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by Bintarti Bertha

Designing Educational Robots (Edot) as Space Learning Logic and Spatial Media

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Keywords: Educational Robots, Learning Robot Design, Robot Toy, Simple Logic.

Abstract: The Edot educational Robot is a robot for early childhood, which can be played by children from the age of 5 years. Learning with technology media including robots will help children actively engage in learning. Learning for children will be more interesting if they learn while playing. Technology will grow rapidly in the future, therefore it is necessary to prepare a generation that is able to keep up with technological developments. The introduction of technology needs to be started since early childhood. One of the media is an educational robot. This educational robot was developed to help children in the following matters: 1. Explain abstract concepts about STEM (Science, Technology, and Mathematics) and logic 2. Teach the ability to understand the spatial scope of space. This educational robot named Edot is expected to children learn about how to "program" in a simple way that is learning to plan direction from one place to the destination by arranging the direction block card. By planning directions, children learn how to compile orders for Edot who will "read" the commands and carry out according to the instructions that have been prepared. Besides learning to program, Edot can be used to train cooperation skill for children when playing together. Learn to know the environment, learn to sharpen and practice logic thinking.

1 INTRODUCTION

Robots are technologies that are increasingly developing in an increasingly broad scope, not only in industry but also in the scope of everyday life. Educational robots are media to help tp learn with certain specifications embedded in their learning goals. Educational robots are as a medium of exploration for learning through experience. Experience will be easier to remember, understand and then it will be easier to develop in accordance with the level of learning education.

Through learning experiences that are happily obtained, the children will be actively involved so that teachers, mentors, and parents play a role as facilitators and study companions. Therefore this educational robot is designed to be treated as a learning medium through play.

Playing is a learning method while gaining experience. Games performed in a group can teach various aspects of daily life. By playing, eating experiences related to the social, cultural, economic and physical or natural environment will develop. The development of these relations will improve language skills, thinking, behaving, associating and working. When playing children - children will focus their attention, feeling and thinking to play to the nature and shape of the game. (Khohir, December 2009)

Basically, an educational robot is designed to convey learning that is determined according to the needs and age of the child. In this Edot robot learning is designed to be carried out by early childhood, such as Kindergarten and Playgroup so that there are certain requirements related to the design standards of playground equipment related to technology and standard to security.

In addition, designer must consider the basic rules set in safety standards; in applying standards on toy safety, safety signs or graphic symbols for age warning labels, standards for robots and robotic systems, and electric toy security, mechanical safety features and physical, flammable requirements, specifications for the transfer of certain elements, experimental sets for chemistry and related activities and chemical toys in addition to experimental games. (Mouroutsos, 2012)

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The robot design for learning media is adjusted to the development needs of children in kindergarten and Playgroup ages, ranging in age from 4-5 years. Therefore needs media to develop the ability of children aged 4-5 years according to the Directorate of Early Childhood Education (2002) is as follows paying attention to nine children's learning abilities, such as: 1) linguistic intelligence; 2) logic-mathematical intelligence; 3) visual-spatial intelligence; 4) musical intelligence; 5) kinesthetic intelligence; 6) naturalist intelligence; 7) interpersonal intelligence; 8) intra-personal intelligence,and ; 9) spiritual intelligence.

Learning using this educational robot aims to help children learn about simple logic programming, mathematical logic, and spatial visual logic. In addition to the cognitive aspects, children by playing will train their psikomotor skills when arranging objects or installing parts of a robot. The game using educational robots is carried out in groups so that children practice how to socialize, train their emotional intelligence and social intelligence. They must work together, discuss together, and help each other to solve problems.

