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Searching on Groundwater Using Geoelectric Method as Physics Application Learning Model

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geoelectric method;
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high school;
learning model;
physics application;

Abstract

Getting a model of learning physics applications for high school students is not too difficult. Various applications in geophysical methods that apply basic science in physics can be applied. One of them is the geoelectric method. The geoelectric method is a geophysical method that works by injecting an electric current into the ground and measuring the potential difference, it creates. In the geoelectric method, there are many physics concepts, interrelationships between concepts and how to measure physical quantities contained in them unlike strong electric current, potential difference, and resistivity. The search for groundwater using the geoelectric method is one application of physics. The students here can measure the current directly, the potential difference and calculate the relation in the form of resistivity. This activity has been conducted at *Sekolah Menengah Atas Bali Mandara Bali*. First, given basic knowledge about electricity flow, then explained how electricity is applied in measurements on the earth. The activity continued with measurements on the schoolyard. The situation on the schoolyard is a leaky water pipe, there is a safety tank, there is a drill well being worked on. In this place, there are suspected groundwater reserves, which is why drilling is conducted. At the time towards training, drilling was conducted to a depth of 29 m. The results of drilling have not found water. The results of the geoelectric method measurement found that there was a pipe leak, safety tank, and groundwater reserves at a depth of 39 m. The verification is conducted with the students, it is true there is a leaky pipe (visible) and safety tank (visible). For drilling groundwater reserves have not found any water due to the position of the drilling with measurement results different from 3 m and not yet reached the estimated position of groundwater reserves. Giving found the results like this; it can be concluded that groundwater search activities using the geoelectric method can be used as a model of learning physics applications for high school students.

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1. Introduction

Getting a model of learning physics applications for high school students is not too difficult. Various applications in geophysical methods that apply basic science in physics can be applied. One of them is the geoelectric method. The geoelectric method is a geophysical method that works by injecting an electric current into the earth and measuring the potential difference it causes [1, 2]. In the geoelectric method, there are many physics concepts, interrelationships between concepts and how to measure physical quantities contained in them unlike strong electric current, potential difference, and resistivity. Searching for the groundwater using the geoelectric method is one application of physics. The students here can directly measure the current strength, potential difference, and calculate the relation in the form of resistivity [3].

The activity of physics applications learning model in the geoelectric method to search for groundwater was conducted at *Sekolah Menengah Atas Bali Mandara Bali* in the context of community service. The students are grouped into *Kelompok Siswa Pencinta Mata Pelajaran (KSPM)*. One of the KSPM that has been formed is *KSPM Kebumian*. In this group, the lesson is focused on the application of basic science concepts (physics) in the field of the earth, thus, supporting equipment and learning models are needed. Seeing the condition as mentioned above, it appears that this school has a future insight that should be fostered. For this reason, community service activities are carried out.

Based on the analysis of the situation as mentioned above, the purpose of this community service is the students of *Sekolah Menengah Atas Bali Mandara Bali* who choose KSPM to have a solid understanding in the field of geography by providing physics application learning models. The application of physics here is to find groundwater using the geoelectric method.

The benefits of community service activities are to make students understanding in the field of geography become solid. Unlike the provision for students to pursue higher education. Strengthening understood in the field of earth can be conducted by implementing physics application learning models in the searching on groundwater reserves using the geoelectric method.

2. Theory of Geoelectric Method

The geoelectric method is one of the geophysical methods that works based on electric currents injected into the earth and then the potential difference is measured [1]. Schematically, the set of equipment in the measurement can be described as follows [4].

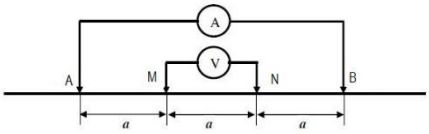


Figure 1. Scheme of toolset series

A and B are current electrodes, M and N are potential electrodes. The circuit is measured by the strength of the injected current (I) and the potential difference caused (V). Using Werner's configuration, the method of retrieving data follows the steps as follows [5]:

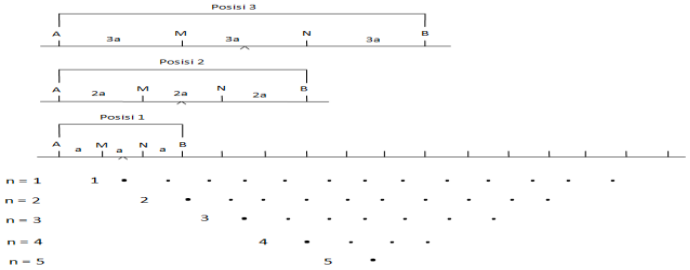


Figure 2. Shift and change in distance of the Wenner configuration electrode spaces

