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Research Article

Challenges and Benefits of Inquiry-Based Learning in Physics

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ABSTRACT

This qualitative research study investigates the experiences of Grade 12 STEM students in inquiry-based learning in physics at a private high school in Central Mindanao. The study aims to understand the challenges and benefits of this teaching approach, considering factors such as gender, academic performance, and prior exposure to inquiry-based learning (IBL). The study involved ten students who were selected through purposive sampling. The data were collected through one-on-one interviews. The findings reveal that the most challenging experience students faced in inquiry-based learning are problem-solving, lecture and laboratory activities, and theoretical concepts. Meanwhile, the benefits of IBL include collaborative learning, interactive discussions, and enhanced interest in learning. Most students preferred hands-on learning, while few preferred auditory and visual learning. The study suggests that development in IBL can be made based on students' challenges and learning styles, and the benefits that they can get from the approach in a supportive learning environment.

Keywords: *Benefits of Inquiry-based Learning, Challenges in Physics, Learning Styles, Collaborative Learning, Problem-solving*

Introduction

Education is the backbone of a nation. With quality education, any country can develop the human capital required to drive socioeconomic growth and national development (Heng & Sol, 2022). To ensure quality education, relevant sectors must take responsibility for boosting educational standards such as regular curriculum review to update its elements and satisfy the needs of the industries. Active learning, problem-solving, and critical thinking should be encouraged in the classroom to help students develop the necessary skills. The use of an inquiry-based teaching and learning approach in teaching Science is highly encouraged to help the learners to overcome their problems in engaging with the lesson; the teacher is encouraged to use the inquiry-based teaching and learning practices model to help them in attaining consistency of the inquiry

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process within their lesson; and lastly, a replication of this study is encouraged with in-depth and wider in scope to better determine the effectiveness of InquiryBased Teaching/Learning approach (Bioco, M. S., & Echaure, J. S. 2021).

Another concept that can be integrated with IBL is topic-based learning (Kori, 2021). The inquiry-based learning module in mathematics has demonstrated its effectiveness in cultivating a deeper understanding of mathematical concepts, fostering critical thinking skills, and promoting collaborative and in-dependent learning.By engaging students in active exploration and discovery, this module has helped them become active learners, prob-lem solvers, and lifelong learners. Thus, it is recommended to incorporate the inquiry-based learning module as a regular component of the mathematics curriculum. This will en-sure that students have consistent opportuni-ties to engage in inquiry-based activities and develop their mathematical thinking skills. (Lumabit, A. M. C., & Sagge, Jr., R. G. 2023). In topic-oriented learning, learners are usually more concerned with the final product, and the learning process follows more steps (Kori, 2021). The purpose of IBL is to engage students in the real process of scientific evidence, explicitly from a pedagogical perspective, and divide the complex scientific process into small but logically connected units of learning, thereby drawing students' attention to the important details of scientific thinking (Pedaste et al., 2015). Moreover, classroom-based inquiry learning allows students to design their experiments, collect data from the experiments, interpret the results, justify the conclusions with the results, and communicate the results to others (Teig et al., 2018).

In other words, inquiry-based learning is an approach that allows students to conduct their scientific experiments to construct knowledge, rather than acquiring new knowledge directly from the teacher's lecture process (Jerrim et al., 2020). It is a student-centered teaching method with many scientific evidence-based steps. However, the literature does not precisely define how inquiry-based learning is implemented, and its learning models take many forms. It is also related to other different learning strategies that include modern teaching practices (Cairns & Areepattamannil, 2019).

For example, a constructivist approach to teaching at all levels of school is needed in IBL to gradually change the conventional teaching practices that give emphasis on learning answers more than an exploration of questions, memory at the expense of critical thought, bits and pieces of information instead of understanding the context, and reading instead of doing.

Physics instruction poses a unique set of challenges in a variety of ways. It's a subject that's being talked about and maybe accurately described as difficult. The emphasis in university Physics classes is on concepts, comprehension, and logical reasoning. There is also a need for students to develop strong analytical and mathematical skills., physics is considered one of the hardest subjects that students meet in school, and there is a need to address students' challenges with the subject to better understand the precise causes of their problems (Candido, K. J. O., Gillesania, K. C. C., Mercado, J. C., & Reales, J. M. B. 2022).

