PROJECT-BASED LEARNING IN MASTERING OPTICAL PHYSICS: ENHANCING STUDENTS' LEARNING ENGAGEMENT AND MOTIVATION

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ABSTRACT

This study investigates the impact of Project-Based Learning (PjBL) on student engagement and motivation in an optical physics course. Traditional teaching methods, often characterized by passive learning, are increasingly inadequate in meeting the needs of modern education. PjBL, which involves active student participation in relevant and captivating projects, offers a promising alternative. The study employs a mixed-methods approach, utilizing surveys, interviews, and classroom observations to assess the effects of PjBL on 45 students over a semester. Quantitative data from pre- and post-course surveys indicate significant improvements in student engagement and motivation, with average engagement scores rising from 3.2 to 4.1 and motivation scores from 3.4 to 4.3. Paired t-tests confirm these increases are statistically significant. Qualitative data from interviews and observations further support these findings, highlighting the benefits of collaboration and hands-on activities in making complex concepts more understandable and the learning process more enjoyable. The results demonstrate that PjBL not only enhances engagement and motivation but also fosters a deeper connection with the course material. Educators are encouraged to integrate PjBL into their teaching strategies to create a more dynamic and effective learning environment. The study underscores the value of interactive and practical learning approaches in advanced scientific education.

Keywords: Project-Based Learning; Optical Physics; Learning Engagement and Motivation

INTRODUCTION

Education is continuously adapting to fulfill the requirements of the modern workforce, which is determined by swift and frequent changes. These alterations necessitate adjustment to the learning process. Traditional teaching methods, which often rely on passive learning and lack a focus on student-centeredness, are becoming less effective to adopt. Novel educational procedures should be created or substituted with interactive methods that focus on student learning experiences. One such approach that has garnered significant attention in recent years is Project Based Learning (PjBL).

PjBL is an educational method where students gain and apply knowledge and skills via active involvement in relevant and captivating activities (Handhika et al., 2018; Putri et al., 2022). It exhibits high efficiency, especially in intricate and theoretical domains like optical physics. Optical physics is a specialized field of physics that specifically investigates the properties of light and how it interacts with different substances (Ferywidyastuti, 2019; Ferywidyastuti & Dwi Wuryanto, 2020). The subject includes a set of advanced concepts including as wave-particle duality, diffraction, interference, and polarization. This topic can present challenges for students in comprehending traditional lecture-style teaching. This study examines the impact of Project-Based Learning on the attainment of expertise in the field of optical physics (Gunawan et al., 1386).

By examining the influence of PBL on students' learning engagement and comprehension, my objective is to elucidate its effectiveness as an instructional tool in this demanding field. This paper examines the challenges involved in teaching optical physics and provides a rationale for implementing PjBL as a remedy for these challenges. Next, it provides an overview of the fundamental ideas of PjBL, how it is incorporated into the physics curriculum, and the resulting student engagement and learning outcomes. PjBL is not only a viable but also a very advantageous approach for teaching optical physics. PjBL has the capacity to completely transform students' educational experiences and cultivate a more profound comprehension of this captivating scientific field.

The objective of this study was to evaluate the efficacy of PjBL in augmenting student engagement and comprehension in the domain of optical physics by addressing the subsequent research query: Education is continuously adapting to meet the needs of the modern workforce, characterized by quick and frequent changes. These improvements necessitate adjustments to the learning process. Traditional teaching methods, which often rely on passive learning and lack a focus on student-centeredness, are becoming less effective to adopt. Novel pedagogical approaches should be created or substituted with interactive methodologies that focus student learning experiences. PjBL has garnered significant attention in recent years as a very effective approach. It is an educational method where students learn and apply knowledge and skills via active involvement in relevant and captivating activities. It exhibits high efficiency in intricate and theoretical domains, such as optical physics. Optical physics is a specialized field of physics that specifically studies the properties of light and how it interacts with different materials. The subject includes a range of advanced concepts like as wave-particle duality, diffraction, interference, and polarization. Students may encounter challenges in comprehending traditional lecture-based training when it comes to this particular subject. This study examines the impact of Project Based Learning on developing expertise in the field of optical physics.

