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MOVO AC: AN INTERACTIVE PHYSICS LEARNING MEDIUM TO HELP STUDENTS UNDERSTAND THE CONCEPT OF ELECTRIC POTENTIAL

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Abstract

The problems in physics learning classes are complex. Difficulties in understanding the concept of physics become the biggest obstacle. One of those difficulties is a lack of learning media especially a prop to learn an abstract static electricity concept. This research and development was designed to create a prop of learning media in the form of a feasible tool to show that distance can affect the electrical potential. In this study, ADDIE cosisting of Analysis, Design, Develop, Implementation, and Evaluation were employed. The developed teaching aids were tested in two test classes at SMAN 1 Tulungagung. Results in validity data with vaues of 94% with very good category. The classical completeness of the learning outcomes of students increased from 83% to 92% of the 72 students who were spreaded in class XII MIPA 1 and XII MIPA 3. Meanwhile, from the questionnaire that was distributed, it was found that the response of students who stated it was good to use was 93%. Overall, it can be concluded that movo AC is worthy to use as learning media in static electricity especially to show that the number of distance can affect the electrical potential.

***Keywords**: Movo AC, Learning Media, Electric Potential*

Abstrak

Permasalahan tentang pembelajaran pada mata pelajaran fisika di kelas merupakan masalah yang komplek. Sulitnya peserta didik memahami konsep yang diajarkan menjadi kendala besar. Salah satunya adalah kurangnya media pembelajaran terutama alat peraga untuk mengajarkan materi listrik statis yang bersifat abstrak. Penelitian ini bertujuan untuk menghasilkan media pembelajaran berupa alat peraga yang mampu digunakan untuk menunjukkan bahwa nilai jarak mempengaruhi besar potensial listrik. Penelitian menggunakan metode ADDIE dengan tahapan meliputi Analysis, Design, Develop, Implementation and Evalution. Alat peraga yang dikembangkan diujicobakan pada dua kelas uji yang ada di SMAN 1 Tulungagung. Data hasil penelitian berupa validitas alat peraga sebesar 94% dengan kategori sangat valid. Adapun ketuntasan klasikal hasil belajar peserta didik meningkat dari 83% menjadi 92% dari 72 peserta didik yang tersebar pada kelas XII MIPA 1 dan XII MIPA 3. Sedangkan dari angket yang disebar didapatkan respon peserta didik yang menyatakan baik untuk digunakan sebesar 93%. Secara keseluruhan dapat disimpulkan bahwa alat peraga movo AC layak digunakan sebagai media pembelajaran materi listrik statis khususnya untuk menunjukkan faktor jarak mempengaruhi nilai potensial listrik.

***Katakunci**: Movo AC, Media Pembelajaran, Potensial Listrik*

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INTRODUCTION

Physics is one of the most important subject in science class, either junior or senior high schools. This subject has a significant contribution to technology development (Apriyani et al., 2019). Understanding the concept of physics is needed to analyze natural phenomena that occur and solve technology (Dewi et al., 2020). In the learning process in the classroom, understanding this concept is indicated by the achievement scores of students in the form of cognitive, psychomotor and affective values.

Learning physics in the classroom still faces several problems because the learning activities are still traditional and not contextual (Dwi et al., 2013) Problem solving exercises are rarely given by the teacher. So that in schools it is often indicated that student learning problems are difficulties in understanding the material (Daryanto, 2015), students think that physics is difficult (Dwi et al., 2013). According to research conducted by Hafi and Supardiyono (2018), 78.2% of students have difficulty understanding physics material because learning is only delivered with textbooks and doing some questions that contain formulas. To overcome the difficulties of learning physics, it is necessary to use learning media that is suitable and synchronous with the material to be taught (Hafi & Supardiyono, 2018)

Media in *Latin* means medium or intermediary. In general, media includes people, goods, equipment or activities that enable students to be able to acquire abilities, skills and attitudes (Sanjaya, 2012). The results

of research conducted by Mardiana found that material information through the visual process was easier for students to accept and showed that learning media could increase students' HOTS. Learning media itself is a tool made by the teacher as a tool to help students obtain information (Pradana et al., 2020).

In order to overcome learning problems that often arise in class, teachers are required to be able to use tools as learning media. Or at least can use cheap and efficient tools even though they are simple to achieve the expected teaching goals. Hamalik in Arsyad argues that in addition to being able to use the available tools, teachers are also required to be able to develop skills in making learning media that will be used if the media is not yet available. For this reason, the teacher must have sufficient knowledge and understanding of instructional media (Arsyad, 2016)

One of the visual means of learning media that can be used to provide learning experiences for students is a series of AC voltage measuring devices which serves to show that the distance factor affects the value of electric potential. This tool is named *movo AC* which means modification of the ac voltmeter. In the learning process, this tool is used as a medium for conveying static electricity material in the sub-section of electric potential. The goal is that students are able to understand well that the amount of electric potential is influenced by the distance from the source point.