2 SPATIAL VISUAL MAPPING LOGIC

Learn about visual and spatial sensitivity in children, especially since an early age because this intelligence is needed when children begin to recognize their environment. Visual and spatial intelligence is the ability to view space. With this ability, the child will have a perception of objects that can be seen by the five senses. These capabilities include understanding objects, colors, and space and transforming objects seen in other forms, such as sketches, paintings, and views of geometric space. The ability to perceive geometrically is one of mathematical-logical intelligence. The ability to understand geometric is needed when working with measurements, mapping and imagining space in three dimensions. Whereas according to Piaget & Inhelder: Yilmaz, 2009 ((Alimuddin, 2018) Spatial ability is the ability to understand abstract concepts that include the relationship of understanding the position of objects to space, determining the reference position of objects in space, the ability to see objects from various angles, the ability to estimate distances, and imagine the movement of objects in space.

The learning aapproachment is giving problem-solving tasks to spatial visual logic with games using edot robots. Simple programming logic is done using a method of reading towards a simple symbol of direction. The problem with spatial understanding is given with a pictorial map media that shows the origin of the object and the final destination of the object.

Learning to use robots will help understand abstract concepts of mathematical logic and spatial logic. This educational robot is a teaching medium for teachers and parents so that children are not only listeners but actors. Educational robots are also an introduction to children's knowledge about technology. Children will be actively involved in problem-solving and learning ideas from computer science, and robotics, including the basic concepts of computational thinking.

Robots are the introduction to the concepts of Science, Technology, Engineering, and Math (STEM) for early childhood. Referring to learning standards it is necessary for early childhood to recognize new technologies so that they should integrate technology into the early childhood education curriculum.

3 COMMUNITY RESPONSE

Surveys conducted to find out responses about the use of robots for children's learning media can be grouped as attributes specified in the robot.

Table 1: Educational Robot Attribute Ideas from the community.

No.	Attribute	Description
1	construction	motors, batteries, frames and boards can be assembled for children of the child / Robot can be assembled Assembling parts must be safe / Form not sharp angles
2	Command button	there is an on-off button on the robot in the "programming box" there is a run button to send the program to the robot
3	Battery	Batteries are easy to find/replace the battery can be charged
4	Program	the robot can detect when in the finish box (there is a finish indicator box the program consists of forward, right turn, left turn, sub-program, active magnet, and inactive magnet
5	Size	robot size length = 10 cm width = 10 cm

		12x12cm robot track size grid
6	form	interesting form interesting track shape
7	sound	ruled by voice additional sound according to the direction additional songs if the robot successfully orders
8	accessories	the robot has a sound indicator led lights as a robot face A camera on a robot the robot body is given a light The arrow is lit. The Color on a robot
9	Additional	robots can do matches, soccer Need to add challenges Need English Robot mobility is more flexible

4 STANDARD REGULATIONS REGARDING EDUCATIONAL ROBOTS

Designing tools and toys that use technological elements, which is using motion or Mechanicsm, using electrical resources as a driver and using computer technology related to interfaces and program systems have their own regulatory standards. From the list of rules below are selected from the standard regulations in Chiasson and Gutwin (HCI-TR-2005-02) which are in accordance with the educational robot designed. These regulations include this following belows: The interface must be very visual, avoid text as much as possible and reduce cognitive load. 2. Special content metaphors are useful in helping children navigate the interface. 3. Instructions must be presented in an age-appropriate format. 4. Instructions must be easy to understand and remember. 5. Children are impatient and need immediate feedback indicating that their actions have an effect; otherwise they will repeat the action until some results are felt. 6. The interface must provide structure tools and guidelines to help children remember how to do tasks. 7. Activities must allow expanding complexity and must support children when their skills increase from one level to the next in the use of products. 8. Icons must be visually meaningful for children. 9. Rollover audio, animation, or lights must be used to show where to find functionality. 10. The interface must provide an indication of the current system condition, whether it is busy processing or waiting for input from the user 11. The interface must track and display children's environmental exploration if it is important for them to remember where they were before. 12. The interface needs to consider the fact that children may not understand abstract concepts. 13. Interfaces may not use extensive menus and sub-menus because children may not have the ability to categorize or have the knowledge of the content needed to navigate efficiently. 14. Children are familiar with direct manipulation interfaces, their actions must map directly to actions on the screen. If other styles are used, estimate that most users will need training and that some will not be able to understand how this interaction works. 15. Make interactions as simple as possible. 16. Make all buttons have the same function. 17. Items must be large enough and within each other to compensate for some inaccuracies in targeting. 18. Children like a real interface because they like being able to physically touch and manipulate devices. 19. Direct manipulation allows children to explore and actively participate in the process of discovery. 20. Physical teaching aids and having large input devices encourage collaboration. 21. Small changes in design can produce very different physical interactions. Different interfaces emphasize different actions. 22. Technology must give children the ability to define their experiences and control interactions .23. Providing entertainment keeps children engaged and motivated during the learning assignment. 24. Activities must be interesting and challenging so children want to do it for themselves