By examining the influence of PjBL on students' level of engagement and comprehension, my objective is to elucidate its effectiveness as an educational tool in this demanding field (Gilboy et al., 2015; González et al., 2016). This paper examines the challenges related to teaching optical physics and provides a rationale for employing PjBL as a remedy for these challenges. The present study provides an overview of the fundamental ideas of PjBL, its implementation in the optical physics curriculum, and the impact it has on student engagement and learning outcomes. This means that PjBL is not only a viable but also an extremely advantageous approach to instructing in optical physics. It has the capacity to transform students' educational experiences and cultivate a more profound comprehension of this captivating scientific field.

This study aims to evaluate the efficacy of PjBL in improving students' involvement and comprehension in the area of optical physics. The research will address the following research questions:

- How does Project-Based Learning influence students' understanding of complex optical physics concepts compared to traditional teaching methods?
- What is the effect of Project-Based Learning on students' engagement and motivation in an optical physics course?

METHOD

This study employs a mixed-methods research design to investigate the effect of PjBL on students' engagement and motivation in an optical physics course. The study combines quantitative methods, such as surveys, and qualitative methods, including interviews and classroom observations, to provide a comprehensive analysis of student engagement and motivation.

The study involved Vocational students enrolled in an optical physics course at a university. 45 students participated that have received in Project-based learning activities to master optical physics.

The fifty sophomores participated in semester-long project-based learning, including creating an experiment that recorded on video. Students worked on projects such as designing optical instruments, exploring the behaviour of light through different mediums, and creating models that demonstrate principles like diffraction and interference. The projects will require students to collaborate, research, design, and present their findings.

Data was collected through the following research instruments. Survey: In order to assess the degree of student engagement and motivation following a semester of exposure to the optical physics learning process, pre-course and post-course surveys was implemented. Quantitative and qualitative data was collected through the use of Likert scale questions and open-ended questions in the survey distributed to 50 students of the Optometry program.

Interview: Semi-structured interviews were conducted with a subset of students from both groups to acquire a more profound understanding of their motivation, engagement, and experiences during the course. Five respondents were involved in this study. Classroom Observations: Student engagement, interactions, and participation during class activities was documented through routine observations of classroom activities.

Quantitative data from surveys and tests were analyzed using statistical methods to compare the engagement and motivation levels. Descriptive statistics was used to determine significant differences. Meanwhile, qualitative data from interviews and observations were analyzed using thematic analysis to identify recurring themes and patterns related to student engagement and motivation. This analysis will help to contextualize the quantitative findings and provide a richer understanding of students' experiences with PjBL.

The study adhered to ethical guidelines for research involving human participants. Informed consent was obtained from all participants, ensuring they understood the purpose of the study and their right to withdraw at any time. Anonymity and confidentiality were maintained throughout the research process. By employing a rigorous mixed-methods approach, this study aims to provide a comprehensive evaluation of the effect of Project-Based Learning on students' engagement and motivation in an optical physics course.

FINDINGS AND DISCUSSION

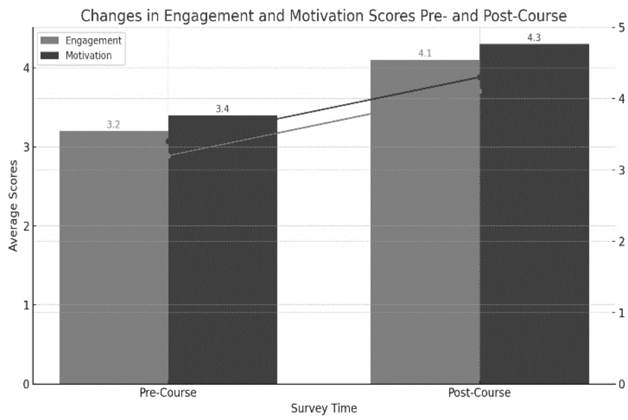
The data collected from interviews, surveys, and classroom observations demonstrate a significant impact of collaborative and hands-on learning approaches on student engagement and motivation in an optical physics course. Increased student engagement was largely attributed to collaborative projects and hands-on activities. Students reported that working on projects with peers made the learning process more enjoyable and interactive. The sense of teamwork and the opportunity to share ideas and brainstorm solutions contributed to a lively and engaging classroom atmosphere, making students look forward to each class.

