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Research Article

Exploring Difficulties in Physics Laboratory Learning Activities from College Students' Perspectives: A Phenomenological Study

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Abstract: This phenomenological study explored the lived experiences of six college students enrolled in physics laboratory courses at Davao de Oro State College. The research examined students' difficulties in laboratory learning, how these challenges influenced their engagement and performance, and the strategies they perceived as helpful in overcoming obstacles. Data were collected through semi-structured interviews and analyzed using Moustakas' transcendental phenomenological approach. Findings revealed that students faced constrained hands-on experiences due to limited equipment and reliance on simulations, procedural uncertainty stemming from unclear instructions and fear of errors, and emotional tension characterized by frustration, anxiety, and occasional disengagement. Despite these challenges, students demonstrated adaptation and growth through iterative practice, peer collaboration, instructor support, and self-regulation. Seven emergent themes captured the essence of students' lived experiences: constrained hands-on experience, procedural uncertainty and technical hesitation, emotional tension between discouragement and productive challenge, engagement as disrupted or strengthened by difficulty, performance as developing competence under constraint, coping through collaboration and self-regulation, and student-centered laboratory support as a pathway to confidence and engagement. The study concludes that laboratory learning difficulties are multidimensional, involving interdependent cognitive, emotional, and contextual factors. Recommendations include enhanced pre-laboratory orientations, structured scaffolding, peer collaboration opportunities, and improved laboratory resources to foster meaningful experiential learning.

Keywords: *physics laboratory learning, phenomenological study, student difficulties, engagement, coping strategies, higher education, Philippines.*

1. Introduction

1.1 Background of the Study

Physics is typically considered the fundamental science that dictates the laws of nature and the interaction of matter and energy. Laboratory work is an important part of physics education because it gives students chances to convert abstract knowledge to concrete understanding. Students in such laboratories have the opportunity to test their understanding, their experimental skills, and their scientific thinking. Physics lab work is generally seen as hard and scary to students, although it is important. This is because, usually, students are faced with challenges that make it hard to have meaningful engagement with the laboratory activities (Dunnett, 2024). These issues impact students' perception of the physics field. Studies of physics laboratory learning should therefore consider how students experience such experiences.

Students face challenges such as vague instructions in physics laboratories, inadequate equipment and insufficient time. These are not just technical issues but also lived experiences that affect students' emotions and confidence (Dunnett, 2024). Students reported confusion, frustration and anxiety in laboratory sessions. Such emotional reactions affected their willingness to participate and persist in learning tasks. Over time, repeated experiences of failure can lead to negative beliefs about their competence (Wilcox et al., 2017). These impressions are internalized in their roles as learners of physics. To explore these experiences it is necessary to hear first hand stories from students.

It was discovered that students enrolled in physics lab courses in Davao de Oro State College encounter challenges in the application of theories in conducting experiments. Students had a hard time connecting what was discussed in the classroom to the practical activities in the lab. Such difficulties were related to shallow understanding and lack of confidence (Wilcox et al., 2017). The problems as witnessed in the lived experiences of the students were not only in the mastery of the content. In the laboratory environment, the students' emotional reactions such as fear of making mistakes and apprehension about their performance, often occurred. These experiences affected the way they solved problems (Cai et al., 2021; Phillips et al., 2021). Such realities called for a phenomenological inquiry into the perspectives of the students.

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The voices of students' experiences in the representation of laboratory learning are often not expressed. In other words, the meanings students make of their struggles are often ignored (Cothrel, 2018; Nicol et al., 2022). Phenomenological research is concerned with describing lived experiences, not with explaining them in terms of variables. This approach allows the nature of learning challenges to emerge in laboratories (Dodgson, 2023). Such knowledge is essential in improving the teaching of physics laboratories.

The matter of physics laboratory learning mirrors wider systemic problems at the local and international levels. Other countries report problems associated with learning in physics laboratories. For example, students from Nigeria and India have the problem of inadequate laboratory facilities and irregular availability of learning resources for laboratory teaching (Oladejo et al., 2023; Pareek, 2019). In the Philippine context, schools have been struggling with perennial issues of lack of laboratory infrastructure and lack of technical assistance (De La Cruz, 2022; Mangarin & Macayana, 2024). Other schools are faced with issues such as low budget allocation to laboratory equipment and poor training of laboratory instructors (Monta & Perdio, 2025). These systemic limitations may hinder students' engagement in laboratory activities and consequently their ability to connect theory with practice. Research from other countries shows that students are in similar circumstances in their local settings where there are inadequate resources and instructional support. This universal experience makes it evident that the issues of the physics laboratory are universal phenomena. Students' interpretations, however, of such experiences are influenced by local contexts. Not much was documented in Davao de Oro State College about such experiences. Information about students' experiences in learning physics lab in this environment was still lacking. This research is an attempt to address this gap by having a focus on the lived experiences of students.

1.2 Statement of the Problem

This study sought to examine and analyze the learning difficulties encountered by college students in physics laboratory settings. This research study focused on the factors that shaped the students' learning experiences and the challenges that hindered their achievement of the expected learning outcomes in physics laboratory activities. Specifically, this study aimed to answer the following questions:

1. What are the lived experiences of college students regarding difficulties in physics laboratory activities?
2. How do these difficulties affect students' engagement and performance in physics laboratory activities?
3. What strategies or interventions do students perceive as helpful in overcoming difficulties in physics laboratory learning?

1.3 Objectives of the Study

This research study sought to investigate the diverse challenges college learners faced in learning physics in the context of Davao de Oro State College. More specifically, the study intended to do the following:

1. To explore the lived experiences of college students regarding difficulties in physics laboratory activities.
2. To examine how these difficulties shape students' engagement and performance in physics laboratory activities.
3. To identify strategies or interventions students perceive that could address difficulties in physics laboratory learning.

1.4 Significance of the Study

The study was significant as it explored the lived experiences of students involved in physics lab learning. It made laboratory matters human by emphasizing learners' meaning-making process. By having a deeper level of understanding from student voices, these insights will enable the teachers to gain better understanding of students' experiences and views. Reflective teaching will be supported by knowledge of lived experience. The study concentrated on the affective aspects of the learning. These insights are crucial for the purposeful instructional reform (Strydom & Loots, 2020).

The research will give teachers insight into how students learned in the lab. The students' stories illuminate the factors which either promoted or hindered their learning. These meanings will be used to inform instructional reflection. It was especially useful to know information regarding students' emotional responses. The study gave more insight into more responsive instructional practices (Lymbery, 2017). It was an opportunity to think about student experience. Such insights will enhance learning experiences in labs.

The study provided administrators with practical insight into systemic problems. Stories of the students reveal concerns about resources and infrastructure. The students' experiences will ground administrators' decision-making in actual learning realities. Knowledge of the challenges of everyday life will aid planning that is equitable. The research will complement the institutional data. The focus was on students' perceptions. Such contributions will support quality education (Strydom & Loots, 2020).

In addition, the beneficiaries of the study are the student support services. Students' experiences in laboratory learning demonstrated that they had emotional difficulties. Understanding these issues will guide counseling and academic support. The students' voices exposed hidden barriers. Such insights help to more holistic development. The research encouraged inclusion and empathy (Benson & Piselli, 2025). The results will shape institutional support.

The study theoretically contributed to phenomenological research in physics lab instruction. It enhanced the knowledge of experiential learning (Yee, 2019). Local experiences were linked to global issues. The research will be a help in qualitative research development in the Philippines. It dealt with knowledge as lived meaning. Such contributions may allow to investigate in a laboratory learning context in the future.

1.5 Scope and Limitation of the Study

This study targeted the college students enrolled in physics laboratory subjects at Davao de Oro State College. This study explored the students' experiences of learning in the laboratory. Its focus was narrow: on student views only. Faculty perspectives were not taken into account. The study did not look at curricula. It was experiential in its focus. This scope was consistent with phenomenological inquiry.

