Proceeding of Integrative Science Education Seminar **Vol. 3, 2023, pp. 303 - 307**

Available online at

PISCES

Proceeding of Integrative Science Education Seminar

Journal homepage : https://prosiding.iainponorogo.ac.id/index.php/pisces

Article

Van De Graaff Generator Accelerator as an Instructional Media for Static Electricity

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Article Info

3rd AVES Annual Virtual Conference of Education and Science 2023

Keywords:

Accelerator;
Instructional Media;
Static Electricity;
Van de Graaff

ABSTRACT

Science consists of several scientific branches, one of which is physics. Static electricity is one of the materials in the branch ofphysics at class IX middle school level. Discussion of material that tends to static electricity It is abstract, making it difficult to understand, therefore, studying static electricity material requiresconcrete efforts, wrong One way is to make learning props. The aim of this research is to determine the Van De Graff acceleratoras a learning medium for static electricity. This research uses theRowntree research method. Rowntree's research model stages consist of planning, development and evaluation stages. Based onthe results of the needs analysis discussion, it shows that 80% ofstudents need help in understanding Static Electricity material. The design was prepared by listing the materials needed and designing innovations by adding components in Van De Graff. The results of the van de graff accelerator validation assessment from material experts and media experts were 65%. It wasconcluded that the van de graff accelerator was included in the valid category or could be used but was necessary slight revisionto try. In this research, the validator provides an assessment in the form of comments, suggestions and numerical assessments of the product that has been developed. These suggestions will be used as a basis for improving the Van De Graff accelerator learning media.

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INTRODUCTION

Natural Science or abbreviated as IPA is science who learn about natural phenomena that have relationship with human life. IPA is related to how to search know about nature systematically, meaning that IPA is not only in form mastery of a set of facts, concepts, or principles, but also is a process of discovery and getting its application in life everyday

Science consists of several scientific branches, one of which is physics. Physics is known as *the mother of science* because it is parent of other science branches (Fitria, 2021). Static

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electricity is one of the materials in the branch of physics at class IX middle school level. Static electricity material explains the concept of electric charges and the phenomena caused by interactions these electric charges, as a result the discussion in this material tends to be is abstract so it is difficult to understand directly (Afriana, 2015). Therefore, studying static electricity material, especially in the subject of electric charge requires concrete efforts. Wrong one way is by making learning props (Afriana, 2015)

. With tools learning demonstration, static electricity material on the subject of electric charge abstract ones can be observed directly by students. The role of the props is wrong one is to make abstract concepts more concrete (Preliana, 2015).

One of the props used to demonstrate the static electricity phenomenon is the *Van de Graaff generator* (GVG). The Van de Graff Generator (GVG) is a device that can produce large amounts of static electricity through a friction process (Sadly & Akhsan, 2023). In the history of the appearance of the *Van de Graaff Generator* is an electricity generating machine that is usually used for research in various laboratories throughout the world (Sholehuddin, 2020). This generator was made by Robert Jemison Van de Graaff (1901-1967). He is a physicist American national (Zulirfan, et al, 2007). This *Van de Graaff* generator works to produce electric charges, especially particle acceleration charge in atomic exploration (Sholehuddin, 2020).

In principle, the Van de Graaff generator produces an electric charge by rubbing (friction method). This friction method occurs between the rubber belt and the lower metal cylinder which creates a negative electric charge and creates a positive electric charge on the rubber belt and the upper cylinder. So an electric charge is formed because exists movement electron (charge electromagnetic) (Sun, 2013). Next, the upward movement of the rubber belt brings positive charges to flow into the dome through the pointed tip at the top. So, the protons will be spread across the entire surface of the dome. With the help of an electric motor that rotates the bottom metal cylinder, the rubber belt will continuously move, resulting in a positive charge flowing into the dome, thus forming a large electric charge on the Van de Graaff generator dome. This process takes place continuously so that the dome can collect positive electrical charges in large quantities (Sholehuddin, 2020).

In producing that much load, an additional tool called an accelerator is needed. Accelerator is a tool that has the main function of forming an electromagnetic field as well as an accelerator its formation field said (Hariyanto, 2000). With the help of the tool, it is hoped that the Van de Graaff Generator (GVG) network can produce an electrical charge in the form of static electricity and can be used as a learning medium for students to understand the concept of static electricity.

METHODS

This research uses the Rowntree research method. The Rowntree research model is a research model that emphasizes product innovation. This research focuses on the Van de Graff accelerator guide product for class IX junior high school students in the static electricity practical material. Before that, one of the studies on static electricity in junior high school learning using the stages in the ADDIE model was carried out systematically. Learning system design model ADDIE with its components, however, this research still lacks understanding for students and the teaching aids section. Therefore, we carry out research in the form of van de graphs so that students can fully understand it (Preliana, E. 2015). The stages of Rowntree's research model.

Planning Stage

The first stage of the research model is the planning stage. At this stage the researcher conducted a literature study, looked for related references, and carried out a needs analysis.

Needs analysis is used as a means to find out students' problems in static electricity subject matter, then identify the material and formulate practicum objectives

Development Stage

The development stage is the product planning and design stage. This stage consists of instrument preparation, design preparation, and product manufacture.