25. A supportive gift structure that considers the level of child development and the context of use helps children stay involved. 26. Technology for children must facilitate social interaction between children. 27. Technology for children must explain children's beliefs about computers and interact in a socially consistent manner. 28. Give children each their own tools when collaborating to encourage participation and cooperation. This also leads to greater user satisfaction.

5 REVIEW OF EXISTING EDUCATIONAL ROBOTS

Robots have been used as learning media for children and many are available in the market. The robot is used as a reference to review the workings and purpose of learning as a reference for designing this educational robot.

The design and system references used by several types of robots as written in table 2, concluded as the easiest system to be created, ease to used by children, is the RFID card reading system. The RFID reader is simpler because of direct reading so that after the robot reads the received signal it will turn on the motor driver to actuate the robot to moves. This easy system will be easy for children to understand because the immediatly reaction after reading the code on the card will immediately seen the difference. Instructions for directing and operating the robot are simpler. With easy instructions and operations, children can play by them selves.

6 DESIGN METHOD

The design method uses a morphological chart method by applying a combination of components using morphological maps. Alternative choices are selected based on the criteria used as specifications for the educational robot. Before making a morphological chart, the components that will be part of the robot are determined so that the robot can be assessed and in accordance with the specifications of the educational robot needed. Therefore needs will be determined as a criterion for their specifications. Determination of specifications through identification of educational robot needs.

6.1 Identification of Needs

The need for educational robots in accordance with the target users, namely early childhood based on the results of interviews selected according to the ease and technical feasibility of the implementation, requires the main things as follows.

Table 2: Educational Robot Specifications.

No.	Spesifikasi	Kriteria
1	Simple, attractive shapes and colors	W
2	Easy to operate	D
3	Give target learning about programming logic	D
4	Give target learning about spatial logic	D
5	Has an interactive element	W
6	Can be done in groups	W
7	Can be developed for other learning	W
8	Safe to play	D
9	Easy to install and install	W
10	Affordable prices	D

Note :
W = Wish
D = Demand

6.2 Technical Specifications

From the reference review of existing educational robots, the use of separate program boards with robots requires complex technicalities. Relationships or connectivity between program boards and robots are needed Wi-Fi or Bluetooth. The program board is the sender/transmitter while the robot is the receiver. In the Bee and Mouse robot the program system is easy, but the program results cannot be seen, because it is based on the number of presses on a particular direction button. With the ability of robots to remember, a large enough dimension is needed. In kubo robots, the system of readings and reminders is a complex system. Running steps must also be two steps.

With consideration of convenience, simplicity and affordable prices, the selection of RFID systems was chosen to make this educational robot. Reading using RFID is a simple and relatively cheaper mechanism. With a simple system it will be easy to make, and still allows for further development

6.2.1 Technical Design

The technical design takes precedence so that the suitability of the system that will be applied to this educational robot can function and execute orders according to the concept of an educational robot that uses RFID control. The complexity of robots is mainly only in the placement of its components. With consideration of PCB layout, component size, and interface between components, it will help determine the shape of the casing or the appearance of the robot.

Power supply / power supply. A 5V DC power supply is supplied to a system that is converted from a 230V power supply. First, the step down transformer will be used here to convert the 230V AC to 12V AC. The microcontroller will only support DC supply, so the AC supply will be converted to DC using a rectifier. The output of the rectifier will have a wave so the 2200 uF capacitor is used to filter the wave.