The research explored students' experiences of laboratory learning. It examines how one lives through and interprets these experiences. Environmental contexts were also further attended to. The environment was institutionally based. No inter-institutional comparisons were made. The emphasis was on rich experience where there were detailed descriptions of personal experiences (Haque & Ahmad, 2025). This highlighted and underpinned rich description.

The data collection was carried out by means of in-depth interviews. This technique has enabled to describe experience in detail (Mishra & Batra, 2025). Participants expressed meanings in their own words. The study favored first-person accounts. The study was concerned with the analysis of the nature of experience. The methodology did not measure. This method preserved phenomenology.

There were limitations to this research study. Results were not generalizable. Researcher reflexivity affected the interpretation of students' experiences. Memory bias can occur with self-reported data (Van den Bergh & Walentynowicz, 2016). No causal statements were made. The research was more descriptive than explanatory. This research study acknowledged these limitations.

Despite these limitations, the research did yield some useful insights. The meaningful information came from the first hand experiences. Readers can assess transferability (Drisko, 2025). Results were used to inform practice and not to predict. The research focused on student voice. It allowed for reflective enhancement. Experience was ultimately considered knowledge.

2. Review of Literature and Theoretical Framework

2.1 Physics Laboratory Learning as Experiential Learning

Through physics lab learning, students gain practical experiences that allow them to engage directly with theoretical concepts, transforming abstract knowledge into a deeper comprehension. Laboratory is not only the place to do experiments but also the place to develop the problem solving skills, integration of theory with practice and building up of critical thinking capabilities among the students. Students' cognitive and practical learning has been found to be enhanced through hands-on activities in a laboratory environment (Dunnett, 2024; Cothrel, 2018).

Students gain the experience of action; reflection and conceptualisation while they internalise concepts and work through the challenges that are inherent in the laboratory tasks. This method of experiential learning encourages linking of experimental results with theoretical principles and leads to better understanding and retention. Learning reinforcement is done by observing the outcomes, analyzing data and interpreting the results (Kapici et al., 2020).

Moreover, the experience of physics laboratories is comprised of emotional and motivational aspects. Students' confidence, interest, and prior experiences influence their engagement, persistence, and performance in conjunction with laboratory activities. Laboratories give students a real-world context to learn, enabling them to develop practical skills, reflective thinking, and adaptive strategies, thereby creating a holistic experiential learning environment (Guisasola et al., 2023).

2.2 Common Difficulties in Laboratory Learning

There are several challenges faced by students in physics laboratories such as procedural uncertainty, limited resources and time constraints. These challenges can impact one's ability to effectively engage with tasks, observe and experiment, and develop skills. Procedural complexity, unclear instructions and inadequate guidance all increase cognitive demands, and students have to work their way through these carefully (Dunnett, 2024; Cothrel, 2018).

The technical problems also contribute to the learning problems. For example, the lack of knowledge on the instruments or using online simulations due to the lack of equipment. Some students may feel reluctant, not sure of themselves when calculating or anxious of making mistakes, which may reduce their confidence and motivation. These are the cognitive and emotional demands of laboratory learning (Kapici et al., 2020).

The environment and context are also a significant factor. Students' engagement is impacted by lack of laboratory infrastructure, lack of peer support, and lack of instructor guidance. The interaction between procedural, technical and environmental difficulties highlights the intricate nature of laboratory learning and the need for structured support systems (Guisasola et al., 2023).

2.3 Emotional and Cognitive Dimensions of Laboratory Difficulty

Learning processes associated with different emotional responses can stem from laboratory challenges. Anxiety, frustration and lack of confidence are often generated by poorly defined procedures, complex apparatus or excessive cognitive load on the student. The sensations are related to poor concentration, engagement and difficulty in understanding theoretical topics (Mitchell-Polka et al., 2020; Ponnambalam, 2018).

Affective responses are closely related to cognitive processing and influence how students perceive obstacles and participate in problem solving. Positive reward, task completion and direction can help reduce negative feelings and increase engagement and resilience. Understanding the relationship between emotion and cognition is key to the development of effective educational interventions (Phillips et al., 2021).

Furthermore, students' emotional states have been associated with teamwork and engagement in the laboratory. Fear of making mistakes or being judged is linked to less contact with classmates or instructors, while confidence gained from completing activities is associated with more participation and enquiry. Educators can leverage their knowledge of these emotive properties to help students and improve the lab experience (Strati et al., 2017).

2.4 Effects on Engagement and Performance

The lab has been linked to increased student enthusiasm, engagement and skill development. Complexity of the procedure, lack of resources and confusing instructions led to reduced attention, engagement and accuracy in performing the task. Disengagement hinders the development of lab skills and conceptual understanding.

By contrast, positive and meaningful laboratory experiences relate to greater engagement through relevance, ownership and the possibility of reflective practice. Assignments are meaningful and provide enough support, students get more engaged, manage to overcome challenges and acquire skills over the period of time (Kalender et al., 2021).

Repeated exposure and feedback has shown changes in performance. The lab exercises promote repetition, reflection and ongoing progression, all of which contribute to skill and confidence development. Engagement and performance are therefore dynamic processes of cognitive, emotional and experiential interaction (Märtsin, 2019; Holmes et al., 2020).

2.5 Student-Suggested Supports and Interventions

Students like that there are structured learning experiences that make sense to them, such as demonstrations, pre-lab briefings and post-lab discussions. These tactics reduce confusion and increase confidence to streamline processes, which results in greater engagement and learning outcomes (Kalthoff et al., 2018; Appleby et al., 2021).

Peer work and mentoring helps people cope too. People can help you work through problems, give you emotional support, and let you know that you know what's going on. Instructor mentorship offers reassurance and guidance for students in difficult tasks, which enhances self-efficacy (Cai et al., 2021).

Students also need sufficient laboratory resources and a conducive environment to participate. Good content, good use of equipment and a good connection to the instructor are associated with higher levels of cognitive and emotional engagement. Emotional support, awareness of errors and normalisation are associated with positive learning experiences (Sobhanzadeh et al., 2017; Overman, 2019).

2.6 Gap in the Local Context

The literature addresses common laboratory challenges. There is limited empirical phenomenological research in local settings. More specifically, the life experiences of the students in Davao de Oro State College have not been fully explored and we do not know the cognitive, affective and contextual factors that affect laboratory learning (Guisasola et al., 2023).

Most of the previous research has focused on structural or procedural issues and ignored students' diverse experiences and opinions. Capturing such experiences is important for a better understanding of how students make sense of difficulties and engage with laboratory assignments (Kalender et al., 2021).

The experiences of students in a particular locality can inform the design of curricula, pedagogy and support systems appropriate to the needs of that locality. This ensures that the treatments address real-life problems, and also to improve the quality of laboratory teaching in general by considering the students' viewpoint.

2.7 Theoretical Framework

Experiential Learning Theory (ELT)

Experiential Learning Theory tells us that we learn by doing and then thinking about what we did. It says learning is active when students are engaged in real world tasks, and passive when knowledge is transmitted. In physics labs, ELT emphasizes on practical experimentation where students employ instruments, procedures and experiments to obtain deep understanding and practical skills (Chae, 2024).

ELT stresses the cyclical nature of experience, reflection, conceptualisation and experimentation. Students experiment, reflect on their results, analyze the data, and learn the concepts. This cycle of repetition promotes critical thinking, problem solving and the application of academic concepts to real life situations. The approach appreciates the active and reflective aspects of learning (Jackson et al., 2018).

Moreover, ELT recognizes the role of emotional and motivational factors in the process of learning. The learning results and the development of skills are affected by the interaction of the involvement in the lab with previous experiences, interest, confidence and affective responses of students. In this study, the impact of ELT (Creely, 2018) on reflective thinking, resilience and competence is explored by providing students with opportunities for experience in physics laboratories.

Phenomenology

Descriptive phenomenology is interested in understanding the lived experiences of participants and the meanings they attach to these experiences. It enables researchers to explore the core of students' perceptions, emotion, and interpretations in the context of a physics laboratory (Jackson et al., 2018). Phenomenology is a way to explore such subjective experiences and it will show how the learners see the challenges and how they deal with the experimental tasks.

