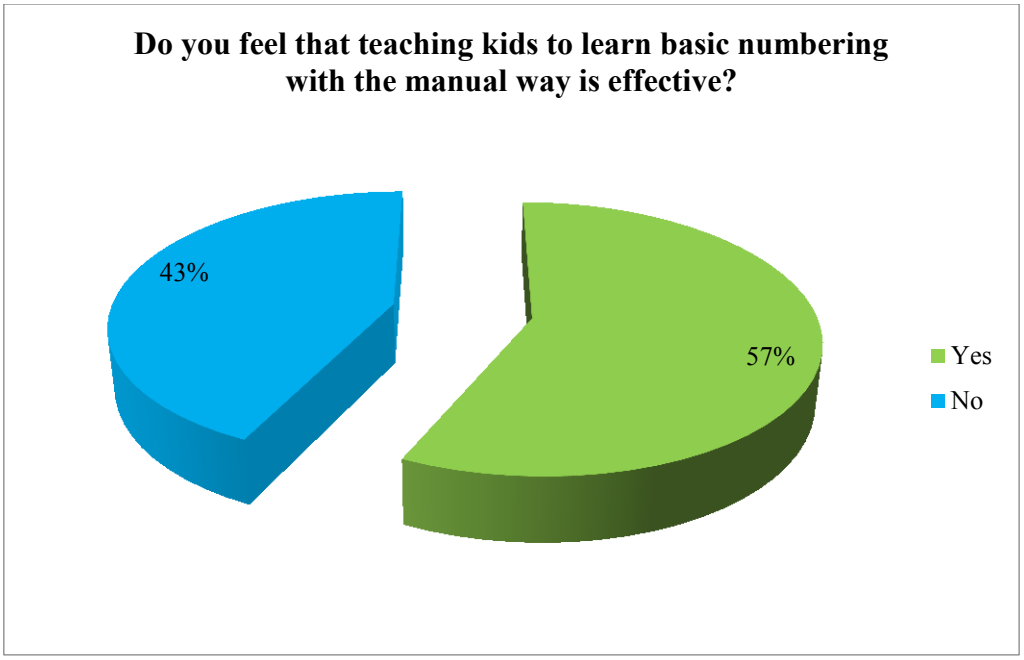


Figure 3. Responses for Question 2

Question 3: Do you feel that teaching kids to learn basic numbering with educational game board is effective?

Figure 4 show the data that has taken from respondent for this question. Referring to the results, 97% of the respondents agree that educational game board can teach kids to learn basic numbering effectively. This is because they believe that kids can learn better when entertainment elements are added into knowledge.

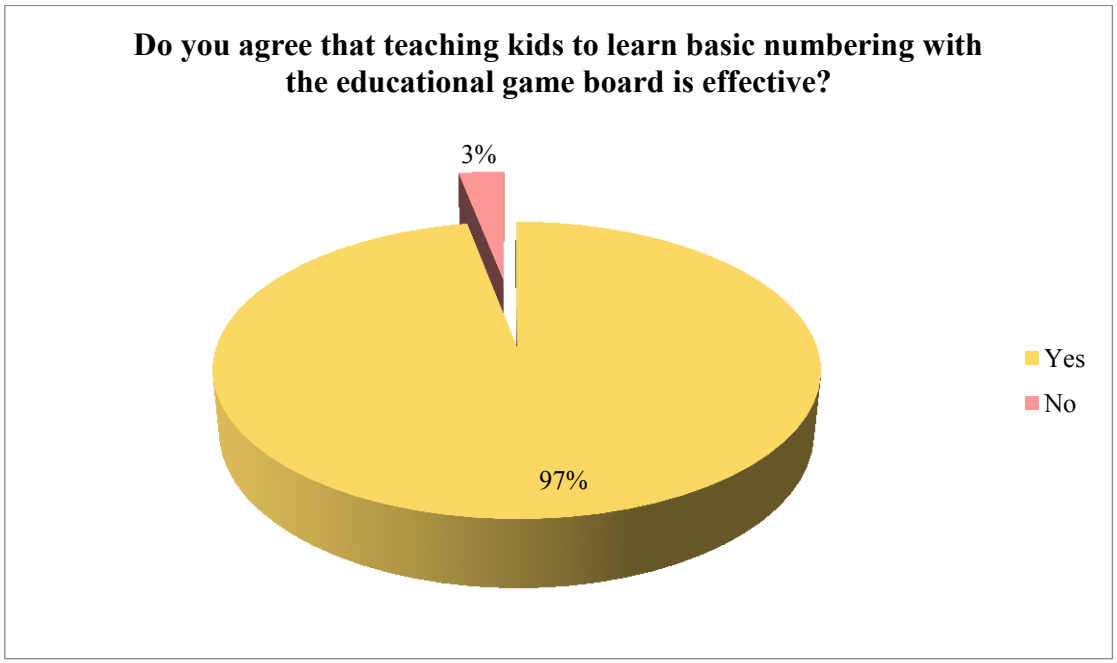


Figure 4. Responses for Question 3

Question 4: After you taught the kids with the game board, do you feel that it helps kids to improve their learning in numbers?

