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Introduction of Quantum System, Step Potential and Barrier Potential to Class X Students of SMA Budi Utomo Bengkulu City

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Abstract

Physics is a science that is very close to everyday life. However, physics learning is often a subject that is less attractive to students because it tends to be difficult to understand. This community service aims to introduce and provide an understanding of physics, especially quantum systems, including potential steps and potential barriers to students of SMA Budi Utomo Kota Bengkulu. Activities are carried out in 3 stages namely preparation, implementation, and evaluation stages. The community service method used in this study was socialization and material exposure with PPT instruments. The research was aimed at class X students with a total of 31 students at SMA Budi Utomo Kota Bengkulu. Implementation This service activity was carried out in November 2023. The results showed that students can understand abstract physics material using simple language and examples in everyday life. It can be concluded that students will more easily understand abstract physics material if it is delivered effectively and involves active learning activities.

A. Introduction

Physics is a natural science that studies the phenomena of the physical world and its surroundings. It is closely related to human life, as some of its concepts can be applied to the development of useful technology and equipment (Harefa, 2019). Quantum mechanics is a fundamental branch of physics that underpins technological development, particularly on a microscopic scale (Elisa et al., 2023). Quantum mechanics is a branch of physics that deals with the behavior of matter and energy at the microscopic level. It involves the study of particles such as neutrons, protons, atoms, and electrons, which cannot be observed directly (Aini et al., 2020).

The Schrödinger equation is a second-order differential equation that describes the quantum state of a system that changes with time, expressing particle dynamics at the microscopic level. Its solution provides information about the behavior of particles under the influence of a potential, including the energy spectrum and wave function. In quantum systems, various cases are analyzed using different types of potentials (Mita, 2021). Two common potential forms in one dimension that are frequently used in quantum systems are the step potential and the barrier potential (Sudiarta, 2019).

The step potential and the barrier potential are two types of potential barriers that restrict the movement of particles in a quantum system. These potentials have a similar form and can be solved using the time-independent Schrödinger equation. It is important to note that technical term abbreviations, such as 'Schrodinger equation', should always be explained when first used.

$$-\frac{\hbar^2}{2m_e}\frac{d^2\psi(x)}{dx^2} + V_0(x) = E\psi(x) \quad (1)$$

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To solve the Schrödinger equation for a step potential, the system is divided into two regions. For a barrier potential, the system is divided into three regions. Each potential is analyzed in two cases when the energy is greater than the barrier potential ($E < V_0$) and when it is less than the barrier potential $E < V_0$) (Zettili, 2009).

Several studies have been conducted on step potential and barrier potential, including attempts to control the quantum system at these potentials to maintain an adiabatic state from the initial to the final state. Adiabatic processes occur in quantum systems when the external parameters of the Hamiltonian change slowly (Setiawan et al., 2019). Efforts are made to maintain this adiabatic state using the fast forward method (Hutagalung et al., 2023). The fast forward method is a method to accelerate adiabatic quantum dynamics that was first proposed by Masuda and Nakamura in 2010 (Masuda & Nakamura, 2022). The fast forward method regularizes the wave function by adding terms such as adiabatic phase and adiabatic potential (Setiawan et al., 2021; Villazon et al., 2019). This adiabatic phase and additional potential will guarantee the quantum system on the potential step and potential barrier moves adiabatically from the initial state to the final state (Elisa et al., 2022).

Physics in daily life is sometimes a very interesting topic to study, especially in quantum physics, but there are obstacles for them to enter this field because it is sometimes limited to existing learning media (Economou et al., 2020). So that students are less interested in studying quantum physics because students tend to feel that quantum physics material becomes less relevant in everyday life (Moraga-calderón et al., 2019). Physics is a relatively difficult subject, as evidenced by the UNBK results in 2019 where the average value of physics was only 40.47, while chemistry reached 50.99 and biology reached 50.61 (Nuraini et al., 2022). The average UNBK physics score is low because students have difficulty understanding the material and lack of student interest and response in learning activities (Suharto, 2021). Quantum physics material is abstract material so that media is needed in the form of images to make it easier for students to understand the material (Rahmah et al., 2023). Learning media is a tool that can help teachers in delivering quantum physics material (Ashari et al., 2023). Learning media can also be used as a tool to facilitate the delivery of material, making it easier for teachers to deliver material (Rahim et al., 2022).

One example of a learning tool is power point (PPT). PPT or Power Point is a learning media that can display text images audio and video (Putri & Yefterson, 2022). Based on previous research, PPT payment media can improve teacher performance and can improve student learning outcomes (Hadinoto et al., 2023). In addition to using learning media, to make it easier for students to understand physics material, students must be directly involved in learning activities. Thus, the system used is a 2-way and student-centered learning system (Yenusi et al., 2023). Based on previous research, the presentation of quantum physics material to students can increase student learning motivation, especially in quantum physics material. So it is expected that the results of this study can be useful for students to increase their learning motivation (Silberman, 2022).