Husserlian phenomenology focuses on intentionality of consciousness and bracketing, where the researcher disregards his/her prejudices and considers only the participants' perspectives. This strategy allows researchers to precisely characterize student responses to laboratory tasks in terms of their cognitive, emotional, and environmental reactions such as anxiety, enthusiasm, and confidence (Creely, 2018).

The combination of phenomenology and ELT provides a persuasive theoretical framework. The experiential and reflective learning style of ELT is well suited to phenomenology for effective collection and interpretation of students' life experiences. Through this, the study is able to evaluate the laboratory learning processes and subjective interpretations students draw from these experiences, thus illustrating a holistic understanding of cognitive, emotional, and contextual factors (Kuk & Holst, 2018).

2.8 Conceptual Framework

The conceptual framework guiding this study illustrates the intertwined elements of students' physics laboratory experiences and the influence of these experiences on engagement and learning outcomes. The framework is constructed on descriptive phenomenology and aims to describe the essence of the lived experiences of students, illustrating how students' perceptions, emotions and interactions impact their laboratory learning (Jackson et al., 2018).

Figure 1. Conceptual Framework of the Phenomenological Research Study on College Students' Difficulties in Physics Laboratory Learning

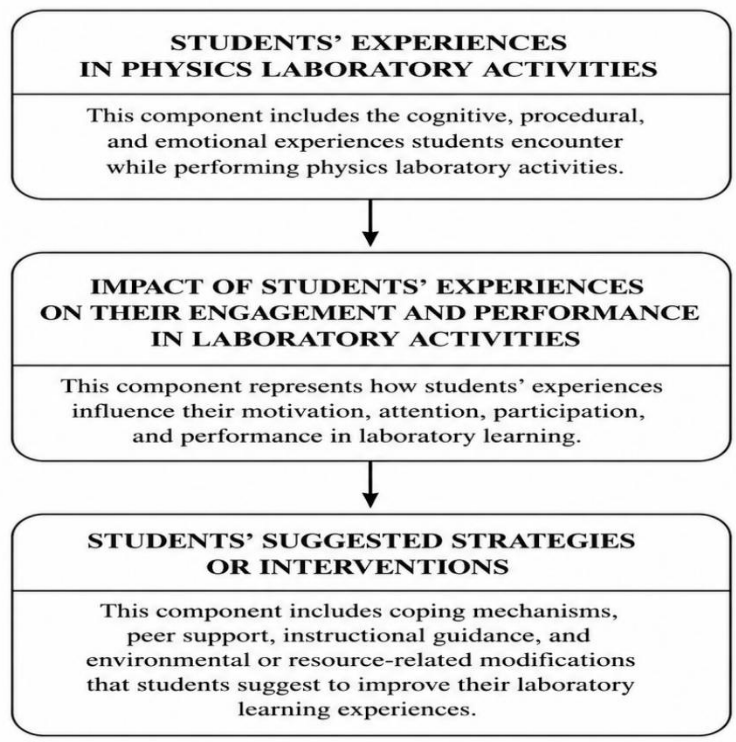

Diagram showing three components: (1) Students' Experiences in Physics Laboratory Activities (cognitive, procedural, emotional dimensions), (2) Impact on Engagement and Performance (motivation, skill acquisition, conceptual understanding), and (3) Students' Suggested Strategies or Interventions (coping mechanisms, peer support, instructional guidance)

The first component is Students' Experiences in Physics Laboratory Activities which consists of cognitive, procedural and emotional dimensions. It is related to students' perception and reaction to laboratory tasks, difficulties encountered and the influence of previous knowledge on their performance. This component encompasses a variety of feelings, including anxiety, confusion, confidence, and curiosity, reflecting the heterogeneous nature of participation in a laboratory (Cai et al., 2021).

The second component, Impact on Engagement and Performance, examines the impact of these experiences on motivation, engagement and skill acquisition and conceptual understanding. The third component is Students' Suggested Strategies or Interventions which discusses coping mechanisms, peer support and instructional guidance suggested by students to overcome difficulties. These components are co-constitutive and interacting to influence students' understanding and competence. The framework relies on the students' voice to direct data collection and analysis, and devise interventions to enhance the laboratory learning outcomes (Guisasola et al., 2023; Tarmizi et al., 2025).

3. Methodology

3.1 Research Design

The descriptive phenomenological research design was employed in this study to explore the lived experiences of college students in facing the challenges encountered in physics laboratory learning. Specifically, data collection and analysis were informed by Moustakas' (1994) transcendental phenomenology. This design allowed the researcher to capture the essence of the participants' experience, and to bracket personal biases to provide authentic descriptions. The emphasis of the study on the subjective experiences of the learners was meant to explore the cognitive, emotional and procedural aspects of their involvement in the laboratory.

The descriptive phenomenological method is interested in the understanding of phenomena from the perspective of the participants themselves and not from existing theories or hypotheses. This way the study reflects the students' perspectives and lived experiences without any external interpretation. It provides a detailed and nuanced view of students' experiences of difficulties in physics labs, the procedures they are asked to do, the technical tasks they are asked to do and their emotional responses.

Furthermore, the phenomenological design provides for a systematic approach to the interpretation of qualitative data that maintains scientific rigor. It has structured steps like bracketing, horizonalization and theme development that help increase the credibility and validity of findings. This approach ensures that the findings are grounded in the shared experiences of the participants, and yet recognizes their individual differences.

3.2 Research Locale

The study was conducted at Davao de Oro State College, a government owned university in the Philippines that offers undergraduate science programs. The university has physics courses which are laboratory based. The institution chosen is that there are students who are now in laboratory classes. The labs gave a controlled environment for students to work directly with equipment and experiments and explore their own learning experiences and problems. The study was conducted in this site to expose the participants to the practical aspect of lab activities which is the core of the research objectives.

Davao de Oro State College was also selected to investigate the local contextual factors which affect physics laboratory learning. Similar constraints exist for college labs, including limited resources, changing availability of instructors, and reliance on demonstration or simulation technologies. These conditions provide a realistic context for examining the living experiences of students and the barriers they face in participating in laboratory activities. Contextualising the findings and customising solutions to the institution's specific conditions is critical, and this understanding of the setting is important.

Also, the setting of the study makes it possible to collect large qualitative data by direct contact with students. The interviews with the participant about their laboratory environment provide insight into the procedural, cognitive and emotional aspects of learning. In this way, the setting provides a pragmatic as well as a theoretical benefit for the ecological validity and relevance of phenomenological research.

3.3 Participants and Sampling

Six participants were purposively selected on the basis of their experience and enrollment in physics laboratory courses. Participants were selected if they had completed at least one laboratory course and were willing to share personal reflections of their experiences. Participants with no previous laboratory experience were excluded to ensure relevance and depth of insight. Such a selective purpose is in line with phenomenological principles that stress richness of experience rather than representativeness.

The participants varied in terms of their previous laboratory experience, academic performance and attitude towards learning physics, thus providing a variety of experiences that enriched the findings of the study. During the interviews, the researcher noticed patterns that kept reoccurring to make sure that data was sufficient. After the 5th and 6th interviews, the researcher noticed repeated meanings and there were no new themes that emerged thus showing saturation. Therefore, the study confirms that the sample size was adequate to evoke the essence of the students' lived experiences.

Ethical considerations were also taken into account in the selection of participants. Participants were recruited voluntarily and were aware of their rights, including the right to withdraw from the study at any time. They agreed to participate as a question of ethics and transparency when sharing personal and possibly sensitive experiences. These measures helped to maintain trust and authenticity throughout the data collection process.