This study examined the students' challenges and benefits in inquiry-based learning instruction in physics. Furthermore, the results of this study helped probe into how students perceive, engage with, and benefit from this approach; and sought to uncover valuable insights into the effectiveness of IBL in the teaching-learning process. These may also inform educators, curricularists, and policymakers to invest in IBL as a dynamic and student-centric approach to physics education.

Scope and Delimitation

The researcher limited the scope of this study to students' experiences in inquiry-based learning in high school physics classes at a private school in Central Mindanao. The participants were Grade 12 students in the school year 2022-2023. Ten (10) STEM students were interviewed, all of whom were studying physics.

Methods

Research Design

This study used qualitative research design to provide a comprehensive and interpreted understanding of the concepts, experiences, and opinions of Grade 12 STEM about the challenges and benefits of inquiry-based learning in physics to improve teaching instruction in the classroom. Bhandari (2021) asserts that qualitative research is an effective means of gaining a deeper understanding of a topic and generating new research ideas by gathering and analyzing non-numerical data to get a deeper grasp of a topic and produce new research ideas.

Sample

The respondents of this study are ten (10) Grade 12 STEM students who were currently enrolled in the academic year 2023-2024 from a private high school. The researchers used purposive sampling to select the respondents of the study and consider factors such as gender, academic performance, and prior exposure to inquiry-based learning in physics classes to ensure diverse perspectives.

This study's inclusion criteria are: Students must be in Grade 12 and enrolled in a physics subject. They must have experienced inquiry-based learning approaches in their physics classes, as evidenced by curriculum materials, teacher interviews, or student self-reports. In addition, students and their guardians must express informed consent to engage in the research.

Meanwhile, the following are the exclusion standards for this research study: Participants who are not enrolled in a physics subject or who are not in Grade 12 will also be disqualified. Additionally, students who did not participate in inquiry-based learning in their physics classrooms would be disqualified. Furthermore, incomplete or non-compliant data submissions will result in student exclusion. If the focus of the study is on conventional education settings and methods, then children with specific special education needs may be left out, depending on the design of the research. Lastly, pupils who just moved to the school and haven't got a lot of experience with the inquiry-based curriculum will not be allowed to enroll.

Table 1. Demographic Profile of the Respondents

Participant	Gender	Age	Grade level/ Strands
1	Male	17	Grade12-STEM
2	Male	17	Grade12- STEM
3	Female	18	Grade12- STEM
4	Female	17	Grade12-STEM
5	Male	17	Grade12-STEM
6	Male	17	Grade12-STEM
7	Male	18	Grade12-STEM
8	Female	18	Grade12-STEM
9	Male	17	Grade12-STEM
10	Male	17	Grade12-STEM

Data Gathering Procedure

The researchers developed a semi-structured interview to explore students' perceptions, experiences, and challenges related to inquiry-based learning and the benefits of the said approach. The semi-structured interview undergoes an expert review to verify alignment with study objectives, pilot testing to find ambiguities, and cognitive interviews to improve question clarity and consistency are all steps in the validation process of an interview questionnaire for qualitative research. The questionnaire is revised and improved based on feedback from these processes. By using a methodical approach, the questionnaire can collect valid and trustworthy qualitative data, which increases the validity and trustworthiness of the research findings.

Data were gathered through one-on-one interviews. Students will be interviewed one-on-one for about thirty to forty-five (30-45) minutes each. While keeping students engaged,

this length of time permits in-depth conversation. There responses were audio-recorded and transcribed verbatim.

Moreover, the researchers carried out classroom observations to observe students' behaviours, interactions, and participation during inquiry-based learning activities. This method enables researchers to capture real-time data on students' engagement, collaboration, and problem-solving skills. Lastly, various documents such as students' reflective journals, teacher-provided learning materials, and worksheets, were collected and analyzed to gain additional insights into students' experiences and their learning progression.

Generally, the researchers established the validity of the study through triangulation of multiple data sources such as interviews, observations, and document analysis. This helped establish the credibility and trustworthiness of the findings. Additionally, member-checking was conducted to ensure the accuracy of the interpretations by seeking feedbacks from participants on the preliminary findings.

The duration of the data collection process is three months. In the first stage, consent will be sought and a questionnaire for interviews will be created. Regular classroom observations and respondent interviews will take place in the second month. The data will be coded, transcribed, analyzed using thematic analysis, and triangulated for interpretation over the last month. This well-organized plan guarantees a comprehensive evaluation while adhering to academic calendars and moral principles.