Towards Figure 2 it can be seen that for n = 1 the distance of each electrode AM=MN=NB=a, for n = 2 the distance of each electrode AM=MN=NB=2a, for n = 3 the distance of each electrode AM=MN=NB=3a, and so on until the path length is finished [5]. The relationship between the two physical quantities I and V result in the apparent resistivity (ρ) as follows [6]:

$$\rho = K\frac{\Delta V}{I} \quad \text{.....(1)}$$

wherein;

$$K = 2\pi a \quad \text{.....(2)}$$

i.e., the Wenner configuration geometry factor

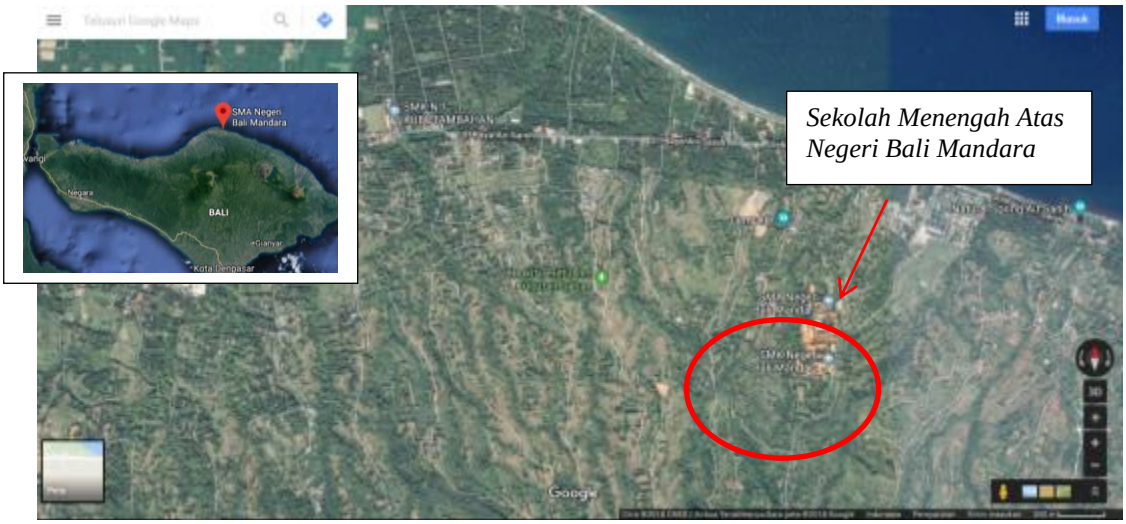
3. Implementation of Activities

3.1. Strategic Target Audience

The strategic target audience in community service is students and teachers of *Sekolah Menengah Atas Negeri Bali Mandara* and *Universitas Udayana* lecturers as service teams.

3.2. Implementation of time and place

The community service was held during April 2018-June 2018 at *Sekolah Menengah Atas Negeri Bali Mandara*. Location position can be seen in Figure 1.



Source:https://www.google.co.id/maps/@-8.0792218,115.1970066,2293m/data=!3m1!1e3

Figure 3. Location of *Sekolah Menengah Atas Negeri Bali Mandara*

3.3. Method of Implementation

The method used in implementing the community service to be more effective in achieving the goal is by providing an introduction to the geoelectric method. Its activities include the explanation of the theory of geoelectrical with the application of basic sciences to earth problems, measuring, analyzing measurement data, then proceeding with the interpretation of measurement results. After completion of the activity, an evaluation was held to find out how much material that had been given could be absorbed by students.

4. Results and Discussions

4.1. Results

As explained above, the steps taken included explanation of the theory; taking measurements and analyzing measurement data. Interpretation of measurement results, as well as test/evaluation of the material mastery. In detail, each stage of the results is as follows.

4.1.1 Explanation of theory

Explanation of the theory besides being given to students is also given to physics teachers and principals who incidentally as the physics teachers. In the following Figure 4, the principal appears accompanied by a physics teacher who is following the explanation of the geoelectric theory.

Figure 4. Explanation of the geoelectric method to the principal of *Sekolah Menengah Atas Negeri Bali Mandara*

Explanation of the geoelectric method given to students briefly in the class. The students are very enthusiastic following the explanation. The following Figure 5 shows students following the explanation of the geoelectric method.

Figure 5. Explanation of geoelectric theory in classes

4.1.2 Conducting of measurements

At this stage, the students are invited to conduct measurements in the field (schoolyard). The activity starts from looking at the field situation, determining the trajectory strike, installing the measurement electrode, installing the measurement cable, and setting the geoelectric device. The geoelectric toolset used by the SkillPro brand belongs to the Department of Civil Engineering, Faculty of Engineering, Universitas Udayana. The situation on the schoolyard is a leaky water pipe, there is a safety tank, there is a drill well being worked on. In this place, there are suspected groundwater reserves, which is why drilling is conducted. At the time, training drilling was conducted to a depth of 29 m. The results of drilling have not found water. The distance between

electrodes is used 4.75 m, therefore, the measurement path length is 47 x 4.75 = 223.25 m. The geoelectric method measures the physical magnitude of the injected current (I) and the potential difference caused by an electric current injection (V). In the SkillPro geoelectric set, both physical quantities are automatically recorded automatically in the toolset. Based on the magnitude I and V can be calculated the amount of rock resistivity in the measurement area (ρ), but the resistivity (ρ) here is a quasi-resistivity.