The electric force between two charges is along the line of charges and inversely proportional to the square of the distance. The potential energy in an electric field is proportional to the charge. Potential energy is measured in volts and is generally referred to as voltage. Electric potential is a scalar quantity (Tipler, 2001). The electric potential at a point is the amount of potential energy per unit of potential charge (+) which is at that point. In electric potential energy, it depends on the amount of charge. In Another case, potential energy per unit charge has a unique value in an electric field (Chasanah et al., 2017, Halliday and Resnic, 1978 in (Winanti et al., 2018). Electric potential can be generated with charge q is r from the source charge. as shown in Figure 1 while the relationship between V on q and r is given in Equation (1) (Tipler, 2001).

$$V = k\frac{q}{r} \text{ where } k = 9 \times 10^9 \text{ N·m}^2\text{·C}^{-2} \quad (1)$$

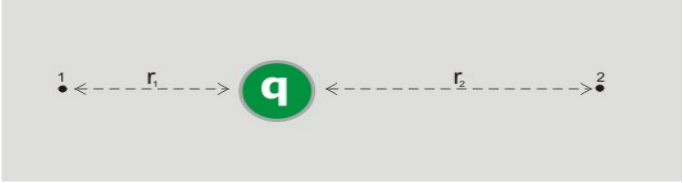


Figure 1. Representation of A Point With Distance *r* from The Source Charge *q*.

METHODS

The development of this learning media uses the ADDIE method. This model consists of five steps, namely: (1) analyze, (2) design, (3) development, (4) implementation, and (5) evaluation (Tegeh & Kirna, 2013). The research was conducted at SMA Negeri 1 Tulungagung Academic Year 2019/2020. The trial of using *movo AC* was carried out in two test classes, namely class XII IPA 1 and XII IPA 3. The analysis technique in the study was the analysis of the results of expert validation to determine the appropriateness of the *movo AC* props, cognitive test sheets, observation sheets of skill scores and attitudes to determine the results. learn students using *movo AC* props and student response questionnaire sheets.

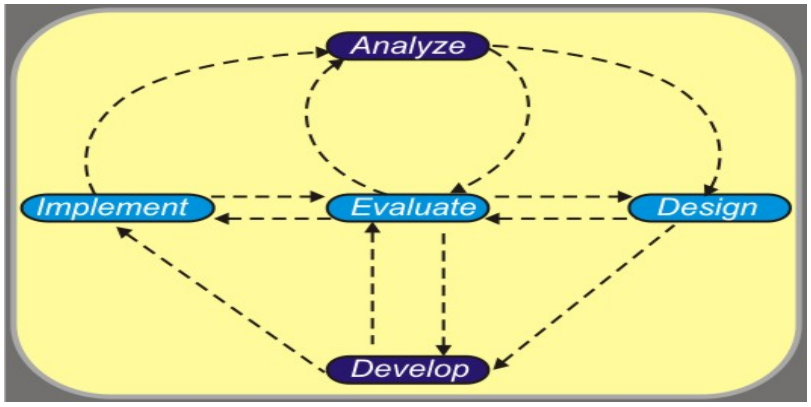


Figure 2. ADDIE Model for The Research and Development

RESULTS AND DISCUSSION

Based on the results of the interview, several class XII teachers informed that empirically, physics is a difficult subject for students. This is indicated by the low average value of daily tests. The low learning outcomes indicated because of the saturation of students in the learning process in the form of a textbook using a discussion and question and answer model. Refreshing learning through practicum activities has never been carried out because there are no props or practicum tools in teaching static electricity, especially media to teach abstract electrical potential. This learning activity is contrary to the concept of learning curriculum 2013 which emphasizes the application of 5M, namely observing, asking, trying, reasoning and communicating. In the application of 5M, students should be invited to do practical work to strengthen physics concepts, develop laboratory skills, and increase confidence about the nature of experimental physics. Wilcox & Lewandowski 2017; Collette & Chiappetta 1994 stated that laboratory work has learning outcomes that can improve attitudes through science, scientific attitudes, scientific investigations, conceptual development, technical skills, and collaboration skills (Sulistiyono et al., 2019)

The theoretical analysis refers to the analysis of Basic Competence (KD). The electric potential is at KD. 4.2. Conducted the following experiment the presentation of the results of electrical experiments and their benefits in everyday life. So it is clear that in learning the electric potential that is in static electricity material should be done through direct learning using media that must be prepared by the teacher. Learning competency skills in KD 4.2 is intended to improve students' cognitive understanding. Muhammad Iqbal et al explained that studying physics material is not only determined by how smart the students in doing physics exercises but also how deep the students in understanding and mastering the concepts of the physics material which is being studied (Iqbal et al., 2020). Physics does not only contain of knowledge to memorize, but in physics it is more emphasized on the formation of knowledge processes and mastery of concepts in the minds of students in the teaching and learning process (Setiyawan (2012) in (Iqbal et al., 2020)).