Table 1. Profile of Participants

Participant Code	Age	Year Level	Program/Strand	Prior Laboratory Experience	Major Difficulties	Relevant Notes
P05	21	3rd Year	BSEd Science	Basic lab exposure	Data collection, experimental procedures	Found lab activities fun but struggled with data gathering
P06	22	3rd Year	BSEd Science	Limited due to equipment scarcity	Simulations, internet connectivity	Frustration led to disengagement
P07	21	4th Year	BSEd Science	Moderate lab experience	Following procedures, thermodynamics	Stayed calm and focused despite difficulties
P08	22	3rd Year	BSEd Science	Limited high school exposure	Boiling nails experiment, equilibrium temperature	Relied on groupmates for support
P09	21	3rd Year	BSEd Science	Caregiving strand (minimal)	Calculations, drawing conclusions	Step-by-step execution, peer support
P10	22	3rd Year	BSEd Science	GAS strand (basic)	Handling apparatus, magnet charges	Learned through observation, peer collaboration

3.4 Research Instrument

The main instrument used for the research in this study was the Phenomenological Interview Guide developed by the researcher. The questions were designed to draw out rich in-depth descriptions of the cognitive, emotional, procedural and contextual experiences of the participants in the laboratory situations. The instrument was based on Moustakas' transcendental phenomenological framework. The interview guide was developed carefully and included three main components: (1) student experiences of difficulties in the laboratory, (2) effects of the difficulties on engagement and performance, and (3) strategies and interventions students perceived as useful in addressing difficulties. The following open-ended questions were used to capture the essence of the participants' lived experiences in physics laboratory settings. These questions were used to allow participants to express their thoughts, feelings, and interpretations as they wished without restriction.

The Phenomenological Interview Guide was expert validated and pilot tested to ensure validity, clarity and methodological consistency prior to its use in data collection. The instrument was reviewed by experts in research methodology and education science concerning the instructions, appropriateness of questions, sequencing, grammar and relevance with the study objectives. Their suggestions were taken into consideration, particularly the use of probing questions to keep the participant centred and not to ask leading or generalised questions of other students. The students not included in the final sample were also interviewed for the pilot session to evaluate the clarity, comprehensiveness, and relevance of the questions. The responses received resulted in a number of revisions to improve the flow of the questions, to ensure the language was easy to understand and to ensure that each question elicited a response reflecting personal laboratory experiences rather than theoretical or general responses.

3.5 Data Collection Procedure

With the permission of the institution and ethics clearance, the researcher identified participants purposively with direct experience of the physics laboratory activities. Prior to the interview, each participant was briefed on the purpose of the study, signed the informed consent form, and was individually interviewed using the validated Phenomenological Interview Guide. Interviews lasted about 45-60 minutes and were audio-recorded with permission. Field notes were taken of non-verbal cues and contextual observations to supplement the interviews. The recordings were transcribed verbatim, anonymised with participant codes and checked for accuracy prior to analysis.

The semi-structured format allowed for the flexible exploration of emergent ideas and unique experiences. The open-ended questions encouraged participants to think critically about their experiences in the laboratory, resulting in rich reports that described both general trends and individual differences. Participants could elaborate and clarify key points through follow-up questions, improving data quality.

Additionally, several interviews with each participant were conducted, as needed, to verify meanings and to ensure dependability of data. Field notes included contextual observations, non-verbal signals and immediate reflections. The triangulation of data sources increased the data set and increased the strength of the phenomenological analysis.

3.6 Ethical Considerations

Ethical safeguards were implemented before, during and after data collection. These included obtaining institutional permission, ethics clearance, explaining voluntary participation, obtaining informed consent, allowing withdrawal without penalty, protecting identities through participant codes, storing audio files and transcripts in password-protected files, and limiting access to the researcher and authorised adviser. They were also told that they could refuse to answer questions or terminate the interview if they felt uncomfortable recalling challenges in the laboratory.

The participants were selected purposefully to ensure that only those who have the relevant experience and the ability to provide rich and meaningful insights to the study were included. The inclusion criteria were college students who had direct experience in physics laboratory activities, having difficulties in laboratory work and willing to participate in one-on-one interviews. The exclusion criteria were students with no laboratory experience or unwilling to be recorded. The inclusion and exclusion criteria were well defined so that participants could give honest and detailed accounts of their lived experiences and to reduce the risk of irrelevant or non-informative data.

All participants were formally consented for voluntariness and autonomy. The participants were thoroughly informed about the purpose, objectives, procedures and possible risks of the study and had ample opportunity to ask questions and seek clarification before agreeing to participate. All participants signed the written consent form which would be kept by the study reaffirming the transparency and respect for participant rights.

The study assured the privacy and confidentiality of the participants to safeguard their identity and sensitive information. Unique codes or pseudonyms were allocated to each participant on all records and no identifying data were released in reports or publication or presentations. Interviews, field notes and supplementary materials were recorded as audio files and stored securely in password protected files to which only the research team had access.

3.7 Data Analysis

The analysis of the participants' lived experiences was initiated with verbatim transcription of the interviews to record authentic statements on learning in the physics laboratory. Each transcript was read several times to immerse the researcher in the data and to bracket preconceptions, as suggested by Moustakas' (1994) transcendental phenomenological methodology. Key statements describing students' experiences of difficulty, coping strategies and engagement were identified and highlighted.

Once the significant statements were identified, similar statements were grouped to form merged statements that represented shared experiences or recurring patterns across participants. The merged statements were then abstracted into invariant constituents that maintained the essential meaning of the participants' experiences while removing redundancy. The invariant constituents were synthesised through a careful examination to emerge as the seven overarching themes, representing the essence of the laboratory learning difficulties, engagement, performance and support mechanisms as reported by all the participants.

Theme Development Procedure

Themes were developed in a systematic phenomenological process. First, the recordings of the interviews were transcribed verbatim. Second, key statements were identified in each transcript. Third, related statements were merged into merged statements. Fourth, we reduced the merged statements to invariant constituents. Fifth, themes were formed by grouping invariant constituents. Finally, the themes were checked against the original transcripts to ensure that they reflected the lived experiences of the participants.

Participant codes were used to protect identity and increase the consistency of reporting. Codes such as P05, P06, P07, P08, P09 and P10 are anonymized participant identifiers, not actual names. These codes were employed consistently throughout the results and discussion and the coding appendix.

Table 2. Coding Matrix and Theme Development Trail

Theme	Invariant Constituent	Merged Statement	Significant Statements (Participant Codes)
1. Constrained Hands-on Experience	Limited access to equipment and laboratory exposure	Students experienced difficulty due to limited equipment, reliance on simulations, and lack of direct hands-on practice	P06: Used simulations due to limited equipment and poor internet; P05: Difficulty in data collection; P08: Difficulty in experimental procedures; P09: Challenges in calculations and reporting; P10: Difficulty handling apparatus and identifying magnet charges
2. Procedural Uncertainty and Technical Hesitation	Unclear procedures and fear of errors	Students hesitated and slowed down when procedures were unclear and tasks were unfamiliar	P07: Difficulty following procedures; P08: Confusion in experimental steps; P05: Needed clearer instructions; P10: Fear of breaking apparatus; P09: Step-by-step execution and checking work
3. Emotional Tension Between Discouragement and Productive Challenge	Mixed emotional responses during laboratory tasks	Students experienced frustration, anxiety, boredom, and motivation shifts depending on task difficulty	P06: Frustration and withdrawal; P05: Boredom and disengagement; P09: Reduced motivation due to difficulty; P08: Manageable anxiety; P10: Confidence and relaxation through peer support
4. Engagement as Disrupted, Redirected, or Strengthened by Difficulty	Engagement varies depending on difficulty and support	Difficulties caused disengagement, peer dependence, or increased attentiveness and focus	P06: Loss of engagement due to frustration; P05: Distraction and reduced effort; P08: Reliance on groupmates; P07: Increased attentiveness; P10: Improved engagement through observation
5. Performance as Developing Competence Under Constraint	Competence improves despite initial difficulties	Students initially struggled but gradually improved through practice, reflection, and support	P06: Difficulty completing experiments; P05: Inaccurate outputs; P07: Improved accuracy over time; P09: Increased organization and confidence; P10: Adaptation through observation
6. Coping Through Collaboration,	Use of peer support, observation, and	Students relied on peers, instructors, digital resources,	P06: Sought help and used YouTube; P05: Asked instructors; P07: Reviewed steps and stayed calm;

Theme	Invariant Constituent	Merged Statement	Significant Statements (Participant Codes)
Observation, and Self-Regulation	emotional regulation	and self-calming strategies	P08: Asked for help and paused; P10: Learned through observation
7. Student-Centered Laboratory Support as Pathway to Confidence and Engagement	Structured guidance improves learning outcomes	Students emphasized need for manuals, demonstrations, scaffolding, and proper orientation	P06: Need for clearer instruction; P07: Step-by-step guidance; P08: Manuals reduce memorization burden; P09: Support improves confidence; P10: Orientation improves performance

3.8 Trustworthiness and Credibility Measures

To ensure the research findings are trustworthy and credible, multiple strategies were implemented in accordance with best practices in qualitative research. First, the use of prolonged engagement in the research setting was employed, whereby interviews allowed the researcher to develop an in-depth understanding of the students' experiences. This approach aided rapport-building with participants and facilitated capturing authentic and complete accounts of the laboratory challenges faced by participants and their coping strategies. Bracketing techniques were employed to reduce researcher bias in interpreting data.

