Physics in geothermal power plants

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Abstract. Many students dont like physics because they feel far away from physics. Therefore physics must be made closer to students through contextual physics. This paper wants to describe the physical concepts that exist in geothermal power plants. The method used is Research and Development (R & D) with the ADDIE model design. The results of the study show that there are many physics concepts that can be taught to students through observation and analysis of geothermal power plants such as the concepts of temperature, heat and displacement, electricity, energy and others. These physics concepts can be packaged in physics learning through the development of enrichment materials. It is hoped that there will be an increase in the mastery of concepts and literacy of students towards the surrounding natural resources.

1. Introduction
Learning physics is essentially learning the symptoms of nature. Nature should be easily understood. However, there are still many students who find it difficult to study physics. There are several underlying reasons, including physics is cumulative. If you miss one concept, it is hard to grasp the next one, physics is very difficult subject, and there is too much material to learn. So far physics has always been identified with various formulas and formulas or mathematical equations. Physics requires good mathematics. Physics cannot be learned without mathematics background [1]. There is a phenomenon where students can solve physics problems, even though they do not understand physics [2]. Actually physics is about nature and physics learning must be closer to nature [3].

In order for physics learning to be close to nature, physics must be taught contextually. Through contextual learning, students will have more motivation in learning and easily associate learning material that is being learned in school with everyday life. Contextual learning can be sourced from anywhere, one of which is from natural resources around students [4]. Natural resources can be geothermal which can be used as geothermal power plants.

Geothermal power plants can be used as a context for learning physics. One strategy is through the development of physics teaching materials. Physics teaching material is one of the efforts to improve student literacy [5,6]. Increasing scientific literacy that comes from phenomena around the students' environment can help students to recognize, understand and explore the natural resources around them. The purpose of this paper is to describe the development of contextual physics teaching materials based on geothermal power plants.
2. Methodology

The research model used is the Research and Development (R & D) development model using the ADDIE research model (Analyze, Design, Development, Implementation, Evaluation). The ADDIE model is a generic instructional design model that provides an organized process for developing teaching materials [7]. According to Magliaro and Shambaugh and McGurr, the ADDIE model is a process that has traditionally been used in Instructional Designs [8]. Despite the fact that ADDIE consists of components from all other design models, it is a relatively simple model [9] although it was criticized as a limited and static model [10]. The research procedure with the ADDIE model is shown in table 1.

| Steps       | Activity                                                                 |
|-------------|---------------------------------------------------------------------------|
| Analysis    | • analyze basic competencies that students must have                      |
|             | • analyze the characteristics of students about their learning capacity   |
|             | • conduct material analysis in accordance with the demands of competence |
| Design      | • design learning objectives                                               |
|             | • design basic material based on the chosen context                        |
|             | • map the physical concepts contained in the context                       |
|             | • choose the appropriate process description                               |
|             | • analyze attitudes that can be raised based on the chosen context         |
| Development | • translate design specifications into physical form                        |
|             | • complete all parts: introduction, contents and closing                   |
|             | • package design more attractive, colorful and balanced                    |
|             | • prepare forms and validation instruments                                 |
| Implementation | • applying the results of development in classroom learning                |
|             | • test the effectiveness of teaching materials                             |
| Evaluation  | • conduct evaluation during learning (formative)                           |
|             | • conduct evaluation after learning (summative)                           |

The steps of the ADDIE model above adopted the Muruganantham study [11]. The ADDIE model is an R & D design that is best known especially in the development of teaching materials [12]. The advantages of the ADDIE model are its simple nature including the ease of application and the possibility of the process cycle features. This is what allows a more holistic view of the instructional design process [13].

3. Results and discussion

3.1. Results of need assessment

The first stage in this research is needs analysis. Analysis of the stage is the most important phase in this process. To carry out the analysis phase we must analyze four things, such as we have to analyze students (where they are, their skills and needs, etc.), develop instructional analysis (to provide the steps needed and present opportunities) to learn and use new information in instructions), making instructional goals (intended to determine the desired end result), and analyzing learning objectives [14].

