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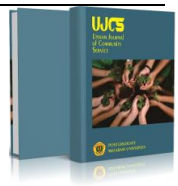

Physics Concept Understanding Training Based on Multirepresentation and Inclusion for Students of SMP Negeri 81 Central Maluku

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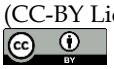

Abstract: Science learning is a subject at the Junior High School level whose material is an integration of biology, chemistry and physics. However, there are still many teachers who do not have a science education background. This can be seen in the Eastern Indonesia region, where science teachers come from a certain discipline background, namely Biology, Physics and Chemistry. This is very disruptive in improving students' conceptualization. For example, biology teachers must teach physics concepts or vice versa. This situation makes it impossible to improve the quality of students, especially in physics learning. This is a concern and a separate note from the Government. Therefore, one of the activities carried out to improve students' conceptualization in physics is throughCommunity service activities (PKM). This activity is in the form of training with the aim of improving students' conceptualization in learning physics, especially Newton's law which is still a mistake and debate among students. This activity was carried out face-to-face for 84 students and accompanied by the principal and science teachers. The result of this activity is that students' conceptualization of Newton's Law increased, where students were able to answer several questions in the form of several physics cases from lecturers as activity speakers. In addition, there were many critical and unique questions given by students related to the phenomena they encountered in their environment related to Newton's Law.

Keywords: Conceptual understanding; Multirepresentation; Inclusion; Physics learning

Introduction

Physics is formed primarily as an experimental science: its laws are based on facts obtained experimentally. These laws are based on certain quantitative relationships and are expressed in mathematical language. Physics is divided into two parts, namely experimental physics and theoretical physics (Imanova, 2022). Physics has long been considered an abstract discipline and removed from the daily life experiences of students (Ramma et al., 2018). Physics is considered a difficult and demanding subject in the school curriculum and, therefore, enrollment in this subject is declining in developed countries, for example the US, UK, Germany, Singapore and the Netherlands (Oon & Subramaniam, 2010). This is proven by the fact that physics and elementary education students still have high levels of misconceptions regarding temperature and heat phenomena (Souisa et al., 2024). Other studies also show low enrollment in related physics subject combinations worldwide, especially at higher levels of study. The main reason for this decline is probably the passive teaching methods most teachers use in physics classes (Khan et al., 2021). The abstractness of physics, among other challenges associated with physics learning, is related to the traditional teacher-centered method, which does not allow students to integrate acquired skills such as critical analysis and creative thinking.(Batlolona et al., 2019). On the contrary, these teacher-centered practices lead to lower student achievement and the development of misunderstandings (Uwamahoro et al., 2021). This

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situation is also the same as the development of learning in schools which are places for community service activities, where teacher practices with traditional learning schemes are still carried out (Leasa et al., 2023). Lack of facilities and geographical location are obstacles for teachers to carry out good learning, so that students consider physics less interesting. This has an impact on students' conceptual weakness (Jamaludin & Batlolona, 2021). They are unable to explain a phenomenon scientifically because they are still trapped in local experiences and culture (Wattimena & Batlolona, 2024). Reasons like this are the basis for training in the form of community service to students at SMP Negeri 81 Central Maluku.

Students need the ability to interpret and reason with mathematical concepts. If students have difficulty with mathematical calculations, they may lose interest in physics (Abdul Halim Roslan & Nur Jahan Ahmad, 2022). Students with weak math skills will also be weak in physics skills (Chiu, 2016;Batlolona et al., 2019). In the context of physics, mathematics not only serves as a representational tool for physics concepts (e.g., equations, graphs, etc.), but also provides a logical path to solving complex physics problems. Thus, students are expected to have a good understanding of basic mathematics to study physics. The context of physics can help students gain a better understanding of mathematical quantities and structures (Bajracharya et al., 2023). Students' ability to solve problems depends on their conceptual understanding of things. Over the past decade, these factors have been widely studied (Bahar & Aksüt, 2020). Teachers' work commitment and performance can be evaluated based on academic achievement data, while students' mastery of concepts and problem-solving skills are directly correlated with their academic success (Khan & Rauf, 2024).

The results of international studies, for example in Israel, stated that 82% of 10-year-olds and 66% of 14-year-olds said that science was interesting. Among 17-year-old students who chose to study science for the matriculation exam, 72% found biology interesting, while only 48% found physics interesting (Tamir, 1988). Israeli middle school girls tend to be more interested in languages, social studies, and the humanities, while boys are more interested in science and technology. Furthermore, boys' interest in science and technology increases with age, while older girls become less interested (Trumper, 2006).

The importance of students' ideas about physics concepts or alternative frameworks is one of the most prominent research topics in science education as a whole. Conceptual change remains one of the most prominent frameworks for understanding science learning (Kulgemeyer & Wittwer, 2023). The main idea is that students already have concepts about the physical world before attending class, their ideas are often different from the scientific point of view, and are difficult to change. In addition, the teaching of science itself sometimes contributes to the development of ideas that deviate from the scientific view (Money, 2003). For example in the concept of optics (Uwamahoro et al., 2021), teachers experience misconceptions of 50% (Cildir, 2016).

