Remote Control Caras Physics Teaching Aids by Utilizing Recycled Wastes

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Abstract. This study aimed to determine the feasibility of a simple remote control car by utilizing recycled waste and to know the responses of students regarding the developed remote control car. This study used a research and development (R&D) method proposed by Borg & Gall adapted from Sugiyono’s development model. The data of this study were obtained from the teacher's questionnaire and students’ responses, material expert validation, and media expert validation. The type of data generated is qualitative data that was analyzed based on the assessment criteria to determine the product’s quality. The score obtained from the material expert is 80.59%, the score obtained from the media expert is 92.92%, the score from the teachers of three schools is 88.33%, and the score from the students in all schools is 82.50%. Based on the assessment of the material experts, the media experts, and the teachers, it can be concluded that the remote control car as physics teaching aids using recycled wastes suitable to be used as teaching aids.

1. Introduction.

Education is a process to influence students to adjust themselves as best as they can into their environment [1], then it can affect changes in individuals who function in social life [2]. Physics is abstract learning and it requires an approach that can facilitate the students to understand what is taught. Physics deals with how to study natural science through concepts systematically and facts obtained through discovery. Physics also plays an important role in producing new technology and it can even be said that technology would not exist without physics.

In the Islamic context, education and science are highly valued as Allah the Almighty states “And We did not send before you any (Messenger) but men to whom We sent revelation. So ask the owners of the Remembrance (Dhikr, those who repeat the Name of Allah continuously) if you do not know " (QS An-Nahl: 43).

The above verse explains that in teaching activities, a teacher must be able to apply all forms of ability so that in the learning process, the students could easily absorb the material. Qur'an itself is a source of knowledge and a source of inspiration for various scientific disciplines and technology.

Physics is a scientific discipline that has an important role in human life. Physics studies nature systematically, so physics is not only a collection of knowledge in the form of facts or concepts but also a process of discovery. Physics education is directed to help students to gain an understanding of the natural surroundings. The physics learners need to have a strong curiosity/criticality, attention and interest in learning physics, as well as tenacity and self-confidence in solving problems. If there are a
strong curiosity and high reasoning power in the students themselves, it will certainly help the physics teacher during the learning process.

On the other hand, technological developments are now experiencing very rapid progress. This development in several aspects has changed the pattern of people's lives [3]. A concrete example of the results of technological development is the emergence of remote control cars. Most of these products use sophisticated systems and tools. The remote control is an electronic device that is used to operate an electronic item remotely. Generally, the remote control is used to control certain items by giving commands from a distance. The use of remote control has been increasingly rapid [4]. A simple alternative if you want to make a remote control car is to use simple tools or even wastes that are certainly easy to find in everyday life [5], this alternative has a positive contribution in the progress of education [6].

Remote control car toys are still in great demand by the student. Usually, the life span of these toys is not long due to physics damage and the electronic system damage. In this study, the researcher designed a simple remote control car from used goods that can be found easily. It is not only fun, but it can also educate the student to recognize the control system and its assembly to enhance student's creativity in designing the tools to be installed. This tool can later be used by almost all circles ranging from student to adult as a media that can be developed to support learning in the classroom.

Teaching aids are defined as a tool to educate or to teach the concepts so that they can be easily understood by the students and become a tool in the learning process [7]. The use of teaching aids aims to provide the real form of the discussed material in the learning. The teaching aids used in the teaching and learning process, in general, have the advantage of enriching the students’ learning activities, saving learning time, giving reasonable reasons for learning because they arouse the attention and activities of the students. Teaching aids play an important role in learning activities. Teaching aids can provide a visual experience to students directly, among others, to encourage learning motivation, clarify and facilitate abstract concepts, and enhance the absorption of learning [8].

Effective learning should use teaching aids. However, most schools do not have appropriate facilities and infrastructure. Teaching aids are still quite difficult to obtain, even if it is available, it does not necessarily suitable for the learning material. A very rational and realistic solution is to make teaching aids yourself, although they might be very simple [9]. By making simple teaching aids, teachers can be more precise and effective in using them. The teaching aids made by the teacher have several advantages, namely, the teacher can use the teaching aids as they wish so that the use of teaching aids is more appropriate because the one who uses them is the maker. Schools will never be short of teaching aids because teachers can make their own by utilizing the surrounding environment. The cost is very cheap [10].