Data Analysis

The researchers' collected data was transcribed, coded, and thematically analyzed using qualitative data analysis software. According to Cresswell (2018), thematic analysis is a method that involves identifying, analyzing and interpreting patterns and themes in data. Emerging themes were identified based on participant responses, observations, and documents. The analysis involves an iterative process of coding, comparing, and categorizing data to identify recurring patterns and develop a comprehensive understanding of students' experiences and perceptions.

The data collected were subjected to thematic analysis to identify patterns, themes, and categories. The transcripts were coded to identify significant statements and related meanings. Codes were grouped into themes to organize and categorize qualitative data, which were refined and revised during the analysis process, ensuring consistency and accuracy. Researchers maintain reflexivity to acknowledge and address potential biases in the analysis.

The researchers interpret the findings by examining the relationships between themes and considering the broader context of inquiry-based learning in high school physics classes. Moreover, to enhance the validity and reliability of findings the researchers compare and contrast data from different sources and involve multiple interraters during the analysis.

Result and Discussion

This study aimed to explore the experiences of students in inquiry-based learning in studying physics. The respondents were asked about this research question:

1. What are the challenging and beneficial aspects of inquiry-based learning in physics?

Challenges in using inquiry-based learning in teaching Physics

Problem-solving

Physics, being an elemental science, due to its dominant problem-solving nature primarily attained its esteem as an arduous subject. The pervasive use of mathematics in physics adds to its complexity as it demands precision in describing physical phenomena. In essence, physics encompasses both theoretical frameworks and empirical observations, treating all aspects as interconnected mathematical relationships and measurable physical quantities. This combination of conceptual depth and quantitative rigor contributes to the perception of physics as a challenging and foundational scientific discipline.

One student responded said that:

> *"In physics, the things that made it difficult for me are solving and analyzation about the problem or topic, especially since it has a lot of different formulas and*

problems that we need to solve and understand." (P2)

The participant identifies challenges in physics, specifically related to problem-solving and analysis. The participant highlights the complexity introduced by numerous formulas and problems that require in-depth comprehension and solving. This perspective sheds light on the intricate nature of physics, emphasizing the need for effective problem-solving skills and a comprehensive understanding of the subject matter.

The rationale for the difficulty in problem-solving in physics has been identified by numerous researchers as physics students fail to construct meanings of the problem statement, unable to interlink the meaning of the statement. Most of the students lack the appropriate knowledge of structural construction in specific content areas. Therefore, the approach to teaching problem-solving in physics should be appropriate to enhance students learning (Ogunleye, 2009).

Lecture and Laboratory Activities

Students regard physics as an abstract and cognitively challenging subject. Physics is considered an abstract subject due to the lack of a colloquial meaning to connect it to ordinary real-life experiences. A participant shared her experience and stated that,

"Sometimes, I ask our teacher for guidance in answering the activities, especially if it was a very hard and complex one. It helped us but not that much because the lectures can sometimes also be complex and hard to understand." (P3)

Another participant substantiated,

"A particularly challenging inquiry-based learning activity in physics that comes to my mind involved designing and conducting an experiment to investigate the relationship between force, mass, and acceleration. The challenging aspect of this activity was devising a method that could effectively isolate and measure the impact of each variable while ensuring the experiment was both safe and accurate." (P7)

The participant mentions seeking guidance from the teacher for complex activities in inquiry-based learning. The other participant discusses one intricate physics-based inquiry activity that required designing an experiment on force, mass, and acceleration relationship. The challenge lay in isolating variables safely and accurately.

Students' negative attitudes are typically associated with more traditional approaches to science instruction (Deslauriers et al., 2019). Teaching physics through an interdisciplinary manner and constructivist approaches may help students boost self-esteem (Saka, 2011). Ogunleye (2009) stated that the most significant component in learning physics is fostering necessary abilities through laboratory practice. Professional development programs for physics teachers should prioritize enhancing their abilities to teach using an inquiry-based approach (Balta, N., et al. 2024)

Learning interest in physics will be boosted by good instructional design with the knowledge of applicable ideas (Esquembre, 2002). Physics learning activities at school are found dull when students cannot perceive the benefit of the work necessary to study physics (Saleh, 2014).