Triangulation was used to improve credibility. The data were collected using semi-structured interviews, field notes and related literature review that allowed for cross verification of participants' accounts and ensured that the interpretations were not based on a single source of information. Significant statements were shared with participants for member checking to verify that the interpretations represented their views accurately. These strategies, prolonged engagement, triangulation and member checking, collectively contributed to the trustworthiness and credibility of the phenomenological findings.

4. Results and Discussion

This chapter discusses the findings on the problems faced by college students in learning physics laboratory. The data are collected from the responses of six college students who have direct experience in physics laboratory activities. The participants were identified as P05, P06, P07, P08, P09 and P10 to ensure confidentiality and improve consistency in reporting. Findings were organized to describe the nature of students' difficulties in laboratory learning and the meanings they made of the experiences.

The analysis centered on participants' accounts of limited hands-on practice, procedural uncertainty, emotional tension, engagement, performance, coping strategies, and preferred forms of laboratory support. Each theme was described in terms of the persons who directly articulated the experience, the number of persons who articulated the theme, the variations across accounts, and the phenomenological meaning of the theme, to enhance participant grounding.

4.1 Research Question 1: Lived Experiences of College Students Regarding Difficulties in Physics Laboratory Activities

Emergent Theme 1: Constrained Hands-on Experience

Five participants (P06, P05, P08, P09, P10) mentioned having limited access to laboratory equipment, having to rely on simulations and having difficulty fully engaging with hands-on tasks. P06 wrote:

"Uhmm... First of all, the most problem that I have encountered so far is the availability of laboratory equipment and because of that we always utilized online simulation and it is not effective sometimes because of low internet connection due to this we can't observed clearly the experiment and we can't gather data right away it consumes time."

P05 mentioned: *"Laboratory activities is very fun and less boring since here we really applied the concept, the only thing that I found hard is during the process of collecting data."* P08 reminisced: *"I think it was on an activity where we boiled some nails and we measured the equilibrium temp of the water after putting the hot nails and the difficult part was the process."*

P09 noted the cognitive load: *"Physics is a challenging subject for me since it involves calculations. Though laboratory activities is more on application of concepts and such, calculating and drawing answers/conclusions on lab sheets and reports is a challenge because you have to be observant on every small details—which is my weakness."* Finally, P10 detailed: *"When we had a laboratory about magnetism, I tend to have difficulty locating the charges of the magnet. But most of the time, I had difficulty in proper handling of lab apparatus."*

Patterns in the data indicate that all participants felt that their learning was limited when they were unable to physically manipulate laboratory materials. The difficulties encountered were delays in the collection of data, lack of clarity in observing experiments and problems with the recording or interpretation of results. The source of constraint was different -- some from equipment scarcity, some from procedural complexity -- but all participants were partially engaged. This highlights the value of hands-on experience in connecting theory to practice and the effect of restricted accessibility to understanding and confidence.

Experience has taught that the best way to learn laboratory skills is through hands-on experience. Simulations and videos are helpful, but they can't substitute for engagement, particularly in activities that require close observation and manipulation. Participants reported feeling less informed and less confident when they were not able to fully interact with the equipment. Emphasis is placed on the importance of experiential learning cycles that include reflection on specific activities, to reinforce theoretical knowledge and skill acquisition.

Hands-on experiences are absent and this builds up the cognitive and affective barriers in learning physics laboratory. Limited engagement is seen as a major barrier for students to learn meaningfully about the content of their learning and their confidence. These results align with other studies that have emphasized the importance of experiential learning and laboratory practice (Jackson et al., 2018; Wilcox et al., 2017; Dunnett, 2024). Good design and good support of tactile access to equipment and opportunities can lead to higher learning achievements and skill mastery.

Emergent Theme 2: Procedural Uncertainty and Technical Hesitation

All six participants (P07, P08, P05, P09, P10 and P06) stated that they felt hesitant and unsure in lab activities because of unclear procedures and fear of mistakes. P07 is characterized by: *"I once had a difficulty understanding the procedures during the experiment, which made it hard for me to complete the activity correctly."* P05 relied on peers and instructors for guidance: *"I asked for help from my groupmates and instructor for more clarification and guidance."* P08 shared: *"I asked my teacher for clarification and reviewed the instruction carefully,"* showing that participants actively sought support to resolve procedural doubts.

Participants also expressed nervousness related to equipment handling. P10 said: *"I feel nervous not because of the difficulty of the lesson but I am afraid to broke lab apparatus."* P09 highlighted careful execution: *"They make me slow down, double-check my work, and become more careful in following the procedure."* Several participants described self-regulation strategies, as P07 explained: *"I manage them by staying calm, taking a short pause, and focusing on the next step."*

In all cases the reasons for hesitation were the vague instructions, the fear of errors and the unfamiliarity with the laboratory tasks. Common strategies involved seeking help from peers or the instructor, close monitoring, repeated checking, and self-pacing. Differences were found in level of nervousness, peer dependency and level of self-regulation. This is a repeating pattern and we can see that the uncertainty of the procedure has an effect on the cognitive focus and the emotional state, and the students have to be careful with the task, slow down and check the work again and again to make sure the task is done correctly.

These experiences suggest that the clarity of the procedure is an important factor for successful engagement in laboratory learning. The participant's anxiety demonstrates the association of cognitive load and emotion. Anxiety is linked to uncertainty and can undermine confidence and interfere with learning if not appropriately supported. Peer strategies, stepwise strategies and instructor strategies are strategies to maintain the focus and continuity of task. Thus, the necessity of a procedural scaffolding, pre-lab teaching and guided demonstration was underlined to overcome technical hesitation and to improve students' involvement in hands-on physics activities.

In summary, experiences of procedural uncertainty and technical hesitation shaped students' laboratory learning. There was a cognitive and emotional load but participants coped with the ambiguity through peer support, careful planning and repeated checking. This corresponds with existing literature that suggests explicit procedures, systematic scaffolding and instructional guidance can alleviate cognitive load, and increase engagement (Dunnett, 2024; Cothrel, 2018; Phillips et al., 2021). Therefore laboratory teaching should be clear and supportive to maximise learning, confidence and performance in challenging situations.

4.2 Research Question 2: Influence of Difficulties on Students' Engagement and Performance in Physics Laboratory Activities

Emergent Theme 3: Emotional Tension Between Discouragement and Productive Challenge

The six participants, P06, P05, P09, P08, P07, and P10, reported mixed feelings during the laboratory activities. Negative feelings were: frustration, anxiousness, boredom, nervousness and embarrassment. P06 wrote: *"I feel very frustrated to the point that I don't like to do any activities in laboratory anymore."* P05 experienced occasional boredom during tasks: *"umm I feel difficulties when it comes to simulation sometimes."* P09 explained: *"Frustration: Frustration for me is an intense emotion given that it could lead to lack of motivation to continue delving on concepts."*

Some participants found challenges stimulating, or rewarding, on the other hand. P08 wrote: *"I felt anxious still it was not that intense that it can make me lose my focus,"* showing manageable tension that did not disrupt task engagement. P07 stated: *"I felt confused and a bit frustrated, but I stayed focused and tried to understand the task."* P10 reported: *"I felt relaxed because I was confident with my classmates, and I believed that more knowledge or perspectives would be shared,"* demonstrating the motivational benefit of peer support.