In this study, the researchers take references from Research and Development (RnD) research conducted by Dzulqarnain et al, the design applications for remote control monitoring cars based on Android on Arduino Microcontrollers [11]. It can control the movement of a remote control car through Bluetooth connection. Research [10] development of teaching aids from waste paper for static electricity learning. According to the expert judgment and questionnaire analysis, it obtained a learning criteria category of 80% which is included in good criteria. Designing simple control car robot using Arduino based on Android System [12]. Students become creative in seeing the connected series and have high curiosity by dismantling and assembling so that it indirectly provides early learning about control and communication systems. Research development of physics teaching aids on viscosity materials as learning media. It can help students to better understand concepts [13].

Based on the results of research observations in SMP (Junior High School) on Bandar Lampung and interviews with the physics teachers who teach at the school, it is known that students' problems in learning physics in class is the lack of understanding of important things from the material, mainly related to electricity material. Therefore, we need a learning system to facilitate students to learn quickly and interestingly. One way to convey physics material that can help to bridge the abstract concepts and the real conditions is learning media.
A concept illustrates the link between several related facts, to obtain facts, and to manipulate ideas to obtain more than just a memory, therefore, it takes a variety of media to be used as an intermediary in learning physics. For example, physics animation, physics teaching aids, and so on.

The problem found at the time of observation was the lack of educational teaching aids that could help in teaching physics. The lack of teaching aids, in general, is more due to schools’ budget constraints. Teachers as motivators in the learning process are required to be more creative in developing educational teaching aids that are as effective and as cheap as possible. Therefore we need teaching aids that are easy to get but still relevant to studied material. One of them is by utilizing recycled waste as a source of innovative educational teaching aids.

The implementation of active and creative physics learning can be realized by the development of physics teaching aids by the use of recycled wastes so that students are trained to think and do in learning physics. Therefore, the researchers need to research the developing remote control car as physics teaching aids using recycled waste. It is expected that the developed physics teaching aids can help teachers in explaining physics concepts, especially the electrical material so that the students learning outcome could achieve the determined minimum criteria of > 70.

1.1 Recycled Wastes as Learning Resources
The word pemanfaatan (utilization) is derived from the word manfaat (benefit) which means to use. The meaning of utilization according to the Big Indonesian Dictionary is the process, method, and utilize. So, utilization is a process or way of getting benefits from something [14].

Utilization of the environment in physics subjects can direct students to actual events or circumstances so that learning resources are more real, actual, and relevant to facts. Utilization of the environment in learning activities is also very influential on physics development, social skills, culture, learning motivation, and emotional and intellectual development of students. The description is in accordance with Iskandar's theory which states the rise of students' intrinsic learning motivation is highly influenced by extrinsic motivation, namely behavior (environment). Used materials can be used as sources and media in learning such as bottle caps, used bottles, rocks, shells, old tin cans, and leftover wood.

1.2 Electricity Materials
Dynamic electricity is electricity that changes or can move and is often referred to as an electric current. This electric current comes from the flow of electrons which flows continuously from the negative pole to the positive pole, from high potential to low potential from different sources.[15] Objects with more positive electric charges have a higher potential, whereas objects with more negative carges have lower potential. Two places that have different potential can cause an electric current if it is connected with a catalyst. Potential difference is usually referred to as voltage. This electric current comes from the flow of electrons which takes place continuously from the negative pole to the positive pole, from the high potential to the lower potential of the voltage source (potential difference). The electric current itself is divided into two types, namely alternating current (AC) and direct current (DC). Meanwhile, the amount of electric current flowing in a certain time is called the electric current (I)[16]. Electricity is also mentioned in the word of Allah in the surah An-Nur verse 35: “Allah is the Light of the heavens and the earth. A likeness of His Light is as a niche (a source that gives off light) in which is a lamp, the lamp is in a glass, the glass is as it were a brightly shining star, lit from the oil of a blessed tree that is neither in the east nor in the west. The oil whereof gives light on its own, even if no fire touches it. (It is) light upon light. Allah delivers to His Light whom He wills and Allah sets forth parables for mankind. And Allah is All-Knowing of everything. "(QS An-Nur: 35) [17].

