

CHAPTER I

PRELIMINARY

1.1 Background of the Study

In era technological advancement, the study of physics has become essential for understanding natural phenomena and fostering innovation. Physics education is often confronted with various challenges, particularly in explaining abstract concepts. Learning physics is not merely about memorization. Rather it emphasizes the ability to comprehend the fundamental theoretical concepts that can serve as a foundation for solving problems and analyzing real-world occurrences (Kurniawan & Sukarni, 2022). However, students frequently face difficulties in visualizing their concepts in real-life contexts. Therefore, students require instructional approaches that can directly illustrate the material explained by teachers in the context of everyday life.

Physics is one of the subjects taught in school. Physics is a branch of science that plays an important role in life, particularly in natural science and technology. Studying physics also helps students develop intellectual and moral attitudes. Therefore, students are required to adapt the change and act based on logical thinking, critical thinking, creativity, and innovation. One way to achieve this is by studying physics (Zaenab et al., 2022).

In physics education, particularly in the topic of work and energy, there are several factors that make the material difficult for students to understand. According to a study by Handayani (2018), students struggle to grasp the concept of work, which may be influenced by their associative thinking. Associative thinking shapes a student's ability to respond to what they observe. For instance, students often assume that work is positive when displacement is to the right, and negative when displacement is to the left. This misconception was found in 16% of students. However, the direction of displacement (whether to the right or left) is not the actual determining factor for whether work is considered positive or negative.

According to Pratama (2017), students also face difficulties in understanding problems presented in questions. The challenge in planning solutions arises from a lack of comprehension of the underlying concepts used in the problems. Mastery of concepts is crucial for students, especially in analyzing natural events related to physical phenomena. Unfortunately, many students still experience conceptual errors due to the complex interrelationships among concepts. Research indicates that preventing misconceptions requires approaches that address these misunderstandings in the topic of work and energy, including teaching methods, the use of high-quality learning resources, and active student engagement in the learning process to achieve optimal learning outcomes (Saputra et al., 2024).

Another factor to students' low learning results in physics is the dominance of teacher-centered learning process. according to Sunarti Rahman (2021), students tend to be passive recipients of information rather than active participants in the learning process. When the learning process focused on teacher-centered, student limits in opportunities to construct understanding through explanation and experimentation. In teacher-centered, student often experience several obstacle that hinder their learning outcomes. Their conceptual understanding tends to be shallow, as lessons are dominated by verbal explanations and formula memorization rather than exploration or visualization of real phenomena. Student participation is minimal, since the teacher plays the dominant role while students passively receive information without opportunities for discussion or practice activities. Students also have a low knowledge transfer because students is passive listening and it makes student easily forgotten the material. Learning results are difficult to improve due to difficulties in solving problems that require conceptual reasoning, not just formulas. Teacher-centered learning make a limitation in developing students' understanding of abstract concepts like work and energy.

Another problem that makes low learning results in the topic of work and energy is the limited implementation of physics laboratory activities in school (Nurrita, 2018). Student rarely have the opportunity to conduct experiments that allow them to observe

the relationship between force, displacement, and energy transformation directly. As result, learning becomes theoretical and abstract, making it difficult for students to visualize how physical principles operate in real situation. Without practical experiences, students tend to memorize formulas, for example is work without understanding the energy transformation and conservation.

Based on researcher's observation at one of senior high school in Medan, the implementation of the Merdeka Curriculum has already been adopted at the school. Teachers are familiar with the use of PowerPoint as an instructional medium, as well as with conducting practical experiments and using teaching aids. However, during physics instruction remains predominantly reliant on conventional tools, such as chalkboards and textbooks, and continues to be teacher-centered furthermore, the execution of practical activities in the school is suboptimal. This lack of differentiated instruction has led to minimal active student participation in the learning of physics.

Teacher competence, student's process skills, and students' knowledge all play significant roles in encouraging active student participation during the learning process. One potential alternative solution to the challenges mentioned above is the use of an innovative instructional model – namely, the discovery learning model. This model aims to enhance the quality of learning by promoting active student engagement, increasing curiosity, fostering creativity, and creating meaningful learning experience. Discovery learning, which emphasizes freedom of thought and student autonomy, is considered suitable for addressing the aforementioned issues. One of its key strengths lies in its personalized nature (Septi et al., 2022). Furthermore, this model allows students to actively engage in learning activities while fostering scientific attitudes in the process of discovering physics concepts.

In the discovery learning model, the effectiveness of the learning process can be further optimized through the integration of instructional media. Instructional media are tools that convey learning content in ways that stimulate students, interest and motivation to learn. One such medium is the Physics Education Technology (PhET)

simulation. PhET Simulation to the limited availability of laboratory activities in schools (Thohari et al., 2019). PhET simulations across a range of scientific topics, each accompanied by experimental guidelines to facilitate exploration and learning.