In principle, the *movo AC* design uses two electrodes from 2 system units, each of which has a different function. The materials used for the design of the *movo AC* consist of two electrodes, MCB, AC voltmeter, cables and insulating materials. To show that the electric potential is affected by distance, water is used as a medium. The electrodes generated by the unit 1 system generate a positive charge. This system is equipped with an MCB which functions to protect the electrical network in the event of an electric overload or a short circuit such as a short circuit. The positive electrode is inserted into the water as a medium. Water in which there is a positive electrode will become positively charged as the source charge. The unit 2 system serves as a measure of the resulting potential value. The measuring instrument used is a digital AC voltmeter to facilitate reading of observations. In system unit 2, the positive electrode of the voltmeter is connected directly to water, while the negative electrode is connected to earth.

The unit 1 electrode generates a positive electric charge which diffuses in the water. The placement of the positive electrode on the water is fixed at one point so that it can be used as the location of the source charge. To show that the amount of electric potential is affected by distance, the measurement is sufficient to change the distance of the positive electrode unit 2 from the unit 1 electrode.By connecting the negative electrode of system 2, there will be a potential difference throughout the system unit 2 circuit and the potential can be measured from the voltmeter. The amount of this potential differs at each point depending on the distance between the source charge and the test charge placed.

The development stage includes testing the validity of the tool by experts and testing the working principle of the *movo AC*. The validity test is carried out by a Science Education Lecturer, State University of Malang. From the feasibility test of the *movo AC* as a learning medium, it gets a validity value of 94% with the very good category. In the trial, the work of the *movo AC* functions as a control variable, the measuring distance is the manipulation variable and the value pointed to by the voltmeter serves as the response variable. The experiment was carried out using calm water in a bath. *Movo AC* is able to work easily and can be used anywhere with the provision of media and AC voltage sources. The data description from the test results shows that distance affects the value of electric potential as in the graph in Figure 3. The greater the point of the source charge, the smaller the electric potential value. This is in line with the electric potential theory concept put forward by Tipler that the potential of each charge is proportional to the charge and inversely proportional to its distance from the charge (Tipler, 2001).