Based on the verse, science and technology have existed long ago but humans do not know it yet, and the existing knowledge is likened to other things. It is not only humans who can give importance to electricity, but the Qur'an first explains before electricity exists. Surah An-Nur verse 35 explains that the lamp is glowing, the light is in a lamp or glass, and the light bulb is already there and this is
one of the facts. So, the Qur'an not only deals with matters of worship, law, etc. but the Qur'an also explains about technology and everything that exists on this earth, one of which is electricity.

Even though the electric current is a flow of moving charge, not all moving charges contain electric current. If there is an electric current through a surface, there will be a flow of charge through that surface\[18, 19\].

### 1.3 Electrical Circuits
Electric circuits are the arrangement of electronic components that are coupled with a voltage source into a single unit that has certain functions and uses [20]. The electric current in an electric circuit can only flow if the electric circuit is open. There are two kinds of electrical circuits, i.e. open electrical circuit and closed electrical circuit. Open electrical circuits are an electrical circuit that has the end circuits while a closed electrical circuit is an electrical circuit that does not have the end circuits. In this closed electrical circuit, electric current can flow following the type of a circuit. Terms of a closed circuit are electric current can only flow in a closed circuit from high potential to low potential or from \((+)\) pole to \((-)\) pole. The electric current in the conductor is in the direction of the charge \((+)\) and the opposite of the charge \((-)\) [21].

### 1.4 Energy
Energy comes from the Greek word *Energia* which means activities. The word consists of en (in) and ergon (work). Energy is the ability to do something. The energy unit in the International System (SI) is Joule (J). Energy units in other systems are calories, ergonomics, and kWh (Kilo Watt Hours). The equivalence of joules with heat are as follows: 1 calorie = 4.2 Joules or 1 Joule = 0.24 calories [22].

Energy cannot be created nor can it be destroyed, but it can only be changed from one form to another. This form of energy can be obtained because the energy changes into another form. In general, the benefits of energy will be seen after changing it into other forms of energy. For example, electrical energy will be useful when changing into light or heat energy. The energy transformation can be illustrated as follow:

![Figure 1 The Examples of Energy Transformation](image)

### 1.5 The Framework
The development is based on identified needs, namely producing teaching aids by utilizing inorganic materials obtained in the surrounding environment for the electrical and magnetic material. Then, the teaching aids are verified through testing directly. The test was carried out directly by material experts and media experts through direct experiments so that the compatibility is obtained with existing theories. Thus, the teaching aids can be operational and the students can conclude from experiments. Also, a questionnaire was used to know the attractiveness and ease of teaching aids.

### 1.6 Product Specifications
A simple remote control car is a tool that can be used to support learning activities regarding static electricity. This tool works with the triboelectric system (materials that can produce electricity, for example, batteries). It is designed by utilizing materials that are easily found around our environment. Some important parts of this tool are dynamos battery, cables, and dynamos that function to distribute
the current. In this case, a used dynamo was obtained from used CDs and the cables were obtained from used telephone cables. This tool can be run by a battery connected to the dynamo via a cable.

2. Methods

This research used research and development methods. Research and development is a research method used to produce certain products and test the effectiveness of these products [23]. The purpose of this development research is to produce certain products and testing the effectiveness of the products so that it functions in the wider community, then the research is needed to test the effectiveness of the product [24]. This research must produce new products or improve existing products that can be accounted for. In this research, the researcher uses the Research and Development method by utilizing inorganic materials. The R&D model used is one proposed by Borg and Gall and Sugiyono.

The validation teams (validators) of instruments are physics lecturers. The experts were 3 material experts and 4 media experts, and 2 teachers. The subjects to find out the product's appropriateness were the ninth-grade junior high school students.