In this study, researchers introduced quantum systems, especially in potential steps and potential barriers that have been regulated using the fast forward method to students of class X SMA Budi Utomo Kota Bengkulu. Quantum theory plays an important role in the development of today's technology (Benggadinda & Setiawan, 2021). Introducing quantum systems to students aims to broaden their understanding of the applications of quantum systems in everyday life. Renewed research in physics, particularly in quantum systems, is crucial for the further development of quantum technology (Kanim, 2020; Setiawan et al., 2023). Therefore, with this background, the researcher conducted this research as a form of service carried out in class X SMA Budi Utomo Bengkulu City.

B. Research Methods

The research method used in this study was socialization and material exposure with PPT instruments. The research was aimed at class X students with a total of 31 students at SMA Budi Utomo Kota Bengkulu. Implementation This service activity was carried out in November 2023. The research implementation method consists of three stages, namely:

a. Preparation

   Before carrying out research activities, it is necessary to prepare materials to convey quantum system material, potential wells and potential barriers. This activity is carried out by discussing related materials and making presentation materials using power point.

b. Implementation
   This activity is in the form of delivering quantum system material, potential steps and potential barriers.
c. Evaluation
   Evaluation activities are carried out in discussion sessions and also questions and answers related to quantum system material, potential steps and potential barriers.

C. Result and Discussion

Community service activities were conducted at Budi Utomo High School in Bengkulu City. The activity began with an introduction and attendance of the students. Figure 1 shows the atmosphere during the introduction activity before the presentation. The students appeared enthusiastic and attentive.

Figure 1. Introductions and Attendance Activities

The next stage is the implementation of presentations related to quantum system material, potential steps and potential barriers. The material is shown through a projector which is carried out for 1.5 hours. The presentation begins by introducing what a quantum system is and also examples of quantum systems in everyday life. The material aims to introduce quantum systems to students and provide an understanding to students that quantum systems are very close to everyday life.

Figure 2. Activity Delivery of Quantum Physics Material and Potential Steps

The second and third sections provide an explanation of step potential and barrier potential in general. To aid in comprehension, graphic images are included to illustrate these concepts. The use of these images proved effective in helping students understand the material. It is important to note that this material may be challenging for students due to its abstract nature. The fact that students asked many questions related to the material is indicative of their high level of curiosity. During the delivery of the material, the researcher aimed to explain the subject matter in a clear and concise manner, providing numerous illustrations to aid in comprehension.

Figure 3. Material Delivery Activity Potential Barrier

The following stage involves a comprehensive discussion of the material from start to finish. The purpose of these discussions is to provide students with the opportunity to ask questions and clarify any knowledge they have gained. The discussion and question-and-answer activities should be conducted in a conducive manner. Additionally, students can summarize the material covered and provide examples of how quantum systems can be applied in everyday life. Through this activity it can be concluded that physics can be easily conveyed to students if delivered with simple language, providing examples and illustrations, and giving students to ask questions and opinions as widely as possible.

Figure 4. Discussion and Q&A Activity

Before the closing activity, a mini game was also held in the form of a question and answer game. Students were very enthusiastic in answering questions. After the mini game was over, we summarized the material and then closed the service activities and photo session together.

Figure 5. Photo with Students

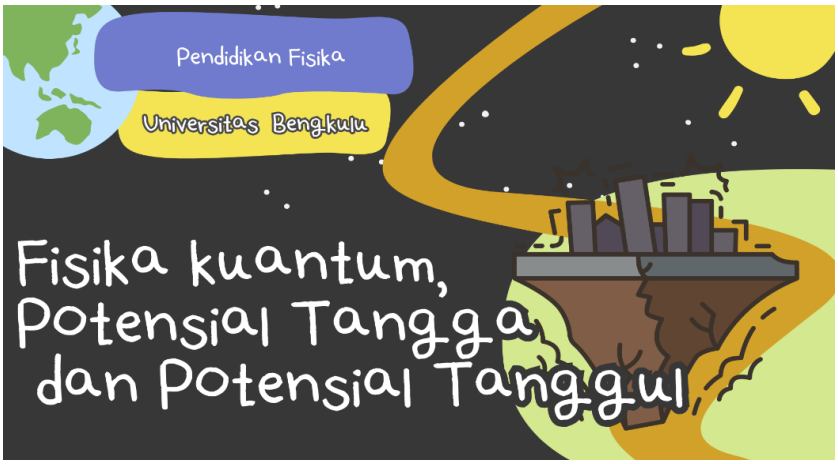

Figure 6. PPT Material

The result of this service activity is that students can understand what quantum physics is, examples of the application of quantum physics in everyday life, as well as the concepts of ladder potential and embankment potential. This can certainly be new knowledge for students about physics. The limitation in this study is in learning media. The suggestion for the next researcher is to use learning media other than ppt, for example in the form of realia media that can support student understanding.

D. Conclusion

This service activity aims to introduce and provide understanding to students regarding quantum system material, potential steps and potential barriers. This service activity can provide new knowledge about the concept of physics. This activity received a positive response from students and students were very enthusiastic in listening to the material, asking questions, answering questions, and expressing opinions. So it can be proven that abstract physics material can be explained well if explained using simple language.

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