Participants described how emotional tension influenced their behavior during experiments. P06 explained withdrawal: *"It really affects me because once we encounter the problem and feel frustrated I will not do the activity anymore and I let my co-members to do the task."* P05 coped by redirecting attention: *"It makes me bored, so I talk to my groupmates instead."* Others, like P07, became more deliberate: *"They make me slow down, double-check my work, and become more careful in following the procedure."*

The analysis identified two patterns. Negative emotions sometimes led to disengagement where students withdrew, became distracted or worked more slowly. At other times difficulty was met with careful attention, persistence, and learning by reflection. Mood affected attention and performance, according to participants. Social and cognitive support, peer collaboration and instructor guidance alleviated the negative influence of emotional strain. The findings suggest that emotional tension in laboratory work is not merely a disturbance but can be a catalyst for productive focus when appropriate support structures are in place.

The emotional experiences show that laboratory problems are simultaneously stressors and motivators. Tension can be controlled and coping strategies and peer support can lead to more engagement, attention to detail and skill development. Frustration, anxiety or embarrassment are barriers to completing the task. Duality suggests the relatedness of affective and cognitive processes in learning. Emotion is affected by understanding and performance is affected by emotion. The students' reflections suggest that the emotional tension is an inherent part of complex hands-on learning and that this tension can be positively directed with appropriate guidance and collaboration.

Finally, the interaction between demotivation and constructive challenge is a sign of the emotional tension of the participants. Laboratory difficulties induce stress and motivation, which in turn influence engagement and learning behavior. These findings are consistent with earlier studies that have reported affective responses to be a component of laboratory learning and that these can either hinder or enhance cognitive performance (Chandni, 2025; Phillips et al., 2021; Strati et al., 2017). Students in supportive environments working with peers can transform emotional tension into productive focus, persistence, and skill development.

Emergent Theme 4: Engagement as Disrupted, Redirected, or Strengthened by Difficulty

Participants reported a range of engagement responses to lab challenges. While some became distracted or disengaged, others redirected their attention to peers, observation, or increased their focus. P06 wrote: *"It really affects me. Because of those experiences once I heard laboratory activities my body and mind becomes tired and I feel like its a waste of time."* P05 said the contrary: *"Since I found lab activities more engaging, I feel like it is more interesting and fun."* P07 highlighted increased attentiveness: *"They make me more careful, prepared, and attentive when carrying out laboratory activities."*

P08 described the collaborative redirection of attention: *"It made me think carefully and it taught me the lesson that you can always rely on your groupmates."* P09 emphasized self-directed engagement: *"Through realizations from experiences, guidance, and support from other people, I learned to handle things with effort and patience by asking, browsing on youtube, and searching supplemental additional information on books and articles."* P10 said: *"These experiences gradually change my view of physics and help me to see the value of cooperation with groupmates during lab activities."*

Available data suggest that engagement is not a static state but a highly dynamic one that is influenced by cognitive and emotional influences. Participants' levels of engagement varied as a function of task difficulty, help received, and personal coping methods. Peer interaction and guidance often increased engagement, while lack of resources or lack of clarity of procedures often led to temporary withdrawal. Differences in responses suggest that lab engagement is context dependent, varying with perceived difficulty and support.

These experiences suggest that engagement is a dynamically constructed process that arises from the interaction of cognitive load, emotional state and social context. Difficulties may be a barrier to involvement but with structured guidance, peer collaboration and personal strategies attention can be re-directed and focus improved. Students are more attentive when they see the difficulties as manageable and supported. This means that engagement is responsive and adaptive. Hence, in the laboratory, social-cognitive contexts are constructed in which students interact with content exercises, with material, with peers and instructors.

Engagement exists along a spectrum of difficulty from disengagement to focused attention. Participants noted the importance of scaffolding and peer collaboration to maintain attention, and the fluidity of lab engagement with context. This is consistent with previous studies reporting increased levels of engagement when tasks are meaningful, scaffolding is provided, and support is collaborative (Cai et al., 2021; Kalender et al., 2021). Therefore, the participation of students can be maintained or even increased despite challenges, when instructional practices are supportive.

Emergent Theme 5: Performance as Developing Competence Under Constraint

Participants reported that their initial laboratory performance was impacted by lack of experience, procedural uncertainty, and limited resources. P06 responded: *"It really affects my understanding cause I never saw the actual applications of the concept making me skeptical of the concept I have learned."* P05 admitted: *"To be honest, I really don't understand this experiment or concept."* P07 described challenges that slowed their performance: *"These difficulties sometimes slow my understanding, but they also push me to analyze the experiment more carefully so I can better grasp the concepts."*

Other participants highlighted iterative improvement through reflection and adaptation. P08 said: *"It made me rethink the actual process of experiments and the need to do them properly."* P09 shared a stepwise approach to competence: *"Facing difficulties on the subject itself is nothing new so when it comes on lab activities, doing experiments, I learned to do things step-by-step like I'll try to understand the core concept first, make some research, and try doing the experiment with patience—just that time allotment and equipment became a constraints."* P10 noted engagement-driven improvement: *"The more you engaged with the topic the easier for you to understand it, so having difficulties in engaging to the topic really affect your understanding."*

Slow development of performance in restricted conditions, shown by patterns across participants. The first days were full of measurement mistakes, misunderstanding and lack of confidence. Through iterative practice, reflection and guidance participants were able to increase accuracy, confidence and quality of output over time. The extent to which the participants improved depended on the extent to which they reflected, collaborated with peers and had access to resources, but all of the participants showed increased competence despite the constraints.

The experiences of the participants show that performance is emergent and context dependent in the lab. Challenges can get in the way of performance, but can also support skill development if the students are engaged and reflect on them, and are supported. Errors, feedback, and refinement have become a part of learning and lead to greater understanding with repeated cycles. This can be seen in the pattern of mastery as being a process that involves practice, mentoring, persistence, and the interplay of the dimensions of cognitive and affective learning.

The constraints of the laboratory environment did affect students' performance, but this did improve as they practiced, reflected and adapted. This is consistent with previous findings indicating that competence will develop through repeated learning and facilitative interaction, not necessarily in ideal situations (Märtsin, 2019; Holmes et al., 2020). Skills can be nurtured to be resilient and competent, despite constraints, by guided reflection, mentoring and repeated practical experience.

4.3 Research Question 3: Strategies or Interventions Perceived as Helpful in Overcoming Difficulties in Physics Laboratory Learning

Emergent Theme 6: Coping Through Collaboration, Observation, and Self-Regulation

The participants reported that they relied on their peers, instructors, observation, digital resources, and self-regulatory strategies for tackling challenges in laboratory tasks. P07 talked about asking for clarification and changing approach: *"I continue by reviewing the procedure again and adjusting my approach step by step to avoid repeating mistakes."* P08 said: *"I tread every step carefully and double check every step to ensure safety,"* showing cautious, self-directed strategies.

P09 reported both peer and independent support: *"I adjust my pacing of learning by studying the concept before going to or conducting the activity or tasks."* P06 relied on peer support when technical constraints arose: *"Sometimes I redo the task in my home but still I can't understand because there's no instructor explaining what really happened in the simulation."* P05 described mindset adjustment: *"I think I am not bothered by the previous activity, so I face the current activity by a different mindset focusing on the current lesson."* P10 added: *"When I am demotivated, my engagement with the topic is affected, so I look for support from my laboratory groupmates to divide tasks efficiently."*

The analysis suggests that students use a combination of social and cognitive coping strategies. Peer and instructor support sustains the flow of the task. They are capable of coping with procedural uncertainty by self-regulation, careful observation and preparation. Some of the participants were independent, some dependent. But they all stressed the importance of taking action to address challenges. Such forms are examples of the collaborative and self-directed nature of coping through the use of social and cognitive resources.