The output of the filter is given to the voltage regulator 7805 which will convert 12V DC to 5V DC. The output of the regulator will be filtered using 1000uf capacitors, so that pure DC 5V gets as the output of the power supply unit. The microcontoler used is the Arduino Nano microcontroller.

Microcontroller. The microcontroller is a device that can process analog and digital signals (Budiarso & Prihandono, 2015). In this design, the microcontroller used is Arduino Nano. This microcontroller is used to read RFID tags through an

RFID card. The results of reading the identity in the RFID tag will be processed by the microcontroller. The results of processing these signals will determine the movement of EDOT according to the program that has been written in the microcontroller. Arduino Nano was chosen because it has small dimensions when compared to Arduino UNO but has specifications similar to Arduino UNO.

Figure 1: Arduino UNO dan NANO.

Sensor Unit. The sensor used in the robt EDOT is an RC522 RFID reader sensor. Radio Frequency Identification (RFID) is a technology used to detect objects by utilizing radio frequencies used to emulate modulated electro-magnetic waves (Hamdani, 2014). These waves will be emitted by the reader (RFID Sensor RC522) which will activate RFID tags that have been filled with a certain identity. This identity will be read by RFID sensors wirelessly without being affected by existing environmental conditions such as light or barrier objects. The workings or readings of the sensors are illustrated in the figure below.

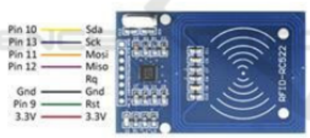

Figure 2: Sensor Reader RFID RC522

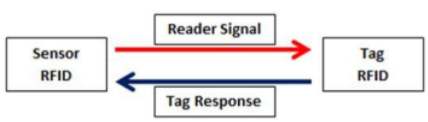

Figure 3: Read method of tag RFID by RFID Sensor

Tag RFID. The RFID tag is a device consisting of electronic circuits in the form of a microchip and an antenna that is integrated with the circuit as shown in the figure below. Memory on the RFID Tag makes this tool capable of storing data in the form of a unique identity (Rerungan, Nugraha, & Anshori, 2014). There are two types of RFID tags based on their identity data, Read Only and re-Writeable. In general, RFID tags have a unique identity for certain needs.

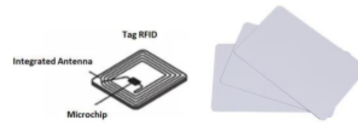

Figure 4: Tag RFID structure

Motor Driver. Motor driver is a device or electronic component used to control a DC motor. The parameters that are controlled are the direction of rotation and the speed of the motor. The driver motor used is the L298N type. An L298N can be used to control 2 DC motors at once. This type of driver is able to drive a DC motor with a maximum voltage of 40 V DC and 2A current on each channel (Adriansyah & Hidyatama, 2013). The L298N driver scheme is as shown in the image below.

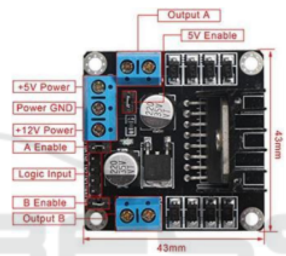

Figure 5: L298N motor driver

6.2.2 Electrical Scheme

The electrical scheme uses a chart as shown in the image below.

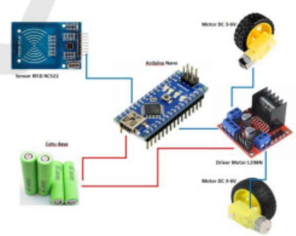

Figure 6: EDOT Electrical Scheme

6.2.3 Layout Analysis Series

Electrical schemes are then arranged with an efficient layout so that the robot dimensions meet the desired size standards. The pattern of compiling electrical components not only pays attention to the location efficiency of functions, but also from security. Lay out for edot robots has four layers, namely sensors, drive systems, control systems, voltage sources (power supply).

Figure 7: Lay-out Sistem EDOT

6.2.4 Mechanism

The way the robot is designed is as follows when an RFID reader sensor receives identity coding, a program that has been inserted in Arduino as its microcontroller will trigger the motor drive as an actuator to move the motor on both wheels. This microcontroller will adjust the speed of motion of the right and left wheels, according to the coding identity that they read.