Difficulties in Understanding Concept

Physics requires the cultivation of problem-solving skills, which can only be honed through consistent practice. The discipline encompasses a blend of theoretical concepts, intricate mathematical calculations, and hands-on laboratory experiments, contributing to a multifaceted and challenging learning experience. The interplay between these elements not only deepens understanding but also fosters a holistic approach to grasping the fundamental principles of the physical world. Engaging in theoretical exploration, applying mathematical rigor, and conducting experiments in the laboratory collectively shape a comprehensive skill set, essential for navigating the complexities inherent in the study of physics. One of the participants answered that,

"For me, the inquiry-based learning activity that I can recall is finding the mass and velocity of a specific object since our physics subject focuses mostly on

problem-solving. Getting its mass and velocity is already difficult for me since I admit that I am not that good in mathematics which is why I'm having trouble answering it but, of course, with the help of my subject teacher I can now fully find the mass and velocity of a specific object. (P1)

The participant encountered challenges related to mathematics, particularly in the context of problem-solving, specifically concerning mass and velocity. Despite the struggles, the participant highlights the positive impact of teacher support, which played a crucial role in improving their problem-solving skills, particularly in the domain of mass and velocity. The participant engaged in an inquiry-based learning experience focused on mass and velocity, indicating that the physics subject places a strong emphasis on developing problem-solving skills.

Students have difficulty with the nature of the subject because of the high workload compared to other subjects, and they must engage with several representations, such as experiments, equations and calculations, graphs and conceptual explanations, and also transformed data, such as flipping between graphical and numerical representations (Erinosho, 2013). Physics is a cumulative subject such that if the initial concept is not clear, subsequent material will be difficult to understand (Ornek et al., 2008).

Benefits of Inquiry-Based Learning in Teaching Physics

Collaborative Learning

Collaborative approaches benefit students in learning important 21st century skills, such as the ability to work in teams, solve complex problems, and apply knowledge from one lesson to others. The research suggests that inquiry-based lessons and meaningful group work can be challenging to implement. They require changes in curriculum, instruction, and assessment practices that are often new for teachers and students. Participant 4 points out that,

Effective member strategies, kung saan every member have the freedom to share their ideas to everyone to enhance teamwork and collective understanding……... Collaboration and teamwork because it can provide more opportunities sa students na makapag learn and makapag share ng ideas from each other that they can use for their development and personal growth." (P4)

The participant suggests that every member should have the freedom to share their ideas with everyone, contributing to the enhancement of teamwork and collective understanding. This perspective underscores the value of open communication and the free exchange of ideas among team members to foster a collaborative and productive learning environment. The participant also emphasizes the importance of collaboration and teamwork in the learning process. The participant suggests that collaboration provides more opportunities for students to learn and share ideas, contributing to their development and personal growth. The statement reflects a positive view of collaborative learning experiences, highlighting the value of shared insights and the potential for mutual learning within a group setting.

In collaborative learning, students work in heterogeneous groups for a common purpose and are responsible for each other's success (Demirel, 2006). Collaborative learning is an interchangeable term that includes a set of structured and focused activities for the students who work in groups to solve, thus motivating interdependent learning (Guraya, S. Y., & Abdalla, M. E. 2020).. Contributing to students' socialization, developing their communication skills, and forming in-group interaction are essential characteristics of collaborative learning (Demirel, 2006; Ünlüsoy, 2006). Besides, collaborative learning increases student motivation and develops their features such as discussion, debate, criticizing ideas, respecting others' ideas, and tolerating a shared decision-making by providing a social environment (Serrano & Pons 2007). Using collaborative learning leads to positive changes in students' characteristics like success and attitude (Topsakal, 2010)

Interactive Discussion

Inquiry-based learning involves fostering engagement through real-world connections, utilizing high-level questioning, and encouraging exploration. This approach promotes experiential and problem-based learning that emphasize student curiosity over traditional information delivery. This method, despite its intricacies, is deemed teacher-friendly as it shifts responsibility to students while maintaining student engagement. The significance of inquiry-based learning lies in its ability to spark excitement and motivate students to become specialists in their learning journey. A participant stated during the interview that,

> *"I think the interactive demonstration of a teacher to a student is more beneficial for understanding complex concepts." (P6)*

Another participant shared their experience and posited;

> *"The double-slit experiment provided an interactive experience, enhancing our understanding of wave-particle duality through the interaction pattern and sporadic hits, requiring critical thinking and analysis." (P10)*

The participant believes that a teacher's interactive demonstration to a student is more beneficial for comprehending complex concepts. While, the other participant explains that the double-slit experiment provided an interactive experience and improved understanding of wave-particle duality through the observed interaction pattern and sporadic hits. It required critical thinking and analysis.