In the context of developing physics teaching materials, the main step taken is analysis of problems, potentials and solutions offered. The results of the preliminary study show that the main problem which is the background of the development of this contextual physics teaching material is the low literacy of students. Table 2 below shows student literacy scores obtained from two schools, which are near and far from the geothermal power plants. Student literacy is measured through literacy instruments that involve processes, content, contexts and geothermal related attitudes.
### Table 2. Student's initial literacy profile.

| Literacy Domain | Close school score | Far school score |
|-----------------|--------------------|-----------------|
| process         | 0.9                | 0.9             |
| concept         | 0.8                | 1.0             |
| context         | 1.2                | 1.4             |
| attitude        | 1.3                | 1.3             |
| average         | 1.1                | 1.2             |

Table 1 states that the average value of science literacy tests of students in close schools is 1.1 on a scale of 0-4, while the average value of literacy of students in distant schools is 1.2 on a scale of 0-4 in the low category. These results reinforce findings from the Spiropoulou et al (2007) [15]. To improve scientific literacy of students it is not necessary to add new subjects, but it can be done by integrating contextual content in existing lessons such as physics. The integration effort can be carried out in various ways: adaptation (in the form of modification of planning and implementation of learning) or additional models in the form of enrichment materials [16].

#### 3.2. Design and development results

The design phase aims to design and prepare instruments needed in development research. The things that are done at this stage are making a composition of teaching materials and grids, looking for sources and information, compiling material and questions of reflection, making presentation designs and displaying instructional materials and instruments.

At the design stage, we use geothermal power plants as a context. In this teaching material, the processes and concepts of physics involved are discussed, such as temperature, heat and displacement, electricity, energy and others. The most important part is a positive attitude about the development of geothermal as one of the renewable energy sources [17]. One of the uses of geothermal is to provide direct heat for industrial and commercial purposes [18].

At the development stage, the design results in the previous stage are translated into a more detailed and specific format. At this stage, the design of teaching materials that have been prepared in the previous stage was developed so that it became a better teaching material and became a single unit. The stage that is no less important in this phase is implementing expert validation and perceptions of readability from students. Table 3 below shows the results of the validation of both.

#### Table 3. Expert and student assessment of learning materials.

| Domain literacy | Expert perspective | Students perspective |
|-----------------|--------------------|---------------------|
|                 | Score | Category | Score | Category |
| content         | 74    | good     | 77    | good     |
| packaging       | 74    | good     | 77    | good     |
| language        | 76    | good     | 78    | good     |
| Graphic         | 78    | good     | 79    | good     |

To determine whether or not the enrichment material is validated, we use the center's reference of the curriculum and books. Both the results of the validation from the expert and the results of student perceptions, both of which indicate that this teaching material is feasible to use.

#### 3.3. Results of implementation and evaluation

After teaching materials are considered feasible, the next step is limited trials in two schools near and far. The results of the gain analysis from the trials are shown in table 4.

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Table 4. Effectivity (N-Gain analysis).

| School            | N-Gain | Category |
|-------------------|--------|----------|
| X (close to location) | 0.35   | medium   |
| Y (far from location)  | 0.37   | medium   |

By referring to the N-Gain criteria proposed by Hake (1999), values of 0.35 (at school X) and 0.37 (in school Y) indicate the effectiveness of physics teaching materials in improving student literacy in the medium category [19]. In addition to the development of integrated physics teaching materials for renewable energy, increasing student literacy can also be done through the geospatial curriculum approach [20].

4. Conclusion

Based on the results of the validation of two validators and perceptions of some students, it can be concluded that contextual physics teaching materials based on geothermal power plants are feasible to use. The test results of the effectiveness of passing the N-Gain analysis showed that the enrichment material proved to be able to improve student literacy. By integrating physics learning with facts and phenomena witnessed by students in everyday life, it is expected that students' learning motivation towards physics will be much improved. Future efforts, so that student literacy gets better, needs another effort to introduce geothermal power plants in software form [21]. The development of physics teaching materials that discuss renewable energy is an effort to involve the public together in energy issues that are proven to consistently contribute to raising awareness and responsibility of all different stakeholders [22]. Ultimately, through increasing literacy, positive and negative impacts are possible because of geothermal development and for sustainable geothermal projects, this impact must be managed to produce positive results [23].

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