Survey results

Moreover, the practical aspect of the course, which involved designing optical instruments, was highlighted as a key factor in maintaining student interest. Students appreciated the opportunity to see theoretical concepts come to life through their projects. This hands-on approach helped bridge the gap between theory and practice, making complex concepts easier to understand and remember. The increased engagement was reflected in the post-course surveys, where the average engagement score rose from 3.2 to 4.1 on a 5-point Likert scale. The integration of PjBL activities in an optical physics course significantly enhanced student engagement and motivation. Pre-course surveys showed an average engagement score of 3.2 and a motivation score of 3.4 on a 5-point Likert scale. These scores increased to 4.1 and 4.3, respectively, in post-course surveys. The statistical analysis, supported by a paired t-test, revealed significant improvements in both engagement ($t(44) = 4.57$, $p < 0.01$) and motivation ($t(44) = 4.83$, $p < 0.01$).

Enhanced motivation among students was another significant finding. Many students highlighted that the projects helped them see the real-world relevance of optical physics, which boosted their motivation to learn. Understanding the practical applications of the concepts made the learning experience more meaningful and motivated students to delve deeper into the subject matter. Additionally, the sense of achievement from completing and presenting projects further motivated students to engage with the course material. The average motivation score increased from 3.4 to 4.3, as reflected in the post-course surveys.

Graphic 1:
Student Engagement and Motivation Scores Before and After Course



The data gathered from the pre-course and post-course surveys reveal significant insights into the impact of the course on student engagement and motivation. Before the course began, the average engagement score among participants was 3.2 on a 5-point Likert scale, indicating moderate levels of engagement. Similarly, the initial average motivation score was 3.4, suggesting a moderately positive level of motivation.

Upon completing the course, there was a noticeable improvement in both metrics. The average engagement score increased substantially to 4.1, while the average motivation score rose to 4.3. These increases signify that students felt more engaged and motivated after participating in the course.

A paired t-test was conducted to statistically analyze the changes in engagement and motivation scores before and after the course. The results for engagement showed a significant increase with a t-value of 4.57 and a p-value of less than 0.01. This indicates that the course had a positive impact on student engagement. Similarly, the motivation scores also saw a significant rise, with a t-value of 4.83 and a p-value of less than 0.01, suggesting that the course effectively enhanced student motivation.

The data indicates that the course had a positive impact on both student engagement and motivation (Gilboy et al., 2015; González et al., 2016). The significant increases in both metrics, as confirmed by the paired t-tests, suggest that the course was effective in enhancing students' involvement and enthusiasm. This implies that the instructional methods or content of the course were likely engaging and motivating for the students

The data indicates that the course positively impacted both student engagement and motivation. The significant increases in both metrics, as confirmed by the paired t-tests, suggest that the instructional methods or content of the course were likely engaging and motivating for the students. This improvement underscores the effectiveness of the course in fostering a more involved and enthusiastic learning environment (Asiksoy & Özdamli, 2016; Kuhn & Vogt, 2013; Lestaringsih, 2017).

Interview Results

The data from interviews and classroom observations clearly indicate that collaboration and hands-on learning significantly contributed to increased student engagement and motivation. The collaborative projects fostered a sense of teamwork and community, making the learning process more interactive and enjoyable. Hands-on learning activities helped students see the real-world applications of what they learned, making the learning experience more meaningful and memorable (Arifianti et al., 2020).

The positive impact of these educational approaches is reflected in the quantitative findings, where engagement and motivation scores showed significant increases after the course. The paired t-test results confirmed the statistical significance of these improvements, indicating that the methods used in the classroom effectively enhanced student participation, focus, and enthusiasm.

Thus, incorporating PjBL activities into the curriculum can significantly enhance student engagement and motivation. These methods create a more dynamic and effective learning environment, ultimately improving the overall educational experience for students. Educators should consider these findings when designing their teaching strategies to foster a more engaging and motivating classroom atmosphere.

Classroom observation results

Classroom observations supported these findings, indicating higher levels of active participation and peer interaction in the process of learning. Students were more actively involved in class discussions and activities, asking more questions, volunteering answers, and participating in debates. The students also displayed a higher level of peer-to-peer interaction, with students frequently discussing their projects, sharing insights, and troubleshooting problems together. This collaborative environment contributed to a more dynamic and engaging learning experience.