Based on John Dewey's philosophy, education begins with the curiosity of the learner, inquiry in the classroom places the responsibility for learning on the students and encourages them to arrive at an understanding of concepts by themselves. Lee et al. (2004) defined inquiry-based learning as an "array of classroom practices that promote student learning through guided and, increasingly, independent investigation of complex questions and problems, often for which there is no single answer". Students are supported in developing their abilities to: ask good questions, determine what needs to be learned and what resources are required to answer those questions, and share their learning with others while engaging in interactive discussion. Education should be able to address such challenges, so as to equip future citizens with the skills, aptitudes and dispositions needed to respond to these and similar issues. For instance, the process of education can aid the development of children's critical thinking skills, their ability to engage in effective collaboration with peers, or children's creativity. (V.O.M. Ventista and C. Brown. 2023).

Enhanced Learning Interest

Inquiry-based learning connects a new concept or area of study with students' interests and lived experiences. Therefore, this methodology awakens their natural curiosity. This increases engagement in learning experiences and, hence is more relevant to students' lives. A participant shared a personal perspective and stated that,

> *"Personally speaking, participating in inquiry-based learning activities significantly influenced my interest and motivations in physics class. These inquiry-based learning activities help me actively participate, explore, and find the importance of the different concepts of physics." (P1)*

The participant shares a personal perspective on the impact of inquiry-based learning activities in their physics class. The participant highlights that participating in such activities has a significant influence on their interest and motivation in the subject. Engagement in inquiry-based learning is described as an active process that involves participation, exploration, and the discovery of the importance of various physics concepts. This suggests that the hands-on and exploratory nature of inquiry-based learning plays a key role in enhancing the participant's interest and understanding of physics concepts.

Interest-driven learning, or the process of connecting curriculum content to student interests, has the potential to create environments where student engagement persists toward mastery of a skill or acquiring knowledge (Azavedo, 2013). In classrooms, educators seek

to enhance the inquiry process and maximize student development of science process skills (Balta, N., et al. 2024). One possible method of enhancing the inquiry process is by exploring students' questions and interests that arise within the classroom (Edelson & Joseph, 2004). The exploration of students' questions and interests contextualizes learning by connecting the curriculum to students' real-world experiences (Brown & Adler, 2008).

The participants were also asked about this question to gather rich narratives on how the challenges and benefits of IBL vary in different learning styles.

2. How do the challenges and benefits of inquiry-based learning vary on students' learning styles?

Variation of Students' Learning Styles

Hands-on Learning

Most of the participants prefer a hands-on learning style as a method of teaching physics. Inquiry-based learning is a student-centered teaching method that encourages students to ask questions and investigate real-world problems. In this type of learning environment, students are actively engaged in the learning process and are allowed to explore their natural curiosities. This type of learning is often hands-on and allows students to connect what they learn in the classroom and the real world. One of the participants said,

> *"I, myself prefer hands-on learning that usually encounters challenges related to a more theoretical and abstract thinking in inquiry-based learning, when we say hands-on learning, it is a type of learning through reflection on doing. Just like my physics teacher always says, "You cannot solve it if you don't do it yourself and most especially you will not learn". I like this type of learning approach because I believe that by doing any specific activity personally you can understand and value the importance of it to our lives. For instance, during class discussions, our teacher usually asks us to share our observations and experiences on a specific topic. For me, my way of approaching that specific topic is to express my understanding using my own words and by learning its role in my life." (P1)*

The participant expresses a personal preference for hands-on learning, emphasizing its practical and experiential nature. The participant notes that hands-on learning aligns with their physics teacher's philosophy that understanding comes from doing. The participant values the opportunity to share observations and experiences during class discussions, using their own words to express understanding and highlight the relevance of physics concepts to their life. This response underscores the importance of active engagement and personal connection in the learning process.

According to Miller (2014), many studies have been conducted to determine the learning approaches that will best enable students to not only acquire a deeper understanding of science concepts but also to equip them to apply that new knowledge in their daily activities. Inquiry-based, hands-on learning involves students participating in activities that reflect methods of scientific investigation. The effective utilization of the inquiry-based learning approach demands the inclusion of learners in a self-directed learning environment, the ability to think critically, and an understanding of how to reflect and reason scientifically. Furthermore, inquiry-based instruction is most effective when supplemented with guidance that can be personalized based on these moderating factors and can even involve providing direct instruction. (De Jong et al. 2023).