Discovery learning encourages students to take an active role in exploring and uncovering concepts through experiments and simulations related to physical phenomena. This model fosters students' curiosity, thereby enhancing their ability to understand and retain concepts more effectively. PhET simulation provides meaningful learning experiences by allowing students to visualize abstract physics concepts that are often difficult to comprehend through verbal explanations alone (Sari & Simanjuntak, 2016).

The discovery learning model offers an effective solution to overcome the limitations conventional, teacher-centered instruction. This model emphasizes students' active participation in constructing their own understanding through exploration, experimentation, and reflection. In the context of physics, discovery learning encourages students to investigate physical phenomena, identify patterns and formulate relationships among the topic of the material. Such process promote creativity and curiosity, to mastering abstract concepts like work and energy. By allowing students to take ownership of their learning, discovery learning transform the classroom from a teacher-centered into an interactive, inquiry-based setting that enhances both conceptual understanding and learning results.

The implementation of PhET simulations further strengthens the implementation of discovery learning by providing interactive, visual, and experimental learning experiences. Through the use of simulations, students can observe and manipulate physics material in real time, enabling students to test hypothesis and draw conclusion based on evidence. In energy skate park basics, allows students to explore the concepts of mechanical energy through a virtual skateboard moving along a track. Students can visualize the transformation between kinetic and potential energy, observe the influence of mass and friction and verify that the total mechanical energy remains

constant within a closed system. Such interactive engagement not only depends on students' conceptual understanding but also bridges the gap between theory and practice that often exist in physics learning.

PhET simulations have been proven effective in helping students understand challenging concepts such as energy, which cannot be seen or touched directly. Furthermore, the combination of discovery learning and PhET simulations is considered capable of developing 21st century competencies, including critical thinking, collaboration, communication, and creativity (the 4C). Numerous studies have shown that the use of this learning model has a positive impact on students' learning outcomes, particularly in the topics of energy and work (Muchoyimah et al., 2016).

In addition to energy skate park basics, other PhET Simulation such as pendulum lab and skate park offer valuable contexts for increasing the concepts of potential energy, kinetic energy, and the law of conservation of energy. In pendulum lab, students can experiment with variables such as string length, mass and gravity to observe how these factors affect energy transformation within a pendulum system. These simulations align with the principles of discovery learning by enabling students to actively construct knowledge through observation and experimentation rather than in conventional learning when students listen and solve the problem of the material. The discovery learning assisted by PhET simulations provides an instructional approach to improve students' conceptual understanding, engagement and learning outcomes in the topic of work and energy.

Based on the background explanation, the author designs a learning model using discovery learning assisted by PhET simulation to address field problems, by conducting a study titled **“The Effect of Discovery Learning Model Assisted by PhET Simulation on Student Learning Result in the Material of Work and Energy”**.

1.2 Problem Identification

Based on the background above, the problem identification in this study are:

1. Students demonstrate low interest in physics learning when it is delivered through conventional teaching methods.
2. Students' learning results have not yet met the expected learning objectives outlined in the Merdeka Curriculum.
3. The use of instructional media lacks differentiation, particular in implementing simulation based learning.
4. Students rarely engage in practical learning.

1.3 Scope of Study

The research that is conducted in 11th grade SMA Negeri 8 Medan during the odd semester, focuses on the effect of discovery learning model assisted by PhET simulation on student learning result in the topic of work and energy. The learning results are then measured using a learning result test instrument.

1.4 Scope of Problems

The limitation of problem in this research are:

1. The teaching design implemented in this research is the use of discovery learning model assisted by PhET simulation.
2. This research focused on observing student's learning result.
3. The main topic taught is work and energy.

1.5 Research Problem

Based on the background, the research problems are:

1. How are the students' learning results on the topic of work and energy when taught using the conventional learning model in grade XI at SMA Negeri 8 Medan?

2. How are the students' learning results on the topic of work and energy when taught using the discovery learning model assisted by PhET simulations in grade XI at SMA Negeri 8 Medan?
3. Is there a significant effect of implementing the discovery learning model assisted by PhET Simulations on students' learning outcomes on the topic of work and energy in grade XI at SMANegeri 8 Medan?

1.6 Study Objective

Based on the research problem, the study objective of this study are:

1. To determine the students' learning results on the topic of work and energy when taught using the conventional learning model in grade XI at SMA Negeri 8 Medan.
2. To determine the students' learning outcomes on the topic of work and energy when taught using the discovery learning model assisted by PhET Simulations in grade XI at SMA Negeri 8 Medan.
3. To determine whether there is a significant effect of implementing the discovery learning model assisted by PhET simulations on students' learning outcomes on the topic of work and energy in grade XI at SMA Negeri 8 Medan.

1.7 Research Purposes

The researches purpose are:

1. To provide input and guidance for teachers in applying the discovery learning model assisted by PhET simulation, to improve student learning results.
2. To offer information on physics learning results using the discovery learning model assisted by PhET simulation, on the topic of work and energy.
3. To serve as an alternative source of information for selecting a teaching model for the topic of work and energy.
4. To provide input for researchers to expand their understanding of the discovery learning model assisted by PhET simulation.