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Improving Students' Understanding in Physics Using Experiential Learning

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Abstract

Today, education faces significant challenges because of the rapid progress in information and communication technology. These advancements have introduced numerous innovative educational techniques aimed at enhancing the efficiency of educational processes. One of the most significant developments is experiential learning, which has a favourable impact, particularly on the idea of guided self-studying. This method provides students with an alternative way to apply the knowledge they have learned through activities like demonstrations. With this approach, it can help students not only comprehend the material being covered in class but also develop their confidence and communication abilities. This paper focuses on a student's understanding of physics using experiential learning. A group of pre-diploma students was chosen to demonstrate interactive science activities to the kids in preschool. The science activities were mainly focused on topics like waves, electricity, and electromagnetism, all of which were included in their curriculum. According to the survey given at the end of the program, most of the students agreed that experiential learning can help them learn the subjects being taught better while also enhancing their soft skills in terms of confidence and communication abilities.

Keywords: Experiential Learning, Physics, STEM, Pre-Diploma, Academic Performance

Introduction

Post-covid learning poses a new challenge for educators because it requires them to impart knowledge to students more creatively and innovatively. One of the four pillars of the UiTM Education System outlined in the UiTM Teaching and Learning Policy is student-centred delivery, which optimizes student engagement and learning experience to promote active learning. It requires students to be more active and to be able to think critically and creatively (Serevina & Lestari, 2021), and lecturers must encourage students to participate actively and improve their capacity to comprehend the material covered in class.

During the semester between October 2022 and March 2023, the UiTM Cawangan Negeri Sembilan implemented a hybrid learning model in which some courses were taught in person and others were taught online. For Physics courses, particularly for the group of Pre-Diploma in Science (STEM C and Arts Streams) students, face-to-face delivery was utilized in its entirety. This was their first time attending a lecture in the classroom, as they had studied physics online in the previous semester. Consequently, lecturers face significant challenges in arousing students' curiosity in this field, as physics is commonly portrayed as a tedious and uninteresting subject that requires memorization of numerous theories and formulas. In addition, the group of students also came from a non-science background, as they did not receive any instruction in physics during their secondary education.

Thus, lecturers must combine multiple learning activities to meet the requirements of a variety of students, promote connectivism, and accommodate their diverse learning styles (Dipietro, 2010). One of the methods is incorporating experiential learning activities or programs for students to gain enriching and diverse learning experiences (Chan, 2023). By using this learning approach, the students were required to demonstrate science activities to the local community, focusing on topics such as waves, electricity, and electromagnetism that will be assessed on the final examination. Thus, it improves their comprehension of the topics while simultaneously enhancing their communication skills and self-assurance. Besides that, the performance of students in the subject of Physics will also be evaluated based on their grades from semesters I and II, to determine the efficacy of experiential learning in teaching and learning activities. Therefore, this strategy is beneficial for lecturers who encounter the same challenge of educating students without a science background, as it may assist them in understanding the subject more effectively.

Literature Review

Active learning has become a significant issue in the world of education, along with curriculum enhancements at both the high school and university levels. Active learning in the classroom refers to instructional strategies that encourage students' participation, critical thinking, and problem-solving abilities. Multiple activities can be implemented in the classroom to promote active learning such as group discussion, problem-based learning (PBL), case studies, hands-on experiments and demonstrations, role-playing and simulations, flipped classrooms, peer teaching, and many more.

In science education, hands-on experiments and demonstrations, also known as experiential learning, are incorporated because they improve students' cognitive, practical, and affective domains. The concept of experiential learning can be traced back to the teachings of Confucius around 450 BC: “Tell me, and I will forget. Show me, and I may remember. Involve me, and I will understand” (Oxendine et.al., 2004). Lewis and Williams (1994) define experiential learning as learning by experience or by doing. Meanwhile, in 1984, David Kolb proposed his model, Kolb's experiential learning cycle, which consists of four phases beginning with a concrete experience, followed by reflective observation, abstract conceptualization, and active experimentation (Kolb, 1984).