Method

The PKM activities carried out consist of scientific activities, training, and simulations. This training is carried out using several methods as follows: 1) Training is carried out using a case study method in the form of questions to students related to physics phenomena in everyday life; 2) Training is carried out by providing demonstrations to students; 3) Training is carried out in a participatory manner, namely PKM implementers accompany and actively participate in order to ensure the success of the training carried out. In this PKM activity, it is hoped that it will be able to achieve success, namely that students' physical concepts are more improved when compared to physics concepts before training. This is achieved by the participation of schools in this training program which act as participants. Participant participation here means the role in signing the cooperation agreement. In addition, partners also strive for conducive conditions and environments with the support of adequate facilities and infrastructure in organizing PKM activities.

The implementation of this community service activity needs to be evaluated so that input can be obtained as suggestions for improvement in carrying out the next activity. The evaluation carried out in this activity is to hold a post-test. This aims to measure the extent to which the participants understand the material presented. Furthermore, observations and interviews are carried out on the implementation of the PKM activity. The evaluation that has been given a questionnaire regarding satisfaction with the PKM activity. Therefore, this evaluation is expected to be able to provide input in the form of results of measuring understanding, identifying the success of actions in practice, and participant satisfaction with this activity.

The activity was carried out for 2 days, namely October 15-16, 2024. The speakers for this activity were Jamaludin, S.Pd., M.Sc and John R. Batlolona, S.Pd., M.Pd with the moderator Drs. Sefnath Nuniary, M.Pd. This activity was held at SMP Negeri 81 Central Maluku which is located in Sanahu Village. The distance from Pattimura University to Sanahu Village, namely the activity mantra, is 75.1 km. The travel time to Sanahu Village is 4 hours. This is because from Pattimura University, namely Poka Village, using a four-wheeled

vehicle to Liang Village with a journey of 1 hour. Then cross the sea using ferry transportation for 1.5 hours to Waipirit Village. Then continue the journey to Sanahu Village with a travel time of 1.5. The number of participants who took part in this activity was 84 people who were students of the 2024/2025 academic year, odd semester. PKM activities run well because they are supported by the availability of internet at school which is assistance from the Accessibility and Information Agency (BAKTI).± ± ±

On the first day of the event, students were given several physics topics with the aim of studying them at home. The goal is that when the activity is carried out the next day, they will have ready knowledge and be able to ask questions that they understand. This discusses the determination of the location of the agency and reviews from visitors to this location. The second day focused on training in the form of providing physics material focused on Newton's laws. The resource person showed several videos related to Newton's laws (Figure 2). Students were stimulated with learning videos that represented several things, namely words, graphs, mathematical equations, and diagrams to help students explore critical and creative ideas that they would put forward. In addition, it can also reduce misconceptions that occur in their thinking. This is because students still hold local knowledge that is very different from scientific principles. Furthermore, students were given the opportunity to ask several questions related to everyday life phenomena related to Newton's laws.

Results and Discussion

This training activity was opened directly by the Principal of SMP Negeri 81 Central Maluku. The principal felt grateful and thankful for the assistance and concern from partners, namely lecturers from the Physics Education Study Program, Pattimura University, Ambon, who had taken the time to go to school to provide materials to students. The principal also hopes that students can have good knowledge of science, namely physics, because so far the teachers who teach physics are biology teachers. There are no teachers with a concentration in physics, so students find it difficult to understand physics well. So the principal hopes that there will be graduates from science who are placed in schools to help in learning. This view is the same as the results of a study in Jiangxi Province, China, which stated that the ratio between biology and physics teachers at the junior high school level is relatively far different, namely the average science in junior high schools is filled with biology teachers, namely 43.7% and teachers with a physics background, namely 3.8%. On average, graduates become teachers due to several factors. The results of the study showed that 34.8% of them preferred to become teachers simply because they wanted to do the teaching profession; 20.8% happened to be teachers; 16.8% became a teacher because it was easy to get a job; and only 0.7% of them believed that teachers' salaries were satisfactory.(Baran et al., 2015). In fact, the government, namely the education department, has forgotten that the conceptual formation of students' physics is very important. Where in the current era, physics is the end of the wall in the development of science and technology. Conceptual understanding is an important goal in learning in general, but is especially relevant in science education because this understanding is needed to understand phenomena (Phanphech et al., 2019).

Figure 1. The training activity was opened directly by the principal of SMP Negeri 81 Central Maluku, namely Thopilus Batlolona, S.Pd.