Evaluation Stage

The evaluation stage consists of a self-evaluation stage carried out by the researcher himself. Next is a validity evaluation by a team of media experts and material experts to determine the suitability of the product. The calculation of validation test results is carried out using the Average Assessment per Validator formula

Table 1. Learning Media Eligibility Test Criteria

Validity Criteria	Validity Level
81% - 100%	Very valid or can be used withoutrevision
61% - 80%	Valid or usable but needsslight revision
41% - 60%	Not valid, it is recommended not to use itbecause it needs major revisions
21% - 40%	Invalid or may not be used
0% - 20%	Very invalid or should not be used

RESULTS AND DISCUSSION

Planning analyst

The result of the planning stage of this research is an analysis of students' physical education needs and continued with the formulation of learning objectives. Needs analysis was carried out by distributing online questionnaires to grade 9 students. This analysis was carried out to determine students' problems in learning static electricity material. Needs analysis shows that 80% of students need help in understanding Static Electricity material. This difficulty is caused by the static electricity material which is abstract and requires monotonous practical activities and learning activities.

Development analyst

The preparation of the instrument is carried out by compiling instrument questions which will be used as a reference in developing data analysis in practicum activities. The preparation of questions on the analysis instrument can be seen in table 2

Table 2. Preparation of indicators for analysis of Material Expert and Media

Material Expert Instrument Analyst Indicator
Relevant to the competencies that students must master
Relevant to the material that students will study
Material packaging according to learning media
Learning media components meet material needs.
Learning media components can explain related material concepts
Learning media components can measure or search for data
Learning media makes it easier for students to understand related material.
Learning media has clarity on how to use it
Media can improve student learning outcomes
Media is easy to use and store
The media is in accordance with the basic competencies of the learning context
Utilization of environmentally friendly materials in learning media
Complete and adequate learning media
The attractiveness of learning media design
Learning media can be interacted with students
Has safe materials (not sharp and not heavy)

The design is prepared by listing the materials needed on the van de graff and designing van de graff innovations by adding components to the van de graff. The materials needed in

the van de graff are cans, belts (wool thread), tissue, 12volt dynamo, charger adapter, fiber cable, top roller, bottom roller, PVC pipe, and exposed wood. The components added to the van de graff are 2 glass bottles and aluminum which will later be connected to the cans in the van de graff.

The steps for making a Van De Graff accelerator are, first cut the PVC pipe into two parts, approximately 15 cm and 15 cm. Provide 4 top and bottom holes for belt support. Place a rubber belt around the larger PVC pipe. Connect the copper cable with the charger adapter. Attach the copper cable with the small dynamo to the end of the larger PVC pipe and secure it well. Connect the copper wire to a metal ball or electrode tip made of conductive material. Attach a paper roll or piece of plastic bottle to the smaller end of the PVC pipe. Place this tool on a flat base. Make sure that the copper cable does not come into contact with anything other than the electrode. In dry conditions, the simple Van de Graaff generator that you make will collect positive electrical charges on the electrodes

Evaluation Stage

At the evaluation stage, the van de graff accelerator learning media will be evaluated itself. Self-evaluation is an assessment carried out independently by researchers. After carrying out the self-evaluation, validation is carried out by material experts and media experts

The self-evaluation stage is carried out by reviewing the products that have been made correctly and working well. The product that has been made, namely the van de graff accelerator, experienced several problems, including the belt being difficult to rotate, preventing the mica attached to the can from reacting. The evaluation stage involved two validators from several aspects, namely content, media and suitability. Validators fill out validation sheets offline.

Table 3. Results of validator assessment by media experts and material experts

Validator	Score obtained	Item scores	Final score	Categories	
Media expert	25	8	62.5%	Valid or necessary revision	usable but slight
Material expert	27	8	67.5%	Valid or necessary revision	usable but slight
Average			65%	Valid or necessary revision	usable but slight

The results of the van de graff accelerator validation assessment from material experts and media experts were 65%. So it can be concluded that the van de graff accelerator is included in the valid category or can be used but needs slight revision to try. In this research, the validator provides an assessment in the form of comments, suggestions and numerical assessments of the product that has been developed. These suggestions were used as a basis for improving the Van De Graff Accelerator learning media. Comments and suggestions from validators are in table 4

Table 4. Comments and suggestions from media experts and material experts

Comments and Suggestions	Revision Decision
Repair the source terminal by replacing the battery with a charger adapter	Replaced with a charger adapter but theresults are still the same
Replace the cable with a better cable	Replaced with a cable that has a lot of fibers but the results are still the same
Choose a better belt	Replaced with a new belt but there has been no reaction to the mica sticking to the can
Addition of pulley in the rotating support section	
Added ring to the swivel support section	

CONCLUSION

Based on the research that has been conducted, the results of the validation assessment of the van de graff accelerator from material experts and media experts are 65%. The van de graff accelerator is included in the valid category or can be used but is necessary slight revision to try. In this research, the validator provides an assessment in the form of comments, suggestions and numerical assessments of the product that has been developed. These suggestions will be used as a basis for improving the Van De Graff accelerator learning media. Further research and experimentation is needed in testing the van de graff accelerator as a learning medium for static electricity material that can be used properly.

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