The data suggest that coping strategies allow students to feel engaged and confident when facing procedural, technical or resource-based challenges. Social support provides guidance and reassurance. Self-regulatory strategies which improve focus and task continuity include reviewing procedures, pacing tasks and monitoring performance. The use of collaborative and independent strategies necessitates the need for adaptive social-cognitive strategies to overcome the challenges of the lab. This highlights the importance of structured guidance and peer interaction for better learning outcomes.

The participants faced laboratory challenges through teamwork, observation, and self-control. These strategies helped them remain focused, confident, and task-oriented. This is consistent with previous studies demonstrating the importance of social support, peer collaboration, and self-directed strategies in managing laboratory learning challenges (Cai et al., 2021; Sobhanzadeh et al., 2017). Therefore, environments that promote collaboration, structured observation, and self-regulatory practices can assist students in managing challenges and attaining better learning outcomes.

Emergent Theme 7: Student-Centered Laboratory Support as Pathway to Confidence and Engagement

Participants emphasised that structured student-centred support increased their knowledge, confidence and engagement with laboratory activities. P05 highlighted the significance of peer and instructor guidance: *"I asked for help from my groupmates and instructor for more clarification and guidance."* P07 noted that careful observation and adherence to instructions improved their engagement: *"I continue by reviewing the procedure again and adjusting my approach step by step to avoid repeating mistakes."* P08 observed: *"I tread every step carefully and double check every step to ensure safety."*

P09 self-regulated preparation with support from guidance: *"I adjust my pacing of learning by studying the concept before going to or conducting the activity or tasks."* P06 relied on structured peer support when facing technical issues: *"Sometimes I redo the task in my home but still I can't understand because there's no instructor explaining what really happened in the simulation."* P10 highlighted collaborative support: *"When I feel demotivated my engagement with the topic becomes affected, so I seek support from my laboratory groupmates to better divide task efficiently."*

Analysis indicated that student-centered supports, including peer collaboration, instructor guidance, manuals, and structured demonstrations, were critical for building engagement and confidence. The supports helped participants to reduce uncertainty, clarify procedures and stay on track. All participants reported that structured support helped to make difficult tasks manageable and meaningful learning experiences. However, their use of social support and self-regulation varied.

These experiences demonstrate how laboratory support mediates challenges and learning outcomes. Structure, student-centered guidance clarifies, lessens cognitive and emotional load, and builds competence and resilience. Participants reported higher confidence, engagement, and persistence when scaffolding was adequate. It illustrates how instructional design and support systems can help students convert obstacles into positive learning experiences.

Student-centered laboratory support increased confidence, engagement, and competence. The participants' experiences demonstrate that learners can overcome procedural, cognitive, and emotional challenges when they are provided with structured guidance, demonstrations, clear instructions, and adequate resources. These findings agree with prior research suggesting that sufficient scaffolding can convert challenging laboratory experiences into meaningful learning that promotes skill development and sustained interest (Jackson et al., 2018; Guisasola et al., 2023).

4.4 Synthesis of the Lived Experience

The college students' physics practical laboratory experiences are complex intertwining of the cognitive, emotional and social attributes of learning under limitation. Practical problems mentioned by students included a lack of equipment, digital tools and/or simulations, unclear procedures and challenging experimental tasks. These limitations influenced the way they lived out these experiences in many ways, causing them to feel frustrated, fearful and bored, as well as having the opportunity for focused engagement, learning and reflection. During lab activities, participants had to ensure they collected data carefully, to observe, follow the steps of procedures and troubleshoot repeatedly. It showed the complex realities of their everyday interaction with experiments and laboratory things. Cognition and emotionality were embodied in sensory participation, manipulation of equipment, observation of phenomena, measurement of outcomes and engagement with peers, that brought theory to practice (Dunnett, 2024; Cothrel, 2018; Kapici et al., 2020).

Beneath these superficial characteristics the structural bases suggest a common theme of adaptation, resilience and strategic engagement. Students navigated their laboratory environment in a context of scarce resources, inconsistent contact with the teacher and pressures of academic demands in an institutional setting. Participants' interaction with peers and teachers in social context enabled them to deal with uncertainty and enhance their procedural understanding. Students engaged in self-regulated learning strategies: reflection and self-monitoring, incremental task mastery, and self-directed learning, and took control over their own learning pathways, transforming worry into purposeful and targeted learning. This structural dimension concerns how students interact with constraints and limitations from their environment, as well as with social support and personal agency in the creation of the psychological architecture that allows them to actively manage and experience the challenges of the lab as meaningful learning goals that they can achieve (Guisasola et al., 2023; Kapici et al., 2020).

The experiences result in an invariant form that represents the general nature of learning in the confined physics lab, one that is an iterative adaptive process of cognitive effort, emotional engagement and social interaction for the purpose of achieving competence, confidence and resilience. Some participants differed in their practices but all of them used experiential practice, peer assistance and self-reflection with instructors as strategies to deal with procedural ambiguity and technical issues. Laboratory problems are stressors and catalysts are a phenomenon that occurs twice. They impact on focus on attention, skill learning and persistence. Without these essential components of the spirit of laboratory learning -- physical engagement with experiments, scaffolding and adaptive approaches within a context -- the experience would be incomplete, without the cognitive understanding of the laboratory or the personal growth. This synthesis gives a comprehensive and integrative view of physics laboratory learning where challenges and opportunities are intricately interconnected and mastery is achieved through the inseparable marriage of experience, reflection and support (Dunnett, 2024; Cothrel, 2018; Kapici et al., 2020; Guisasola et al., 2023).

5. Summary, Conclusions, and Recommendations

5.1 Summary

This chapter presents the summary, conclusion, and recommendation of the study entitled "Exploring Difficulties in Physics Laboratory Learning Activities from College Students Perspective: A Phenomenological Study." The purpose of this study was to investigate college students' experiences of challenges to the challenges in physics lab activities, how students lived with these challenges, how these challenges affected their engagement and performance, and what strategies or interventions were useful to the student to overcome these challenges. Learning in Physics Laboratory is regarded as a bridge between theory and practice. This research aimed to understand students' personal experiences of learning through the laboratory, especially in the context of limited resources, confusing procedures, technical uncertainty, emotional stress and help.

The research was a descriptive phenomenological research with Moustakas transcendental phenomenological approach. Six (6) college students of Davao de Oro State College were purposively selected as participants who had first-hand experience in physics laboratory learning. Data were collected using semi-structured interviews that enabled participants to describe their experiences, feelings, difficulties, coping strategies and suggested supports in their own words. The transcribed interviews were subjected to systematic analysis that included bracketing, identification of significant statements, clustering of meanings, developing invariant constituents, and formulating emergent themes. Adequacy of data was based on the recurrence of meanings in the responses of the participants. The recurrence of meanings was especially in the fifth and sixth interviews, which was used to confirm and refine the themes that were found. Trustworthiness was enhanced by member checking, field notes and prolonged engagement.

Results showed that there was a relation among the students' cognitive, emotional, procedural and contextual dimensions that influenced their participation and performance. Nonetheless, methods like peer collaboration, observation, self-regulation, well-structured guidance, clear demonstrations and appropriate laboratory facilities played a role in improving meaningful learning and confidence. The results point to the importance of learning by doing, student-centered teaching in the lab, emotional support, and systematic teaching preparation.

Summary of Findings

Seven emergent themes from the study provide insight into the lived experiences of college students in learning physics in the laboratory; and how cognitive, procedural, emotional and environmental challenges influenced engagement and performance. One important factor is the lack of hands-on experience. Participants stated that they could not have enough time to do experiments, they could not access lab equipment, or they had to rely on experiments done in simulation or demonstration. Students' manipulative skills have been developed in a limited way and this affected their knowledge and confidence. However, students appreciated the value of using their hands to apply theoretical knowledge. Tactile experience and experiential learning can help bridge the gap between abstract concepts within the physics curriculum and concrete results in the lab (Dunnett, 2024; Wilcox et al., 2017; Jackson et al., 2018).