Figure 6. Geoelectric tools setting

4.1.3 Data Analysis of Measurement Results

The measurement data were analyzed by the *Res2divn* program. Data analysis is conducted together with the students. It looks like Figure 7, the students were very enthusiastic about the discussion.

Figure 7. Analysis and interpretation of geoelectric data

Res2divn program output is in the form of real resistivity/conductivity and contour of the cross-sectional resistivity of the track. This resistivity contour is interpreted. Contour resistivity cross section can be seen in Figure 8 below.

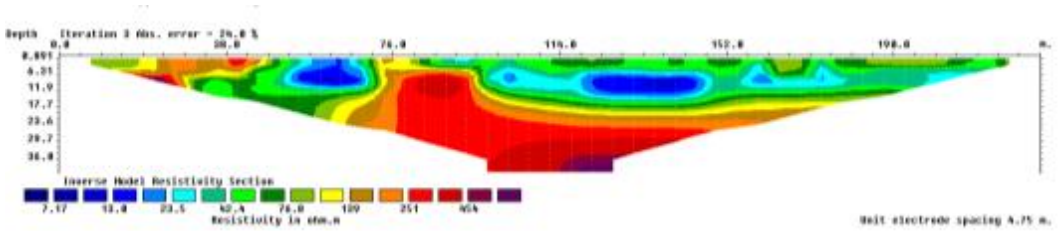


Figure 8. Cross-section resistivity contour

4.1.4 Interpretation of measurement results

Having seen Figure 8 above, it can be interpreted that the small resistivity (13 Ω.m) at position 57-66.5 m near the surface and at position 123.5-152 m at a depth of about 6 m. It is suspected that water in the coating. After verification, it turns out that the small resistivity at position 57-66.5 m is a leaky water pipe, the water seems to be inundated on the surface. At position 123.5-152 m it turns out that the safety tank. A small resistivity is also found in the position shown 118.75-128.25 m with a depth of about 39 m. Around this place (position 114.0) drilling is underway to make bore wells. Drilling has been carried out to a depth of 29 m but water reserves have not been found. For drilling groundwater reserves have not found any water due to the position of the drilling with measurement results different from 3 m and not yet reached the estimated position of groundwater reserves. The position of the drilling slightly deviates from the alleged position of the aquifer.

4.1.5 Test/Evaluation of Material Mastering

The last part of the activity is carried out a test/evaluation to find out the mastering of the material that has been given. The test material related to technical material in accordance with the curriculum they received at school. This material is in accordance with the material contained in the geoelectric method. The average value of mastering test material is 88.57 with a range of values 84-95. The results of this test mean mastery of the material in the good category.

4.2 Planning Further Stage

The introduction of the geoelectric method is an initial activity of the students in establishing the application of their physical knowledge to the earth cases. The students are invited to be directly involved in measuring the physical quantities of current (I) and potential difference (V) and calculating the apparent resistivity (ρ) produced. The emergence of apparent resistivity due to the measurement of the earth is considered in one layer that is homogeneous and isotropic. In order to obtain resistivity values, modeling needs to be conducted in the data analysis. Modeling using the *Res2divn* program directly involves students.

The students seemed very enthusiastic about taking part in this activity. They believe that the physics formulas they have learned in school have proven their application to the earth problems. For this reason, the initial simulation model needs to be followed up. Therefore, the students can have more solid knowledge by applying the geoelectric method to uncover relevant cases in the field.

The closest case is the failure of drilling in the construction of bore wells in the school. This case might be revealed by the geoelectric method. The results of the disclosure can be in the form of an explanation as to why the previous drilling wells failed. The results of the disclosure can be used as a study or scientific work of students and the physics teachers at *Sekolah Menengah Atas Negeri Bali Mandara*. Through this learning model activity, cooperation is expected to be well established in the development of physics education.

5. Conclusions and Suggestions

5.1 Conclusions

The learning model activities conducted in *Sekolah Menengah Atas Negeri Bali Mandara* can be summarized as follows.

a) The activities can be accepted by the students and teachers, it can be seen with they enthusiastic participation in all events.
b) Through the activities of this learning model, student's knowledge becomes steady in applying their physical knowledge to the earth problems.
c) This learning model activity needs to be followed up by continuing to collaborate in uncovering relevant cases in the field. Therefore, it can uncover cases and produce scientific works in the form of the scientific works by students and scientific works by the teacher.

5.2 Suggestions

Based on the results of this learning model, the suggestions can be proposed as follows.

a) This kind of activity needs to be done to strengthen students' understanding of the physical theories they have studied.
b) This activity needs to be followed up to uncover problems in the field and produce the works for both the students and teachers.

Conflict of interest statement and funding sources

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Statement of authorship

The authors have a responsibility for the conception and design of the study. The authors have approved the final article.

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