The development procedure is based on Sugiyono's instructional materials design. The resulting product is a teaching aid in physics learning that can be utilized by students in improving the quality of physics learning that can affect the achievement of learning goals to improve learning achievement.

According to Sugiono, the research and development steps include potential and problems, data collection, product design, design validation, product revision, product testing, product revision, field implementation testing, final product revision, dimension, and implementation [25, 26].

The initial activity before developing the teaching aids is preliminary research. The potential in this research and development is in a number of SMP/MTs N on Bandar Lampung which has some facilities in the form of science laboratories, there are also many inorganic wastes that have not been used properly, and there are no teaching aids in the form of simple remote control cars on static electricity material.

After finding a complete and clear potential problem, the next step is to collect the resources. The materials were chosen because they are more difficult than the previous material. Also, to make it easier for students to understand each subject, the teaching aids were made of wastes which are cheaper, effective and do not require a large cost to make them so that they can assist students in understanding the subject.

Activities before developing teaching aids or teaching materials are needs analysis. The needs analysis was in the form of preliminary observations in learning activities. Teacher observations and interviews were carried out during the learning process. Then the researchers analyzed the problems in the field. The processes were as follows:
1) Lack of use of teaching aids that utilize the surrounding environment.
2) Analyze physics teaching aids to see the suitability of the media with competency standards and basic competencies.
3) Less interactive learning media to improve the quality of learning.

After gathering information, the researchers then make an initial product teaching aids that are interesting, so that it is beneficial for teachers and students in improving the quality of learning. In the design of teaching aids, several sources of books were used and the web as a material guide. The visual design consists of ice cream sticks, used bottles (2 pieces), bottle caps (4 pieces), small size cable, 9 volt battery (4 pieces), 9 volt battery holder, DC motor (2 pieces), solder, cardboard, cutter, scissors, small rubber (2 pieces), gun glue, pens, and skewers. These tools and materials are arranged in such a way to be a simple remote control car for explaining the concept of static electricity. When the dynamo is connected to a battery through a wire, it will rotate the rubber which is rotated by a gear made of used material. The rubber friction continuously generates static electricity.
Design validation is a process of activities to assess whether the product design will be more attractive than other learning media. This validation is said to be rational validation because this validation is still an evaluation based on rational thought, not field facts.

From the results of product trials, if the responses of teachers and students say that this product is interesting and if it is more effective and beneficial for the learning process, then it can be said that this teaching aid has been developed to produce the final product. However, if the product is not yet perfect, the results of this trial will be used as material for the revision and improvement of the teaching aids so that it can produce the final product that is ready to be used at school.

The validation sheet contained aspects that have been formulated including the design of interactive learning aid and procedures. Each aspect was developed into several statements. This validation sheet was filled out by physics lecturers who are experts in the field of instructional media and junior high school teachers who teach physics. This validation sheets aimed to find out whether the guidelines for interviews with students were valid or not. The questionnaire was used to determine the teacher’s response toward the teaching aids by utilizing wastes (inorganic materials). The questionnaire was given after the learning process took place.

An interview was used to find out the use of teaching aids in the classroom. To interview the students, the interview guidelines were made. The interview guideline contained questions about the instructions, contents, and time of use.

The data collecting technique in this study was a questionnaire. A questionnaire is a data collecting technique by giving or distributing a list of questions to respondents in the hope of responding to the list of questions [27]. The questionnaire method was used to measure indicators relating to the content of instructional materials, appearance, and quality. The timetable used a five-point response format from a rating scale which is a subjective measure made on a scale. The data was given a number symbol: excellent is 5, high is 4, moderate is 3, low is 2, and poor is 1 [28].

The data analyzed in this study are descriptive, qualitative, and quantitative analysis techniques. The quantitative data was obtained in the form of input from the validators at the validation stage, also input from media experts, material experts, and physics teachers. The quantitative data described the results of product development. Data obtained through assessment instruments at the time of the trial were analyzed using statistical analysis. This method is expected to be used to understand further data. The results of data analysis will be used as a basis for revising the product. The data consisted of opinions or responses toward the product collected through a questionnaire with statistical analysis.