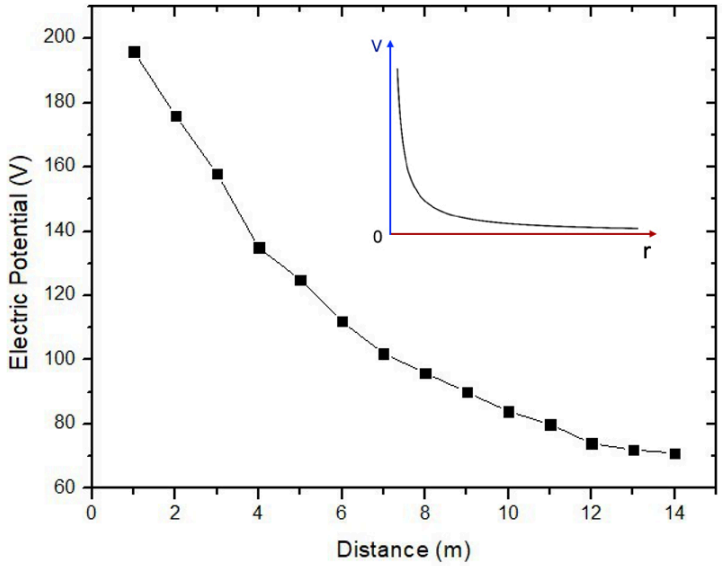


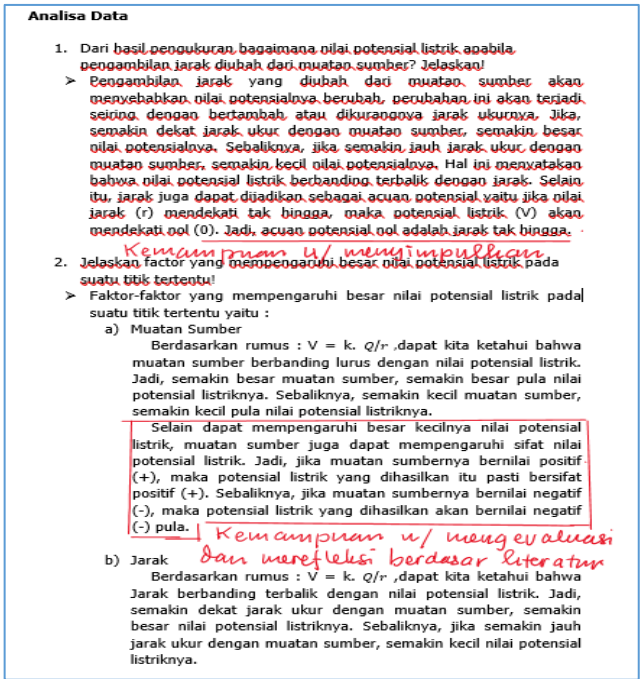
Figure 3. *Movo AC* Measurement Results Representing The Dependence of Electric Potential Upon Distance.

The application of initial trial in using *movo AC* as a learning medium, used two test classes, namely 36 students of class XII MIPA 1 and 36 students of XII MIPA 3 at SMAN 1 Tulungagung Academic Year 2019/2020. The purpose of the trial was to find out whether *movo AC* as a learning medium Physics in class is able to provide good learning achievement results, and is used to determine student responses to the use of *movo AC* as medium for practicum tool. The learning outcomes assessed include cognitive, psychomotor and affective aspects. Observations and assessments are carried out during the learning process. It can be seen that the students are enthusiastic about preparing the media that will be used as practical materials in the form of a large laundry bucket filled with well water. This enthusiasm shows an enhancement in learning motivation as explained by Gunawan (2007) that student learning motivation is an encouragement that makes students enthusiastic about learning (Suminah et al., 2019)

Practicum is carried out in groups and in stages with teacher supervision. Before the practicum starts, all students are given directions on the technical implementation of the practicum, the steps of the activity as well as the risks and dangers in case of carelessness. Directions are made to minimize errors that can lead to accidents during practicum implementation. During the practicum, students have a great sense of curiosity, which can be seen from the enthusiasm of each student who wants to try using the *movo AC* individually even though in fact in the implementation of the practicum it has been divided into work groups with clear division of tasks.

Practical activities run smoothly, there are no significant obstacles because it is indeed a simple *movo AC* system that is easy to use. The big risk that may arise is a short circuit. However, this has been anticipated by installing the MCB. The improvement of student learning outcomes can be seen from the results of observations that show students use *movo AC* skillfully in turn, referring to the opinion of Yuliani et al. (2012) that the process skills approach improves learning achievement (Gazali et al., 2015)

All groups were able to complete the worksheets well. The worksheet contains a data collection sheet for the electric potential value by varying the measured distance from the test point. On the worksheet students are given feedback questions for critical thinking. Critical thinking is a thinking process that involves logical and reflective reasons and can determine decisions (Ennis (1995) in (Trianggono, 2017)). Critical thinkers are able to criticize, ask, evaluate and reflect (Nuryanti et al., 2018). Figure 4 is an example of student work who is able to think critically when carrying out practicum using *movo AC*. On this worksheet students are able to describe the nature of the electrical potential of positive and negative source charges. This description of the answer of students shows the ability to evaluate and reflect on information obtained during the practicum activities.



Analisa Data

1. Dari hasil pengukuran bagaimana nilai potensial listrik apabila pengambilan jarak diubah dari muatan sumber? Jelaskan!
   - Pengambilan jarak yang diubah dari muatan sumber akan menyebabkan nilai potensialnya berubah, perubahan ini akan terjadi seiring dengan bertambah atau dikurangnya jarak ukurnya. Jika semakin dekat jarak ukur dengan muatan sumber, semakin besar nilai potensialnya. Sebaliknya, jika semakin jauh jarak ukur dengan muatan sumber, semakin kecil nilai potensialnya. Hal ini menyatakan bahwa nilai potensial listrik berbanding terbalik dengan jarak. Selain itu, jarak juga dapat dijadikan sebagai acuan potensial yaitu jika nilai jarak (r) mendekati tak hingga, maka potensial listrik (V) akan mendekati nol (0). Jadi, acuan potensial nol adalah jarak tak hingga.