Auditory Learning

Other participants choose auditory learning as an inquiry-based learning style which involves individuals who grasp information more effectively through listening, retaining it better when presented audibly rather than in written form. Auditory learners can enhance students' experience by engaging in group discussions. A regular face-to-face meetings and conversations with teachers were proven to be beneficial for comprehending various responsibilities. The participant responded that,

"Auditory learning, because as a student I observed that most of the students are nakakapaglearn effectively by listening." (P4)

Another participant explains that,

"As a student who prefers auditory learning, I find that the incorporation of discussions and verbal interactions into our inquiry-based learning process significantly enhances my understanding of physics concepts. Engaging in group discussions and verbal exchanges allows me to process information through spoken language, reinforcing my comprehension of the material. These interactions provide me with the opportunity to articulate my thoughts, ask questions, and learn from my peers. Through verbalizing and debating physics concepts, I can internalize the material more effectively, leading to a deeper understanding of the subject matter." (P9)

The participants express their preference for auditory learning, which means that some students can effectively learn by listening. This viewpoint underscores the recognition of diverse learning styles and suggests that auditory methods, such as verbal explanations, discussions, or lectures, are perceived as effective for the participant and their peers.

The other participant conveys that, as a student favoring auditory learning, discussions and verbal interactions within inquiry-based learning significantly enhance the understanding of physics concepts. Engaging in group discussions allows the user to process information through spoken language that reinforces comprehension. These interactions provide opportunities to articulate thoughts, ask questions, and learn from peers. Verbalizing and debating physics concepts contribute to more effective internalization of the material, and eventually lead to a deeper understanding of the subject.

The use of auditory aids in the teaching-learning process has multifarious values (Mohanty,2001). Auditory learning style enables auditory learners to learn best by hearing or through verbal communication. Auditory learners are good at remembering what they hear as they learn information through auditory representation (Kayalar, Filiz & Kayalar, Fethi. 2017). It gives chance to speakers to make a more professional and consistent presentation. The teaching profession is filled with countless opportunities to enrich the academic lives of students, while some concepts and educational objectives will be easy for students to grasp, others will require you to think creatively to ensure that important learning objectives are met. Using auditory aids in teaching is one way to enhance lesson plans and give students additional ways to process subject information (Kunari,2006).

Visual Learning

While the rest of the participant chooses visual learning. Classrooms serve as effective environments for visual learning, prompting many educators to embrace methods like incorporating images, whiteboards, presentations, videos, and other visual aids. The utilization of visual learning strategies not only aids students in reaching their objectives but also fosters the development of essential skills such as critical thinking, improved decision-making, problem-solving, and enhanced comprehension. Participant 7 and Participant 8 stated that,

"This visual and practical experience significantly contributed to my understanding by reinforcing theoretical concepts and promoting critical thinking and problem-solving skills." (P7)

"Visual aspects can enhance understanding, so incorporating diagrams, simulations, or interactive visuals can significantly improve my learning experience." (P8)

The participant stresses that the visual and practical experience played a crucial role in reinforcing theoretical concepts, fostering critical thinking, and enhancing problem-solving skills. The other participant suggests that incorporating concrete visual representations like diagrams, simulations, or interactive visuals can significantly enhance the learning experience for these students.

Visual learning also helps students to develop visual thinking, which is a learning style whereby the learner comes to understand and

retain information better by associating ideas, words, and concepts with images. Visual information is presented through various interactive visual tools, such as information and communication technologies (e.g., web services), and 2- and 3-D visual environments.

With today's advanced technology, digital visuals are being used as a viable learning enhancer due to their capability to convey the desired instructional message instantly and universally. Therefore, visual literacy has become a required competency for teachers and instructors of all levels as well as for students in many formal educational settings. Visual literacy is defined as the ability to understand, use, and create images effectively (Lohr, 2008).

Finally, the third research question delved into some potential improvements that can be made in IBL based on the challenges, benefits, and learning styles of the students.

3. What improvements can be made in inquiry-based learning based on the challenges, benefits, and learning styles of students?