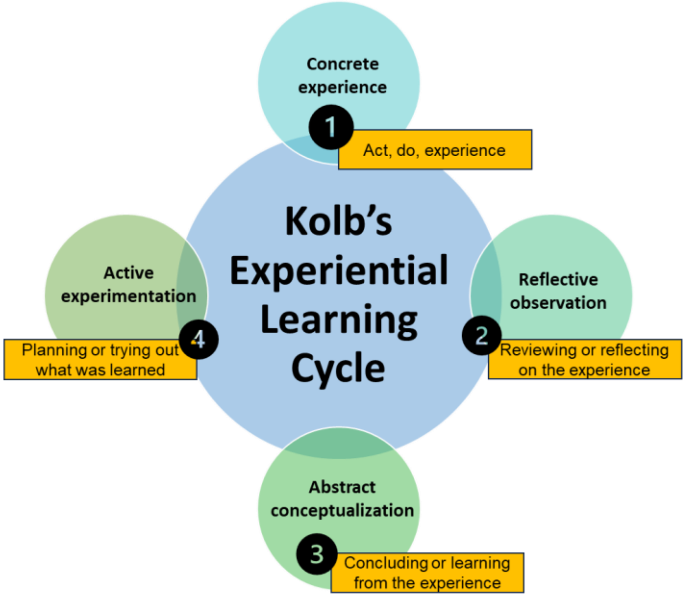

Figure 1: Kolb's Experiential Learning Cycle

Experiential learning has been studied and found to be effective for student learning, especially for the development of holistic competencies including soft skills, generic skills, 21st-century skills, transferable skills, and employability skills (Chan, 2023). All of these skills are critical for individuals to succeed in the increasingly global and technology-driven society of the 21st century. It can be divided into two major categories: field-based experiences, which occur outside the classroom, and classroom-based learning, which occurs within the classroom. Both approaches teach students to be resourceful, to think critically, to work in groups, to solve problems, and to develop interpersonal skills. Therefore, holistic competencies will benefit not only the professional development of students but also their personal growth.

Methodology

On 5 January 2023, a program named Super Little Scientist was initiated to promote experiential learning to eight Pre-Diploma in Science (STEM C and Arts Streams) students at UiTM Kuala Pilah. The program focused on play and learning themes, to introduce Science, Technology, Engineering, and Mathematics (STEM) to youngsters aged 4 to 6 as early as possible. Based on the Physics for Pre-Diploma II (PHY012) course, 34 children from Tadika Eden Hafiz Montessori participated in interactive scientific activities on topics such as waves, electricity, and electromagnetism.

The selection of science activities was proposed by the students and validated by the physics instructors before being demonstrated to the children. The students were instructed to conduct a science demonstration and briefly clarify the physics concept of the selected topic to the audience. Through this program, students can gain a deeper understanding of the topics covered in class and increase their communication confidence.

During the program, the children were split into four groups and rotated through four activities: "Let's Make Waves," "Electric Buzz," "Fun-static," and "Magnetic Friends." In the activity Let's Make Waves, the students built a telephone out of two paper cups and rope. Then, they demonstrated to the children how to generate a sound wave. When using the cup phone, the vibrations in one cup will propagate through the string to the other cup, causing it to vibrate as well. This circumstance makes the voice audible when speaking.

In the Electric Buzz activity, students demonstrate to children the difference between series and parallel circuits using light bulbs. In addition, there is the Fun-static activity, which is a demonstration related to electricity. The students demonstrate by rubbing the balloon on their hair before directing it towards a small piece of paper. A piece of paper rose spontaneously to the balloon. This is referred to as the electrostatic concept, in which opposite charges attract one another. An additional activity is the demonstration of water deflation, which entails rubbing the PVC conduit and bringing it closer to the water flow. Due to the dissimilar charges between the PVC pipe and the water, the water is attracted to the PVC pipe. In addition, students demonstrated activities for determining whether a material is a conductor or insulator.

The final activity was "Magnetic Friends," where students taught the children about electromagnetism, including different types of magnets, objects that attract and repel magnets, and a basic electromagnetic circuit. They also learned how to set up a simple circuit to attract as many paper clips as possible.

Once the program ended, the questionnaires were disseminated to the students and children to determine their perceptions and impressions of the program. As for the students, there were 10-point Likert scale questions ranging from Strongly Disagree to Strongly Agree, as well as an open-ended question regarding the student's perceptions and experience while demonstrating the program to the children. In addition, their performance in physics was assessed based on their final exam grade to determine the effectiveness of experiential learning in improving their course understanding.

Figure 2: Science demonstration activities during Super Little Scientist program.

Results and Analysis

The survey was completed by eight Pre-Diploma in Science (STEM C and Arts Streams) students who enrolled in the PHY012 course in their second semester of studies. It was discovered that 75% of the students were female as opposed to male. The three elements questionnaire was systematically developed to collect empirical data on the self-confidence, communication skill, and effectiveness of experiential learning in terms of perceptions and acceptance after participation in the Super Little Scientist program. All items in the questionnaire were measured using the 10-point Likert scale, ranging from Strongly Disagree (1) to Strongly Agree (10).

According to Soh et. al (2013), "to understand fully and aware of children's science learning, one should look not only at learning that takes place in the kindergarten and primary school but also in learning that takes place outside the classroom". According to the feedback provided by the Pre-Diploma students in Table 1, it was determined that all scores are higher than the average, with the highest mean value being 9.75. These findings indicate that the participants acknowledge the significant advantages of experiential learning in the development of Physics knowledge and the improvement of their communication abilities. More than 20% of students suggested the experiential learning concept should be included especially in theoretical, laboratory-based, and design courses (Ayob et. al., 2011).

Figure 3 compares the performance of pre-diploma students in the subject of physics during their first and second semesters of study. Due to the COVID-19 pandemic, their first semester of teaching and learning was conducted exclusively online, and they were never able to visit the university and participate in the experiential learning in this course. Based on their first semester PHY011 final examination results, 12.5% of students earned an A-, 50% earned a B+, 25% earned a B, and 12.5% earned a B-.