Procedural uncertainty and technical reticence was one of the major problems, students get confused when they are given vague instructions or unfamiliar equipment. The attention and engagement was tinged with worry and fear of making mistakes. There was a knot of emotion and cognition. These challenges were overcome through peer collaboration, self-regulation, careful planning, and regular checking. The results indicate that laboratory learning is not a technical issue but it is rather a continuous process which demands cognitive flexibility, emotional regulation and strategic interaction with the learning environment.

An emotional tension of feeling discouraged and productively challenged was a recurring aspect. Irritation, boredom and anxiety were frequently linked with temporary decrease or withdrawal of motivation. Conversely, problems were better presented in a positive way, leading to higher engagement, concentration and perseverance. Data suggest that emotional responses are an important factor in learning in the laboratory as they impact on attentional deployment, interactions with peers and acquisition of skills. Regulators (Reflective Practice, Pauses, Peer Support) allowed students to regulate their emotions and make problems good learning opportunities. This example highlights the emotional and cognitive aspects of the hands-on learning of science (Strati et al., 2017; Phillips et al., 2021).

Lab support for students was an important component to the troubleshooting and the building of competence, confidence and continuous participation. Easy and less stressful learning, cognitively and emotionally, was found to be supported by clear instructions, demonstrations, structured support, manuals, and appropriate resources. Engagement and performance were iterative and accuracy, procedural mastery and reflective skills were developed over time. Key factors for successful management of limited laboratory situations are: the concept of responsive instructional design, scaffolding and collaborative support. In summary, the study suggests that learning in physics labs is a complex and dynamic process impacted by both the context and culture, and students' personal agency and their reflective engagement (Jackson et al., 2018; Guisasola et al., 2023; Kapici et al., 2020).

5.2 Conclusions

The study results revealed that the major problems of the college students in Learning Physics Laboratory skills were limited resources, unclear procedures and emotional challenges. All these factors influenced students' engagement, performance and confidence, implying that laboratory learning is a multidimensional phenomenon that encompasses cognitive, procedural and affective elements. The main factors affecting the technical execution and motivation and focus of the students were lack of hands-on experience, unclear instructions and unfamiliar equipment. These findings align with the notion that laboratory activities require physical resources and structured, supportive instructional frameworks to enable meaningful engagement (Kapici et al., 2020; Dunnett, 2024).

Participants employed coping strategies including working with peers, observing, and self-regulation to address these challenges. They were able to turn problems into opportunities for reflective learning and skill development through these strategies. The variety of coping styles suggests that learning in the laboratory is a social process and is idiosyncratic for each student, a process where their agency, collaboration and adaptive responses are influential in their experiential learning. Resilience and competence were enhanced, with student centred methods that enabled students to consult with staff, to watch other people and to manage their own rate of learning fostering engagement (Jackson et al., 2018; Chae, 2024).

We found that structured, student-centered support was important in addressing procedural uncertainty and technical hesitation. Clear instruction, demonstration, manuals and feedback helped to make laboratory tasks easier and helped to improve students' confidence and performance. The scaffolding and guidance provided enabled participants to participate with more depth, less mistakes and problem solving skills. The findings support the importance of adaptive instructional design, where laboratory education should have clear procedures and opportunities for iterative reflective practices to improve learning outcomes (Guisasola et al., 2023; Tarmizi et al., 2025).

Last but not least the study recommends that even though the laboratory offers challenges, it can be a facilitator to competence, resiliency, and meaningful learning if nurtured and extended. These experiences and challenges are not only emotionally challenging but they are intellectually challenging and are part of the learning process that has an impact on students' development. The findings indicate the significance of teaching methods that engage students in active learning, cooperative and reflective learning activities for students to overcome difficulties and be confident and competent. They can be employed to make barriers into opportunities for learning by doing, develop capable, confident and resilient learners (Creely, 2018; Chae, 2024) and offer chances for physics laboratory learning.

5.3 Implications of the Study

The results of this research may be useful for teaching and learning in physics laboratories. First, the study demonstrates that the challenge in the laboratory is not only technical but also cognitive and affective. Limited equipment, confusing instructions and time pressure can all add to increased levels of anxiety, decreased confidence and decreased engagement. This knowledge can be used to design better lab sessions, with documented step-by-step procedures, organised teaching, and adequate hands-on experience for teachers. The comprehension of the cognitive-emotional relationship enables teachers to anticipate the difficulties that students will face and give adequate scaffolding to learn physics topics and emotional resilience (Dunnett, 2024; Cothrel, 2018).

Secondly, it is pointed out that strategies for student support should be student-centred in order for students to learn. Barriers to be overcome and skills to be developed were often addressed through peer collaboration, instructor feedback and reflective techniques. This suggests that teaching strategies that promote collaboration, mentoring, and structured reflection may improve participation and outcomes in the laboratory. Within the institutions formalised peer assisted learning or structured mentoring programmes may be established to ensure students are getting procedural and emotional support. These can be ways of making a potential problem in the lab into learning opportunities for students to build confidence and develop practical skills (Jackson et al., 2018; Kapici et al., 2020).

Thirdly, the study shows experience learning is an important way to understand physics laboratory training. Student engagement, motivation and performance were strongly related to hands-on experimentation, iterative practice and opportunities for outcome reflection. The findings suggest that (a) the concepts of experiential learning and students' phenomenological awareness of their living experience can be used as guidelines in the development of students' laboratory curriculum, both in terms of skill mastery and affective needs. The laboratory tasks can also be used by instructors to improve students' self-efficacy in the laboratory by incorporating reflection, feedback, and real-world applications into their learning process, which will improve their understanding of concepts and make problem solving more active (Guisasola et al., 2023; Tarmizi et al., 2025).

Finally the results have implications for policy, resource allocation and future research. This evidence can help administrators and curriculum planners to focus on lab infrastructure, lab materials and teacher training. Documenting students' lived experiences can also help inform the development of student support services (such as counseling or academic support) to help students overcome affective barriers. In addition, this research lays the groundwork for further phenomenological research in similar instructional organisations, where the interaction of the problems in the laboratory and institutional, instructional and personal factors can be investigated. Finally, the results show the importance of cognitive, emotional and social dimensions in learning physics lab (Creely, 2018; Chae, 2024).

5.4 Recommendations

On the basis of the obtained results the following should be carried out: Physics Laboratory Courses. Complete orientation should be given before each major laboratory activity in laboratory courses. The sessions should include step by step directions for the process, introduction to equipment, safety and expected results. Strategies to help students understand the 'why' and 'when' of lab assignments include providing context for each step and explaining the 'why' for each method, to reduce confusion and technical apprehension. Pre-lab material such as annotated manuals, instructions for simulation or short demonstration videos can also help preparation and confidence before jumping into real world activities.

Instructors should be able to provide structured scaffolding and guided demonstration to avoid procedural and technical confusion. Peer-assisted learning and collaborative problem solving can help students with challenging or novel tasks, and can increase students' confidence and interest. Teachers are encouraged to observe the progress of students during the laboratory work and give feedback to clear misconceptions, clarify procedures and ensure safety. Learning should be iterative and provide students with the opportunity to experiment with approaches, test measures and reflect on what they have learned, thus strengthening their approach to procedure and their understanding of concepts.

From the importance of emotional experiences in laboratory learning, it is needed for the teachers to make a deliberate effort to establish a good and encouraging learning atmosphere. Such strategies may include the following: Reflecting and discussing. Sharing solution strategies that have helped others in the group to achieve success. Failure and positive coping can make failure normal, and turn frustration into productive engagement. Small debriefing sessions after tasks can be useful to foster metacognition and for students to connect emotional regulation with attentional focus and improved performance.

Finally, laboratory support (instructional and institutional) is important to effective laboratory learning. Resources must be adequately allocated and equipment regularly maintained and laboratory infrastructure invested in to ensure equal and regular access for all students. Instructor training and professional development programs should emphasize experiential teaching, scaffolding methodology and good laboratory management. Well equipped laboratories, instructor preparedness and student centred instructional methodologies will make physics lab education a holistic, adaptive and empowering process for students to be competent, confident and resilient.

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