To determine the overall score of the product by calculating the average score of all assessment criteria then converted it into a qualitative value based on the assessment criteria. The score shows the quality of the product. The obtained data were also calculated using the following formula [29]:

\[
P = \frac{S}{N} \times 100\%
\]

Description:

P = Ideal number
S = The number of research components
N = Maximum score

Based on the data, the product development process will end when the assessment score meets the feasibility requirement which covers the level of appropriateness, the appropriateness of the teaching aid, and the technical quality of the teaching aid. It will be categorized as very interesting or interesting.

3. Results and Discussion

The study was conducted in three schools in SMP/MTs N located in Bandar Lampung. The teachers and tenth-grade students were the respondents in this study. Researchers used a research and development model by adapting the Borg and Gall R&D method which has been modified by
Sugiyono from stage 1 to stage 7. The needs identified as the results of the analysis are, problems and data collection from the literature review and pre-research conducted during the needs analysis is generated at the identification stage.

Some theories were found that support the feasibility and usefulness of physics learning aid in the form of a remote control car a physics teaching aids on static electrical material. The use of the developed product as a teaching aid can clarify learning activities. Then, from the results of a trial of these learning activities, the use of visual aids can also support concept understanding activities with real data. To find out the needs of teachers and students regarding the teaching aids, pre-research or field observation was done. The questionnaire was given to the teachers and students. The questionnaire was focused on the teachers’ ability in developing the remote control car and the students' response in using the remote control car.

The utilization of teaching aids in learning physics in the classroom is not optimal is the result of field observations. Besides, there are still many students who do not yet have a handbook in the form of manuals. For that, to help students learn independently, it is necessary to develop a teaching aid in the form of a remote control car as a simple physics teaching aids.

The developed product is a simple physics teaching aids that will help teachers and students in the learning process and students learn independently based on field observation data. The teaching aids in the form of a remote control car in development planning are, the process of making a teaching aid in the form of the remote control car uses a series of components arranged from several components such as ice cream sticks, 12v battery, DC motor, cable, plugs, on-off buttons, glue gun, wheels, and used bottles. The following are some of the display designs of the teaching aids.

**Figure 2** Materials Used to Make the Remote Control Car

**Figure 2** displays the steps are taken to prepare tools and materials and cut ice cream sticks according to the size needed for the car and remote frame

**Figure 3** Pieces of Material That Have Been Cut and Arranged into the Car’s a Frame
The next step is to test the feasibility of the media through product validation after the product is successfully developed. The initial product had been finished before carrying out the design or product validation. Validation was done by 2 expert validations, namely the validation of material experts and media experts. First, the instrument of the research was validated by the experts before it was used to validate the design or product. The validation instrument was given to material experts and media experts as validators.

The material expert filled out an assessment questionnaire sheet on each aspect of the assessment which consisted of 4 aspects and each aspect has several statements. The 12 statements filled out by 2 validators can be seen in Graph 4.8. Some suggestions were obtained from the material and media experts. Then, based on the suggestion as to the input, the initial product design was revised. The observation at Junior High Schools (SMP) in Bandar Lampung is the initial stage carried out when planning the initial product. The teachers always use printed media or printed books when carrying out the learning process that requires quite a lot of time, so the teachers find it difficult to use the time to provide material that has an impact on students’ learning outcomes.

The development process of the learning media including determining ideas, analyzing the material to be shown and determining the material to be used were the initial steps. The teachers wanted the product to be implemented in the learning activities and students can easily understand the concept of learning. The developed products before being tested in the field were validated by expert validators; 2 material experts and 3 media experts who are experts in their fields.

4. Conclusions
The conclusions of this development research are the remote control car as simple teaching aids on dynamic electricity material and the energy transformation for junior high school students is categorized as highly feasible based on the assessment of material expert with a percentage of 80.59% and it is also categorized as highly feasible based on the assessment of the media expert with a percentage of 92.92%. The product gets a very interesting response from the students based on the small-group trial with a percentage of 82.70%. This shows that the learning media developed can be accepted as media that can be used in learning.

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