   Kemampuan u/ menyimpulkan

2. Jelaskan factor yang mempengaruhi besar nilai potensial listrik pada suatu titik tertentu!
   - Faktor-faktor yang mempengaruhi besar nilai potensial listrik pada suatu titik tertentu yaitu :
     a) Muatan Sumber
        Berdasarkan rumus : V = k. Q/r ,dapat kita ketahui bahwa muatan sumber berbanding lurus dengan nilai potensial listrik. Jadi, semakin besar muatan sumber, semakin besar pula nilai potensial listriknya. Sebaliknya, semakin kecil muatan sumber, semakin kecil pula nilai potensial listriknya.
        Selain dapat mempengaruhi besar kecilnya nilai potensial listrik, muatan sumber juga dapat mempengaruhi sifat nilai potensial listrik. Jadi, jika muatan sumbernya bernilai positif (+), maka potensial listrik yang dihasilkan itu pasti bersifat positif (+). Sebaliknya, jika muatan sumbernya bernilai negatif (-), maka potensial listrik yang dihasilkan akan bernilai negatif (-) pula.

        Kemampuan u/ mengevaluasi dan merefleksi berdasar literatur

     b) Jarak
        Berdasarkan rumus : V = k. Q/r ,dapat kita ketahui bahwa Jarak berbanding terbalik dengan nilai potensial listrik. Jadi, semakin dekat jarak ukur dengan muatan sumber, semakin besar nilai potensial listriknya. Sebaliknya, jika semakin jauh jarak ukur dengan muatan sumber, semakin kecil nilai potensial listriknya.

Figure 4. Student Analysis Results in Practicum

Pretest which is the initial test for the assessment of learning outcomes in the cognitive domain is taken at the beginning before the implementation of the practicum. Before the implementation of the practicum, all students had been provided with material about electric force, electric field and electric potential. At the end of the practicum, students are given a posttest. The value of student learning outcomes seen from the average value of interpreters and post tests showed an increase from 75 to 81.

Students are declared complete if they have a value equal to or above the Minimum Completeness Criteria (KKM), which is 75 for stastic electrical material. Learning outcomes using *movo AC* media can help improve student learning completeness classically in the test class from 83% classical completeness to 92% as shown in Figure 5. This is because students find it easier to understand the concept of electric potential and are motivated during the learning process using *movo AC* media that has never existed before.

The evaluation stage is the stage to evaluate the use of *movo AC* media after it is used as a learning medium. The purpose of the evaluation is to obtain information about the advantages and disadvantages of *movo AC* when used as a practicum media. The evaluation instrument is in the form of a response questionnaire to students. From the questionnaire given to all students in the two test classes, a total of 72 children, it was found that 93% of the students responded well.

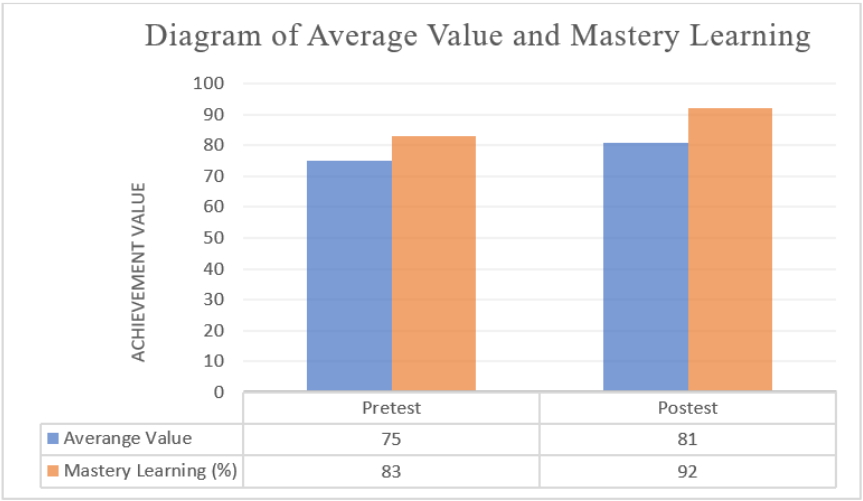


Figure 5. Test Class Learning Outcomes Improvement Diagram

CONCLUSION

Based on the results of the research that has been carried out, the validation results of *movo AC* as a learning medium in the classroom are declared valid by the validator. In terms of benefits, the learning outcomes achieved by students when learning using *movo AC* media are able to increase the average value of learning outcomes and increase students' learning completeness classically. Observation shows that *movo AC* media is said to be practical because there are not many obstacles that arise. Student responses state that learning using *movo AC* is effective. Thus it can be concluded that the *movo AC* media is feasible to be used as a physics learning medium for static electricity material, especially to show the effect of distance on the value of electric potential.

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