Student physics literacy on gas power plants

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Abstract. The electricity we use comes from generators. Not everyone understands how electricity is generated and how it can flow into homes. This paper wants to reveal the concepts and phenomena of physics in gas power plants and how the level of student literacy is about it. This research is a preliminary study using observational methods, surveys, and literature studies. The results showed: (1) there are many electricity concepts found in gas power plants (2) Student literacy related to the working principles of gas power plants is still low. This study concludes that many physical concepts can be explained when electricity is produced at a gas power plant that must be taught to students. This study recommends the importance of efforts to increase student literacy through learning contextual physics.

1. Introduction
Electricity, as a form of primary energy plays an important role in life [1]. Electricity consumption in Indonesia, especially household electricity consumption, continues to increase every year [2]. The large demand for electricity requires the availability of an increasingly large source of electricity supply [3]. Electricity used in daily life is sourced from a generator. The power plant comes from a mixture of various resources such as natural gas, coal, nuclear, and renewable energy [4]. One source of electricity supply is the Gas Power Plant (GPP), which uses fossil fuels in the form of natural gas [5].

GPP is closely related to physical processes that utilize the change in kinetic energy into electrical energy [6]. The availability of electrical energy sourced from generators needs to be maintained by the surrounding community. However, the level of community participation is still not optimal. The community does not yet understand how electricity is generated from generators and how electricity can flow into homes. This phenomena is caused by the low literacy of science. One effort to improve community science literacy is through education in schools [7].

Schools, through curriculum and learning, can teach electrical phenomena to their students more easily. Previous studies have shown various methods for introducing electrical phenomena such as tutorials [8], multimedia learning modules [9], Learning physics in context [10,11]. However, the use of various approaches and learning methods in the context of curriculum development and learning must begin with research and be tested through research [12-14]. This paper wants to unveil a preliminary study of the opportunities for the use of gas power plants as a context for learning physics to introduce the concept of electricity to students.

2. Method
The research method used is observation, survey, and literature study. The study began by observing the GPP site in Cirebon, West Java. The Sunyaragi Gas Power Plant. Then survey a questionnaire to students.
at SMAN X that are close to the location of GPP and SMAN Y far from the location. Determination of the sample using a purposive technique by considering the location of the school with the power plant.

The questionnaire distributed contained four aspects of scientific literacy, namely aspects of the process, concepts, context, and attitudes [15]. Science literacy plays an important role in life, so students can address problems related to science and technology issues [16]. The issue of work principles and the use of GPP is one example of literacy material that must be mastered by students [17].

The final step is the literature study, which aims to confirm the findings at the time of observation and the results of the survey data analysis. Literature studies are also needed to discuss the physical concepts that exist in the GPP.

3. Result and Discussion

3.1. Working principle of gas power plant

GPP is a power plant that converts the kinetic energy of gas to produce rotations in a turbine so that it moves a generator that produces electrical energy. GPP causes CO2 gas emissions in large amounts but lower than coal [18]. Natural gas is used as a fossil fuel for the GPP sector [19]. Figure 1.a shows the location of the Sunyaragi Gas Power Plant and Figure 1.b shows the scheme of the process of gas power plants. The Sunyaragi Gas Power Plant is operated by PT Indonesia Power. The Sunyaragi GPP operation uses gas as the main fuel and High-Speed Diesel (HSD) as a backup fuel. The main components in the GPP work process are pipelines, compressors, gas turbines, and generators [20].

![Figure 1. a. Sunyaragi gas powerplants  b. Scheme of the process of gas power plants](image)

Gas network consists of nodes and pipelines [21]. Diesel fuel contained in ships is channeled into High Speed Diesel fuel and then pumped using a fuel pump. The gas flow rate in the pipeline is determined by the pressure difference between the upstream and downstream nodes. Physically, this work process is related to the fluid principle of Pascal's Law. The working principle of a fuel pump has similarities with the working principle of a hydraulic pump which is the application of Pascal's Law, namely "if a fluid is subjected to pressure, then that pressure will be transmitted indefinitely to every part of the fluid and to the walls of its container" [22]. Mathematically, Pascal's Law has the following equation:

$$\frac{F_i}{A_i} = \frac{F_o}{A_o}$$

Equation (1) shows that the Fo output force must be greater than the Fi input force if Ao > Ai. Besides, in the fuel pump, there are concepts of kinetic energy, potential energy, and exergy. Kinetic energy is produced due to the flow of diesel fuel at a certain speed. The potential energy occurs due to differences in the height of diesel fuel. Exergy is a central concept in the utilization of energy that is
bound to physical processes that transform primary energy into exergy, which is defined as work that can be used inside and outside the system [23].

The electric motor successfully rotates the compressor so that the air will be sucked by the compressor through the air filter so that dust particles do not enter the compressor. The hot air will be flowed into the combustion system, and a combustion process is carried out to produce gas with high temperature and pressure so that it has a high heating value. Physically, the heating capacity tells us how much temperature is needed to calculate the calorific value of the gas in order to increase the value of the greater heat [24]. The calorific value of gas can be formulated as follows.

\[ C = \frac{Q}{\Delta T} \]  

where C is the heat capacity, Q is the heat and \( \Delta T \) is the change in temperature, or

\[ Q = C (T_f - T_i) \]  

Optimization of the gas turbine cycle by spraying steam in the combustion chamber is done to produce the required power [25]. The DC power flow model is used to represent the electricity network [26]. The resulting steam will be sprayed into the gas turbine so that the gas energy is converted into mechanical energy on the shaft of the gas turbine that turns the generator. The generator will produce a potential difference in the magnetic field, which ultimately produces electrical energy [27].

Mathematically, electrical energy has in common:

\[ E_l = V I t \]  

where \( E_l \) is electrical energy, V is voltage, I is current, and t is time. The physics concepts involved in the generator are magnetic induction electric motions including rotation, coils and magnets. A magnet on a generator is a magnet produced from iron wrapped around a wire. If a coil is electrified, a magnet will arise with the equation:

\[ E = B v l \]  

Where E is the electromagnetic force, B is the magnetic field strength, v is the rotational speed, and l is the conductor length [28].

3.2. Student's scientific literacy

Data on scientific literacy of students obtained from Student Activity Sheet (SAS) values are presented in table 1 below.

| Literacy Domain | Close School Score | Far School Score |
|-----------------|--------------------|-----------------|
| Process         | 1.95               | 1.79            |
| Concept         | 1.89               | 1.79            |
| Context         | 2.16               | 2.21            |
| Attitude        | 1.89               | 1.79            |
| Average         | **1.97**           | **1.89**        |

Table 1 shows the average scores of students in the four aspects of scientific literacy about gas power plants. The score obtained by students of SMAN X by 1.97 and students of SMAN Y by 1.89. The data shows that the scientific literacy ability of students in the two schools is still low [29]. These results confirm the results of previous studies [30]. This data shows that the level of literacy of students related to gas power plants is still low both in schools that are near and schools that are far from the location of the plant. This data also shows that students' understanding of the concept of electricity in GPP is still low. There are a gap and miss link between learning electricity in school and the application of physics concepts in the real world. Future research is how to become a real-world in the field, in this case, GPP can be used as a context of learning electricity in schools so that public literacy about physics is related to energy and environmental literacy in which they live [31, 32].
4. Conclusion
Students' understanding of electricity is critical in physical literacy. This initial research shows that the literacy of students towards the gas power plant is still low even though they have learned about electricity. Schools have a role in increasing student literacy through curriculum development. GPP can be used as a context for learning physics to introduce the concept of electricity to students.

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