6.3 Morfological Chart

Morfological chart or referred to as a morphological map, is a table to make it easier for designers to get alternative concepts of educational robots that are sorted according to the division of components. The sorting is based on existing robot references as a reference. The combination of several components into one educational robot unit that fits the criteria in the specification, or has the expected attributes.

6.3.1 Morphological Map

This morphological chart is arranged by division according to the following attributes: Forms, additional working mechanisms, accessories and technical.

Table 3: Educational Robot Specifications.

Component	Alternative A	Alternative B	Alternative C
1. Shape			
	Alternative D	**Alternative E**	**Alternative F**
2.Mechanism (RFID)	Arrange the program or path directions	The map has been determined, the arrangement of directions has been determined, just choose the start position and then run it	Arrange the path into the map then run it
Assecories 3.Lampu	**Alternative G** LED on when running	**Alternative H** the flashing light blinks for the eyes	**Alternative I** LED switch on while run and Off when stopped
4.Sound	**Alternative J** Sound active when running	**Alternative K** the sound active if the task is complete	**Alternative L** Sound active when strat and off when stopped
5.Color	**Alternative M** Casing color is neutral for robot	**Alternative N** Color combined for the robot body and top	**Alternative O** Color can be customized
Adding Technics	**Alternative P**	**Alternative Q**	**Alternative R**
6.Assembling	Knock Down	Only certain part can be knock down	Built in except the batteries
7.Product Properties	**Alternative S**	**Alternative T**	**Alternative U**
	Path directions on cards	Path direction card include a casing in puzzles shape	Direction Path have sticky stickers
	Map with specific theme	Included symbol thing example: house model, signange, flags, etc	Equipped with instructions for developing the goal as needed

6.3.2 Morphological Map

Alternative design is a combination of possibilities on the morphological map above. The selected combination has the following criteria. 1. The shape of a square box with the ease of unloading only on the battery. 2. The color of the robot at the top can be replaced. 3. Robots are operated directly on the cards that have been arranged. 4. The light as an indicator lights up, on the front as the eye. 5. The sound indicates the command is complete. 6. Equipped with an RFID card equipped with a card case. 7. Equipped with instruction instructions for development as needed.

Table 4: Educational Robot Specifications.

atribut	pilihan	pilihan	pilihan
1	A	B	C
2	D	E	F
3	G	H	I
4	J	K	L
5	M	N	O
6	P	Q	R
7	S	T	U

So the combination obtained is 1B, 2F, 3G, 4K, 5N, 6R, 7T. Robot sketches are drawn and selected and then drawn using SOLIDWORKS software, with adjustments to ease of drawing and ease of printing 3dimensions using 3D printer.

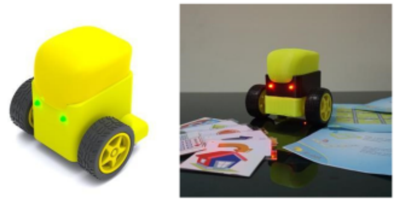

Figure 8: Robot Edot drawing (left) and Prototype (right)

6.3.3 Selections of Alternative Edot Robots Are Selected

Edot robots are designed with sizes 10 x 7 x 12 cm the size is a size that children can still hold easily. Robot weight approximately 250 grams. The material which used is PLA plastic. The top of the robot as a battery cover can be removed while the components and microcontroller are bolted so that it cannot be dismantled by children without the help of adults. The robber is attempted not to have sharp angles so as not to injure the children. The battery can be removed and recharged.

RFID cards are equipped with casing and have been identified with the identity of the direction to be used. In this case the Edot Robot was tested for learning program logic and spatial logic. The two learning targets are agreed to try by arranging the direction from the place of origin to a certain destination that the children want. The completeness of this robot is a map that can be arranged as needed.