Improvements for Inquiry-based Learning

Integrating Distinctive Teaching Strategies

The statement underscores the significance of inquiry-based learning and emphasizes the necessity for deliberate instructional design to facilitate its effectiveness. When educators craft activities, lessons, and units that align with an inquiry-based approach, they create an environment where students are encouraged to question, investigate, and actively participate in their learning. The idea of providing 'room' for inquiry implies allocating space within the curriculum that allows students to engage in exploratory and self-directed learning, fostering a sense of autonomy. A participant said,

"For better learning, make sure that instructions are clear. We should collaborate, share ideas, and get feedback. Also, use materials that include pictures, discussions, and real-life examples, allowing flexible learning. Support each other and ask teachers for help when needed. This makes learning more enjoyable and accessible for everyone." (P6)

The participant with optimimal learning ensure clear instructions, foster collaboration, share ideas, and seek feedbacks. The use of visual aids and real-life examples allows flexibility, supports an enjoyable and accessible learning experience, develops mutual support, and encourages the ease to ask for help from the teacher when needed.

According to Ayeni (2011), teaching is a continuous process that involves bringing about desirable changes in learners through the use of appropriate methods. Adunola (2011) indicated that to bring desirable changes in students, teaching methods used by educators should be best for the subject matter.

Furthermore, Bharadwaj and Pal (2011) sustained that teaching methods work effectively mainly if they suit learners' needs since every learner interprets and responds to questions uniquely (Chang, 2010). As such, the alignment of teaching methods with students' needs and preferred learning influences students' academic achievements (Zeeb, 2004)

Enhancing Teamwork and Collaborative Learning

Collaborative learning, which is considered a contemporary teaching approach, plays a pivotal role in enriching student comprehension. By fostering an environment where students work together, this method not only enhances understanding but also cultivates creative and critical thinking skills.

The synergy created through collaboration contributes to improved student achievement and motivation. This approach instills a sense of active participation and encourages students to engage with the learning process more deeply. Moreover, the continuous interaction among students in collaborative settings facilitates ongoing knowledge enhancement that create dynamic and stimulating learning environments in the classroom. In essence, collaborative learning emerges as a catalyst that boosts pupils' motivation and fosters active learning. A participant said that,

"Inquiry-based learning challenges can be addressed through fostering a supportive environment with ample resources. Encouraging collaborative learning, providing access to diverse learning

materials, and offering mentorship can significantly enhance the effectiveness of this approach. Additionally, professional development for educators in designing and implementing inquiry-based activities can contribute to a more successful integration of this method." (P8)

Another participant supported that,

"Strategies like increasing teamwork during inquiry projects by setting objectives, delegating responsibilities, and implementing transparent communication channels are beneficial when collaboration projects. Also, the whole teamwork experience can be improved by promoting active involvement, settling disputes amicably, and offering tools for efficient cooperation." (P10)

The participant suggests on how to address the challenges in inquiry-based learning through fostering a supportive learning environment with ample resources. It highlights the importance of encouraging collaborative learning, providing access to diverse materials, and offering mentorship.

Additionally, it mentions that professional development for educators in designing and implementing inquiry-based activities contributes to a more successful integration of this method. Meanwhile, the other participant suggests strategies for improving teamwork during inquiry projects, including setting objectives, delegating responsibilities, and implementing transparent communication channels. It also recommends promoting active involvement, settling disputes amicably, and offering tools for efficient cooperation to enhance the overall teamwork experience.

It is seen in the literature that collaborative learning has positive impacts on success. It also makes a statistically significant contribution to the attitudes of students (Güngör & Özkan, 2011). In addition, collaborative learning had positive effects on laboratory skills retention, problem-solving skills, and motivation for success (Gök & Sılay, 2009). Some studies use collaborative learning with inquiry-based learning. They show that the sample group displayed a scientific approach to determining environmental consciousness and development of reading comprehension skills of students (Yılmaz & Top, 2015).

Providing Guidance and Creating a Supportive Environment

Teacher support plays a crucial role in strengthening the teacher-student relationship. When teachers provide support, whether academically or emotionally, students feel valued and understood. This fosters a positive learning environment, to actively engage students in the educational process.

Additionally, teacher support can enhance communication, trust, and mutual respect, creating a foundation for effective teaching and learning experiences. Overall, a supportive teacher contributes significantly to a positive and productive teacher-student relationship. A participant shared her opinions and stated that,

"In my opinion inquiry-based learning requires a supportive environment, including comprehensive resources, peer collaboration, and visual aids, to overcome challenges and enhance the learning experience. It is essential to provide a supportive learning environment to mitigate the difficulties associated with inquiry-based learning. One way to accomplish this is by having access to extensive resources, like interactive simulations and online courses. Incorporating visual aids, encouraging peer cooperation, and providing advice and mentoring from experienced instructors can all greatly improve the learning process and solve issues with inquiry-based learning." (P10)

The participant asserts that inquiry-based learning necessitates a supportive environment, including comprehensive resources, peer collaboration, and visual aids. It emphasizes the importance of mitigating challenges by providing access to extensive resources such as interactive simulations and online courses. Additionally, visual aids, peer cooperation, and advice from experienced instructors are highlighted as essential elements to enhance the learning process in inquiry-based education.