This question is about the did the teachers feel that educational game board helps kids to improve their learning in numbers after they taught them with the aid of game board. Based on the result on survey question, 93% of the respondent agrees that the educational kit can helps kids during their learning session (see Figure 5).

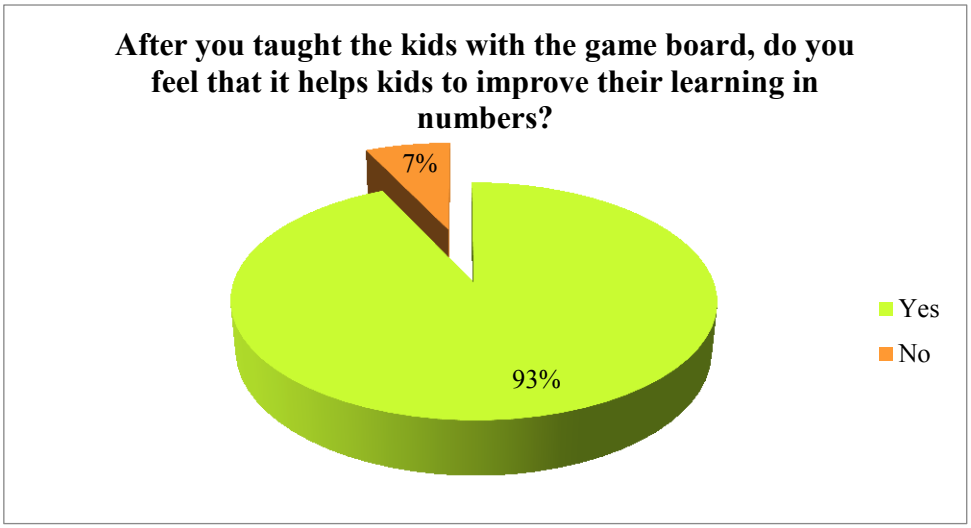
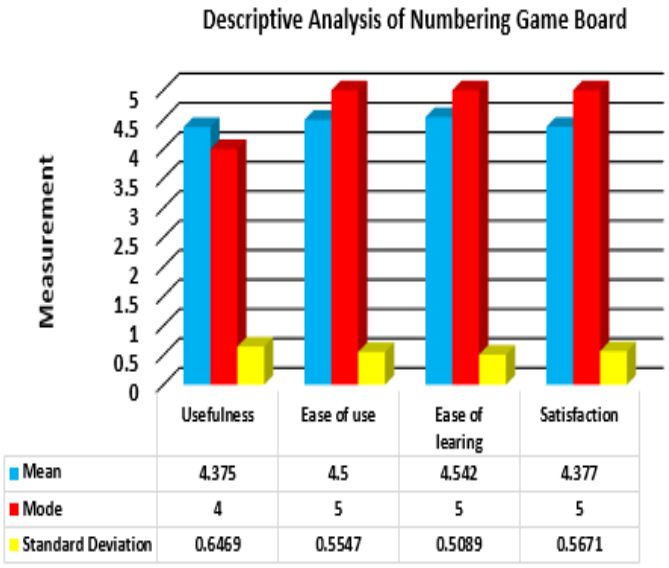


Figure 5. Responses for Question 4

Descriptive Analysis of Numbering Game Board

Figure 6 shown descriptive analysis of numbering game board. The measurement for this question is from 1 to 5 where 1 is strongly disagree and 5 is strongly agree. The mode response for usefulness of the game board is 4, for ease of use is 5, for ease of learning is 5 and for satisfaction is 5.



	Usefulness	Ease of use	Ease of learing	Satisfaction
Mean	4.375	4.5	4.542	4.377
Mode	4	5	5	5
Standard Deviation	0.6469	0.5547	0.5089	0.5671

Figure 6. Installation of Microwave Moisture Analyzer

Conclusion

The main purpose of educational game boards is to teach kindergarten kids basic numbers through games so that they can learn in an enjoyable way. Besides, it also attracts their attention and increases their interest in numbers. This had been done by asking them to play the number game using the game board. When the player places the correct answer card on the game board, a yellow LED will turn on. If the answer card is wrong, the red LED will turn on and proceed to the next question until question 10 and back to the first question. The game is to teach them enumeration of big and small numbers.

Moreover, the game board also helps to train their higher order thinking skill and problems solving skill. Hence, they can have a firm foundation in basic numbers before they are introduced to advanced mathematics. The outcome of the project is to prove that the effectiveness of learning basic numbers using the educational game boards is bigger compared to the effectiveness of learning through the traditional way of teaching. It will not create a boring circumference for the kids while learning in the classroom. All the objectives of the project have been achieved successfully.

Recommendations

There are some recommendations and ideas that can be suggested for this project so that it can be improved in the future for better results of the product. Firstly, the educational game board can insert more functions such as different types of games that can be played with the board. This can make it multiple functions. Besides, the design of the game board also can be enhanced for better attraction. For example, colorful LED can be added to the outer layer of the game board. Other than that, a better quality of materials can be used so that the educational game board is more durable. This is because better grade materials can make sure the game board has a longer life span and it can also reduce the cost of maintenance.

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