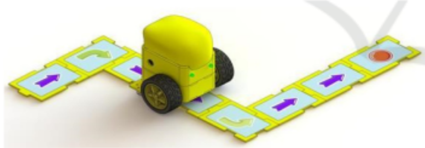

Figure 9: Edot reads RFID Tags

Table 5: Edot Robot Components.

Component	Description
	RFID card with the specified direction code identity, equipped with a direction symbol using a sticker on the card. The card has a puzzle shaped casing
	An RFID card with a Stop code identity as an order stop, equipped with a red circle symbol using a sticker on the card. The card has a puzzle shaped casing.
	DC motors are used by two each - to move the left and right wheels
	RFID readers are placed under Edot so they can read the magnetic frequencies emitted by RFID cards
	The icrocontroller layout is placed as efficiently as possible using restricted space, as the second layer
	The battery is placed as the third layer, with the battery housing. In this section Edot's head cover can be removed and reinstalled to facilitate battery replacement
	The back of the Robot has an ON-OFF button, which turns on the power supply and turns on the LED light as a robot's eye.

6.4 Evaluate the Results of the Trial

The edot robot prototype test was conducted at Ananda Mentari Kindergarten/Playgroup at Condong Catur, Sleman. Game trials are carried out by children aged 4-5 years.

Figure 10: Uji coba prototype Edot di TK Ananda Mentari

Trials are carried out as observations and answers to questions about things as follows: 1. Can the Edot robot be operated independently by children? 2. Can the robot be operational as expected? 3. Are there errors? 4. Is there an idea of the possibility of Development of the Edot Robot? 5. What is the interaction of children with the Edot robot? 6. In addition to answering a number of questions related to the specifications of the educational robot needed,as following belows: a) Simple, attractive shapes and colors, b) Easy to operate, c) Give target learning about programming logic, d) Give target learning about spatial logic, e) Has an interactive element, f) Can be done in groups, g) Can be developed for other learning, h) Safe to play, i) Easy to install, j) Affordable prices,

During the trial, children were gathered in a free classroom, 12 children were grouped into 2 groups who took turns playing the robot. Each prefix plays, the instructions for playing are briefly explained and demonstrated. During the game carried out by children, observations were made while at the same time capturing the responses of children and accompanying teachers through direct interviews. From the trial found a number of things as follows: 1. Preparation of programs to arrange direction signs can be done easily by children. 2. If done on the floor, the enclosed card causes delay in reading the RFID card, so that the Edot robot does not run smoothly. 3. The use of DC geared motors has a character that is not linear in its speed regulation so that the adjustment of the position of the wheel needs to be done delay settings through several trials. This delay also causes children to be impatient and choose to press the button repeatedly or push the robot forward. 4. With the position of the DC motor the "front" direction should be reversed, because it turns out that the position of the motor pushes the robot forward, so that the placement of the lit eyes should be reversed with the position of the ON/Off button. 5. The use of maps is not very important, because it can be played on a wide floor, by determining the place of origin with the purpose added to another card. 6. Development proposals to be developed for other learning, such as counting and language. 7. For robotic casings can be sold separately so that color combinations can be arranged by children, better if you use unique characters / animals. 8. For relatively affordable prices because the technology used is quite simple.

7 CONCLUSIONS

Learn with an interactive Edot robot for children could be the alternative to involve children learning something new. Children can be involved in groups to learn to work in teams. Easy operations make children interested in exploring as many possibilities as possible. Obstacles in the form of errors due to delays make children less patient so they tend to push the robot forward first. For the drive motor, it will be replaced with a DC geared motor with a lower rotation so that the resulting torque is greater and easier to control. The use of jumper cables is still not so neat so that in the future PCB will be used so that jumper cables are no longer needed, so it will be more sturdy, neat and safe. The mass replication of Edot robots is likely to be able to reduce prices for one Edot Robot unit. Furthermore, for the possibility of development can be done using the same system that is using RFID readings, but developed for different learning concepts.

Thus the development potential and potential of early childhood learning using educational robots is very good, it is necessary to develop the ability of educational robots for different types of learning so that it will be more interesting for children.

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