Interactions between students and their teachers play a crucial role in student's learning and their feelings toward school. Students need to feel that their teachers care about them and their achievement to fully engage in learning activities and perform at their best (Federici & Skaalvik, 2014). Teachers support students by encouraging them and taking the time to help them, but also by setting goals and rules, treating them fairly, and allowing them to make their own choices (Wang & Holcombe, 2010). Students who feel supported by their teachers feel more motivated about school and perform at higher levels (Pitzer & Skinner, 2017).

Fostering Interdisciplinary Connection and Real-World Application

Integrating real-world examples and addressing practical challenges in the classroom not only enhances the educational experience but also cultivates enthusiasm, critical thinking skills, and societal awareness among students. This holistic approach to learning prepares them not just academically but also socially for the complexities of the world beyond the classroom. A participant recommends that,

> *"To make it even better, we should focus more on how things relate to the real world, let students choose what they want to learn, and use technology like online tools." (P6)*

Similarly, participant 9 shared their experience stating that,

> *"Based on my positive experiences with inquiry-based learning, I believe that further emphasis can be placed on encouraging independent thinking and creativity. Allowing students, the freedom to pursue topics of personal interest and explore unconventional ideas can foster a deeper engagement with the learning process. Furthermore, expanding the integration of real-world problem-solving and application of knowledge can enhance the overall benefits of inquiry-based learning, these provide us with meaningful experiences that extend beyond the classroom." (P9)*

The participant emphasizes real-world connections, empowerment of areas of interest, and leveraging technology as means to facilitate a personalized and relevant educational journey.

This multifaceted approach encourages active engagement and a deeper understanding of chosen subjects. The other participant's response, based on positive experiences with inquiry-based learning, suggests independent thinking and creativity. It advocates for granting students the freedom to pursue personal interests and explore unconventional ideas to foster deeper engagement.

Additionally, expanding the integration of real-world problem-solving and practical application of knowledge is recommended to enhance the overall benefits of inquiry-based learning. This provides students with meaningful experiences that extend beyond the classroom.

According to Aikenhead (2006), real-world learning opportunities help students increase their understanding of sustainability problems (knowledge), and complement their methodological competence in applying problem-solving approaches (strategic competence cluster). Students critically reflect on and negotiate with collaborating partners about, whether the proposed problem is a sustainability problem or can be reframed as a sustainability problem.

Students negotiate, apply, and critically reflect concepts and methods for problem-solving (from systemically analyzing the problem to building solution strategies) in collaboration with their partners. With the support of academic supervisors and community project partners, these processes help students turn intellectual capability (concepts and methods) into practical competence. Students explore, recognize, and synthesize different knowledge claims and ways of knowing a key competence for successful problem-solving that is complementary to other key competencies.

Conclusion

Based on the foregoing findings, the following conclusions are hereby formulated:

1. The challenges that most of the students experience in using inquiry-based learning in

teaching physics are problem-solving, lecture and laboratory activities, and difficulties in understanding concepts in physics. On the other hand, the benefits of Inquiry-Based Learning are collaborative learning, interactive discussion, and inhanced interest in learning.

2. The majority of students prefer hands-on learning as an inquiry-based learning style while few of the students selected auditory and visual learning about the challenges and benefits of the method used in teaching physics.
3. The result of the study also reveals that improvements can be made in inquiry-based learning based on the challenges, benefits, and learning styles of students. These include integrating distinctive teaching strategies, enhancing teamwork and collaborative learning, providing guidance and creating a supportive environment, and fostering interdisciplinary connection and real-world application.

Recommendation

From the basis of the conclusion derived in the study, the following recommendations are proposed;

1. The teacher should improve physics education through the development of evidence-based strategies and practices tailored to the needs of students in an inquiry-based learning environment.
2. Investigate the benefits and challenges of integrating multiple learning styles within a single instructional approach. Explore how combining hands-on, auditory, and visual elements can enhance student learning and engagement.
3. The findings of the study should be the basis for improving inquiry-based learning by addressing the challenges and leveraging the benefits associated with students, learning styles.

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