Table 1
Mean value of the self-confidence, effectiveness, and communication skills in the Little Scientist Program

Description		
Factor	***Statement***	***Mean value***
Self-confidence in science activities	I am confident in explaining science activities to the children.	8.88
	Throughout this program, I am confident in leading the group in implementing science demonstrations.	8.75
Effectiveness in Learning Physics	I understand how this program relates to my Physics course studies.	9.13
	I gain a better understanding in Physics topics when I demonstrate science activities to the children.	9.13
	I'm happy and excited to be a part of this program.	9.75
Communication Skills	I feel at ease communicating with the other facilitators, teachers and children during this program.	8.50

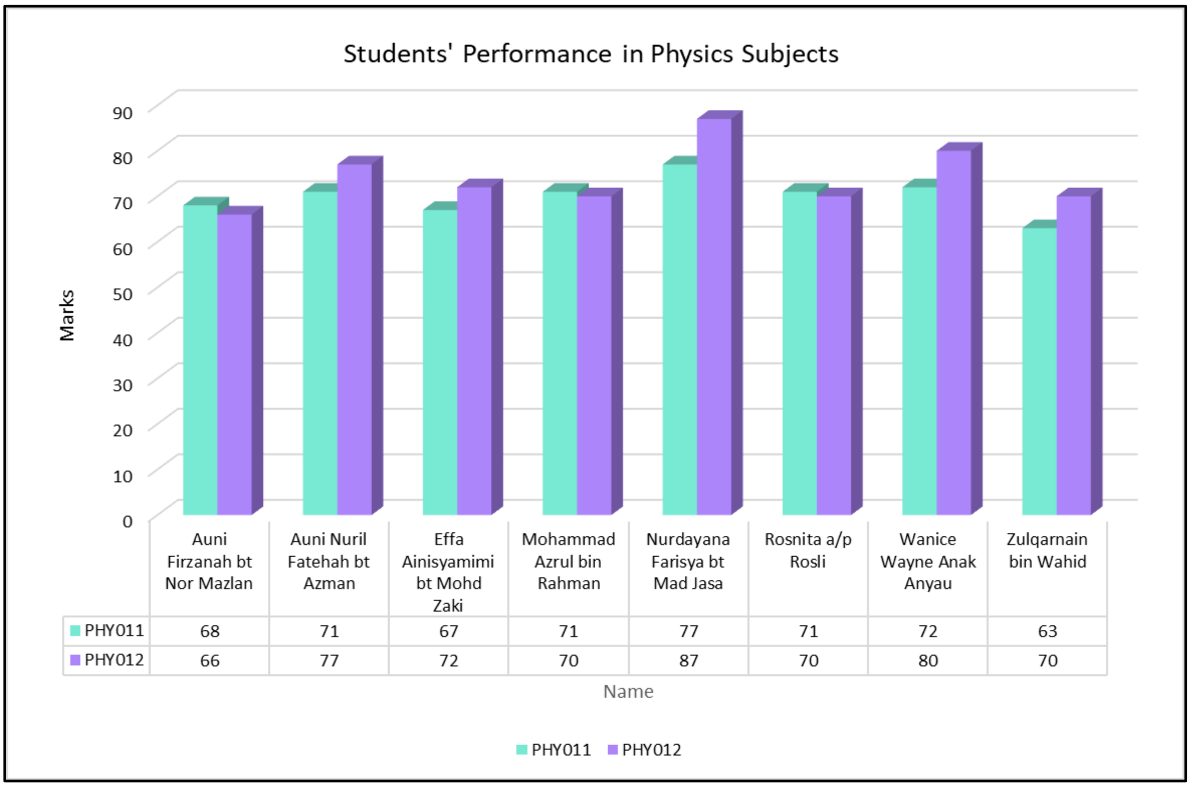

Figure 3: The performance of students in physics courses during the first and second semesters.

During their second semester of study, however, students were required to live on campus and all teaching and learning activities were conducted face-to-face. This semester, they had opportunities to engage in experiential learning through the Super Little Scientist program at Tadika Eden Hafiz Montessori Kuala Pilah with children. The students improved their grades on the second semester PHY012 final examination, as 25% of students earned an A, 12.5% earned an A-, 50% earned a B+, and 12.5% earned a B. Overall, 62.5% of students improved their grades, while the remaining students maintained their previous achievement. The implementation of experiential learning through the Super Little Scientist program aligns with the findings of Johari (2018), who concluded that utilizing a simple physics kit in the experiential learning model enhances its effectiveness compared to experiential learning without such a kit. Furthermore, it confers advantages upon students who gain scientific concepts and skills, while also fostering a favourable attitude towards science.

Conclusion

In summary, experiential learning is an effective approach to help students understand complex ideas and concepts particularly in science courses. The lecturer can utilize this approach in teaching activities to provide students with hands-on experience and facilitate the sharing of their knowledge with the local community. It also motivates students to improve their academic performance, especially in physics courses, while simultaneously fostering the growth of their interpersonal skills and communication proficiencies.

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