Attention and focus were noticeably higher during project activities. Students were less distracted, more diligent in following instructions, and more meticulous in their experimental procedures. Observers noted that students showed a keen interest in their tasks, frequently asking clarifying questions and seeking additional information. The enthusiasm and curiosity displayed by the students were evident, with many expressing their excitement and eagerness to start projects and explore beyond the basic requirements.

Overall, the research findings indicate that incorporating PjBL activities significantly enhances student engagement and motivation. These methods make learning more dynamic, enjoyable, and meaningful, fostering a deeper connection with the course material. Educators should consider integrating these elements into their teaching strategies to create a more engaging and effective learning environment (Viyanti et al., 2022), ultimately improving the overall learning experience for students. The positive impact on student participation, peer interaction, attention, focus, and motivation underscore the value of these educational approaches.

Interview insights highlighted that collaboration and hands-on learning were crucial in maintaining student interest. Students reported that working on projects with peers made the learning process more enjoyable and interactive. For instance, Student A mentioned, "Working on projects with my classmates was really fun. We got to brainstorm together and share ideas, which made the learning process much more engaging and enjoyable." Similarly, Student B expressed, "I loved collaborating with my peers. It felt like we were a team, and it made me look forward to each class because I knew we would be working together on something interesting."

The practical aspect of the course, particularly designing and experimenting with optical instruments, was frequently mentioned as a key factor in maintaining interest. Student C stated, "Designing and experimenting with optical instruments was the best part of the course. It was great to see the theories we learned in class come to life through our projects." Student D added, "The hands-on projects kept me interested throughout the semester. I enjoyed creating models because it made the concepts much easier to understand and remember."

Classroom observations corroborated these insights, indicating higher levels of active participation and peer interaction in the process of learning. Observers noted that students in the students were more engaged during class discussions, asking more questions, volunteering answers, and participating in debates. Furthermore, peer-to-peer interaction was more frequent, with students collaborating on projects, sharing insights, and troubleshooting problems together, fostering a collaborative learning environment.

Enhanced motivation was another significant outcome of the course. Real-world applications of optical physics concepts were highlighted as a major motivator. Student E remarked, "The projects made me realize how optical physics is used in real-world applications. For example, designing an optical instrument showed me how these concepts are applied in creating technology we use every day." Similarly, Student F noted, "Understanding the practical uses of what we were learning really motivated me. It wasn't just abstract theory anymore; I could see how it all fit into real-life scenarios, which made me want to learn more."

The sense of achievement from completing and presenting projects further motivated students. Classroom observations revealed that students displayed pride and accomplishment during their presentations. Observers noted increased motivation in students who successfully presented their projects, with these students becoming more active in subsequent classes and showing greater interest in new topics.

The integration of PjBL significantly enhanced student engagement and motivation. These methods made learning more dynamic, enjoyable, and meaningful, fostering a deeper connection with the course material. It indicates that PjBL significantly enhances student engagement and motivation in an optical physics course. These methods contribute to a more dynamic, enjoyable, and effective learning environment (Touchton, 2015; Williams & Paltridge, 2017). The practical application of these findings can profoundly impact how optical physics is taught, suggesting several key implications for educators in this field. The findings suggest that educators should consider incorporating these elements into their teaching strategies to create a more engaging and effective learning environment, ultimately improving the overall educational experience for students.

CONCLUSION

This research examines how PjBL increases engagement and motivation of optical physics students. Data shows that the course increases student engagement and motivation. Paired t-tests showed substantial improvements in both parameters, indicating that the course content and learning approach engaged and motivated students. These improvements demonstrate that the course creates a more engaging and passionate learning environment.

Interviews and classroom observations confirmed that PjBL increased student engagement and motivation. Projects and the sense of accomplishment from applying theoretical principles enhance learning. The present study suggests that the engagement of students in completing projects collaboratively can increase their level of engagement and understanding in the field of optical physics. This captivating method increases the attractiveness of learning and facilitates student engagement with the subject matter. To increase engagement and the effectiveness of their learning, educators must incorporate these characteristics.

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