Figure 2. Presentation of material for students with resource persons when providing physics material, namely Newton's Laws

Each student has a different type of knowledge and processes information differently to complete their learning cycle. This can be seen from several videos about the concept of Newton's Law shown by the speaker to students. After that, when the speaker asked the questions that had been prepared, none of the students were able to answer. They just looked and smiled at each other. This indicates that students find it difficult to answer questions given by the teacher. There are many classical phenomena that are usually given by teachers and are still oriented to books and when given different phenomena, they will have difficulty answering. The strategy is for the speaker to practice direct teaching and answer the questions given. Provide some physics analogies so that they can understand well and form their physics concepts. The speaker explains slowly to students. Remember that students individually become flexible in learning and become active agents to acquire knowledge and skills(Akinyode, 2016). The results of the study show that most science teachers in junior high schools in Mataram city have a background in biology or physics. For teachers who have a background in biology, they find it difficult to guide their students to study physics material. Science teachers who do not have a complete science background must continue to teach science to their students, as a result, students cannot understand science material completely. Based on the analysis of basic competencies at each grade level in junior high schools, there are 33% of basic competencies that are physics studies, and the remaining 67% are biology and chemistry studies. Science teachers who have a non-physics educational background are less able to understand science material, especially physics material. Therefore, science teachers at junior high schools really need to be given guidance in mastering physics material, especially for teachers with a non-physics background.(Doyan et al., 2019).

Figure 3. The training activity is a number of questions related to physics phenomena submitted by students.

One of the conceptual questions submitted by students is: Why can a coconut still move when it falls and touches the ground? The speaker's answer is: To explain this phenomenon, it can be studied from the concept of energy and the concept of dynamics, namely from the forces that influence it: From the concept of energy, namely potential energy and kinetic energy after the coconut falls and touches the ground, the coconut still has remaining kinetic energy that it obtained when it fell. This remaining energy can make the coconut move or roll if the ground surface is sloping or uneven. The coconut will rotate if the soil that the coconut hits is soft and elastic, bounce if the coconut has elastic skin, old coconut and hard or rocky soil properties from the concept of dynamics or forces that influence the movement of the coconut after touching the ground is influenced by several forces.

1. **Gravitational Force (W = mg)**: The force of gravity continues to act on the coconut, pulling it downwards.
2. **Normal Force (N):** When the coconut touches the ground, the ground exerts an upward reaction force called the normal force. The magnitude of this force is the same as the gravitational force when the coconut is in a still position on the ground, meaning the coconut immediately stops or does not move anymore.
3. **Friction Force, Static Friction:** If the coconut stays in place, then static friction is preventing the coconut from moving further. Kinetic Friction: If the coconut is still rolling or moving after it falls, kinetic friction will slow down the movement until the coconut comes to a complete stop.
4. **Newton's First and Second Laws:** When the coconut falls and is still moving on the ground, Newton's First Law states that an object will continue to move at a constant speed (inertia) until there is another force (such as friction between the ground and the coconut or there is another material around the coconut) that changes its state of motion. Newton's Second Law states that the change in the coconut's motion (acceleration or deceleration) will be proportional to the total force acting on it (namely the kinetic friction force that slows it down to a stop).

Concerns about the learning process in physics are primarily based on observed differences between what teachers teach and what students learn (Guisasola et al., 2002). Conceptual understanding requires the knowledge and ability to use scientific concepts to develop mental models of how the world operates according to current scientific theory (Saleh, 2011). Typically, special representations are used in physics teaching in one of three modes: a) as a means of explaining problems, as occurs when a student draws a sketch of a physical situation and provides a summary of the information given; b) as the subject of a problem, as occurs when a student is explicitly asked to draw a graph, or to find the value of a physical quantity using a graph; and c) as a step in a formal procedure, as occurs when a student is required to draw a freebody diagram as one of the initial steps in applying Newton's Laws to solving a problem (Dufresne et al., 1997). Conceptual understanding as the ability of students to reason in situations or environments that require the careful application of concepts, descriptions, relationships, or representations. Conceptual understanding requires students' ability to synthesize information and knowledge from known schemes and apply them in new contexts. In addition, students' conceptual understanding of physics is manifested by the ingenuity and cleverness to coordinate different parts of knowledge to solve given problems by applying known concepts in new situations (Banda & Nzabahimana, 2021). After the activity, the Principal who directly monitored the activity and even followed the activity from the beginning to the end was pleased that the students were able to understand well and were even able to explain. The Principal hopes that the lecturers from Pattimura University will continue to carry out activities in our school in improving the quality of education in Sanahu Village, Central Maluku.

Figure 4. Group photo with the principal after carrying out training activities.

Conclusion

Based on the PKM activities that have been implemented, it can be concluded that students' conceptual understanding of Newton's Law has increased, where students can answer several questions in the form of several physics cases from lecturers as activity speakers. In addition, there are many critical and unique questions given by students related to the phenomena they encounter in their environment related to Newton's Law. This activity is also able to encourage students to be more actively involved in the learning process and improve their critical thinking skills. In addition, this activity makes learning more interesting and helps students focus more on understanding the material. This community service provides a positive contribution to efforts to improve the quality of education, especially physics science learning in Indonesia and is expected to inspire similar activities in the future. The next activity in 2025 is a physics practicum activity for students of SMP 81 Central Maluku so that they are stronger in the concept of physics, both theory and practice.

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