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A proposed instructional design model for developing learning materials in physics for Filipino learners

Mary Rose Fabila Santos*[1] and Dennis Gamad Caballes[2]

[1]Antipolo City Senior High School, Antipolo, Rizal 1870 Philippines
[2]De La Salle-College of Saint Benilde, Taft Avenue, Malate, Manila 2544 Philippines

ABSTRACT

The purpose of this study was to develop an instructional model to guide the development of physics laboratory experiments to assist students in mastering difficult concepts of physics. The instructional materials are new laboratory activities that offer experiential learning to improve the learning outcomes of students in physics. To create these materials, the research determined the least mastered competencies in the senior high school physics curriculum and came up with corresponding laboratory experiments. The.study employed a qualitative research design. Data were collected through focus group discussions (FGDs) with science teachers and interviews and perception surveys with purposively selected Grade 12 STEM students. The findings were that the REFLECT (Recognize the Concept, Engage and Explore, Facilitate Inquiry, Learn through Laboratory Execution, Evaluate and Explain, Communicate and Collaborate, and Think Critically and Apply) instructional model was used as a basis to create laboratory experiments that enhance conceptual comprehension and student engagement. Teacher and student interview qualitative data brought forth effective teaching practices such as interactive experiments. Survey findings attested to the fact that teachers and students deemed the instructional materials critical to enhancing the learning experience. These findings indicate that the REFLECT model is an efficient model to use in creating laboratory experiments. Its systematic approach improves the education of physics by promoting greater conceptual understanding, enhancing student interest, and enhancing academic performance. The REFLECT model offers an easy, student-centered pedagogy of physics that encourages active learning, discussion, and critical thinking. It provides an integrated model for developing instruction materials to enable bridging the gap between theory and practice. The research gives a contribution to science education by providing a workable model that could be embraced in future research and curriculum development studies.

Corresponding author
Email Address: **maryrose75santos@gmail.com**

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INTRODUCTION

Physics, being one of the foundational sciences, plays an important role in developing students' analytical minds and problem-solving skills. Apart from its technical nature, it enhances curiosity, creativity, and critical thinking, all of which are critical in responding to today's rapidly changing world. Yet, for most students, physics is often considered one of the most difficult subjects to learn. Research has indicated that the abstract nature of physics concepts makes it difficult for students to relate them to everyday experiences, hence the misconceptions and gaps in knowledge (De Jong, Linn, & Zacharia, 2013).

Effective physics instruction involves not only knowledge transfer but also the chance for students to directly participate in the process of learning. Studies indicate that when students are engaged in inquiry and lab-based learning, their scientific reasoning and conceptual retention improve (Wieman & Holmes, 2020). However, these methods are not always uniformly applied in the classroom.

In the Philippine context, teaching and learning physics challenges are further evident. Gerada (2022) uncovered that teachers in senior high schools tend to have difficulty with readiness, especially in Electricity and Magnetism and Modern Physics competencies. Likewise, Remigio et al. (2024) found that most physics teachers show limited ability in employing laboratory-based methods, leading to under-execution of laboratory activities. These gaps limit the potential of physics education in secondary schools.

In spite of such challenges, some creative teaching methods have proved beneficial. Lumampao (2023), for example, illustrated that 5 E learning activities—engage, explore, explain, elaborate, and evaluate—markedly enhanced the science process skills and conceptual knowledge of students. Similarly, (Merciales 2016) revealed that the TRI-P6 reflective inquiry model improved learners' knowledge, skills, and attitudes in physics, highlighting the value of instructional models responsive to student needs.

KEYWORDS

instructional design model, instructional design, learning materials, learning outcomes

With these findings, there is an increasing demand for models of instruction that speak to the particular issues confronting both students and teachers when learning physics. This study presents the REFLECT model, an instructional design model based on qualitative data from physics classrooms. Through the incorporation of practices like identifying concepts, enabling inquiry, learning through execution, assessing outcomes and applying critical thinking, the model seeks to deepen students' command of physics while assisting teachers in addressing instructional challenges. In particular, this research intended to develop and pilot-test the REFLECT instructional design model by means of designing physics laboratory experiments. It intended to examine the perceived usefulness and usability of the REFLECT-designed experiments on increasing students' knowledge of least-mastered competencies, and obtain feedback from both students and teachers for its application.

This study describes the qualitative development and validation of the REFLECT instructional model, which was constructed based on teachers' instructional challenges, classroom practices, and the thematic patterns that emerged from interviews and focus group discussions. Rather than measuring effectiveness through statistical comparison, this study focuses on how the model was conceptualized and how teachers and expert validators qualitatively verified the clarity, relevance, and usability of the designed laboratory activities aligned with the model.

MATERIALS AND METHODS

Research Design

This study utilized a qualitative research design to explore teachers' instructional practices and challenges in teaching physics, which served as the foundation for developing the REFLECT instructional design model. A descriptive-qualitative approach was employed, using interviews and focus group discussions (FGDs) to gather in-depth insights from physics teachers. This design was chosen because it allows for a deeper understanding of lived experiences, perspectives, and instructional realities.Thematic analysis was used to identify recurring patterns, which were later synthesized into the framework of the REFLECT model.

The study specifically focused on identifying the least mastered Physics competencies among the participating students.These competencies included: performing vector addition; solving for unknown quantities in one-dimensional uniformly accelerated motion; applying Newton's Law of Gravitation to determine gravitational force; weight, and acceleration due to gravity; calculating range, time of flight, and maximum height in projectile motion; solving problems involving work, energy, and power; relating momentum, impulse, force, and time of contact; applying the concepts of buoyancy and Archimedes' Principle; describing relationships among amplitude, frequency, period, displacement, velocity, and acceleration in oscillating systems; and defining mechanical, longitudinal, transverse, periodic, and sinusoidal waves. These identified learning gaps served as the foundational basis for the development of the REFLECT-guided laboratory activities.

Guided by these competencies, the designed laboratory activities aimed to develop students' understanding of fundamental physical relationships, examine how forces and interactions affect observable motion, apply conceptual and mathematical reasoning to solve real-world problems, analyze measurable changes in physical quantities through hands-on investigations, and communicate findings using scientific language. These activities were intentionally structured to address the specific conceptual and skill-based difficulties identified among students.

Participants

The participants of the study included seven physics teachers and six STEM students from **Antipolo City Senior High School in Antipolo City, Philippines**. The teachers were purposively selected to participate in interviews and focus group discussions, as they had direct experience in handling physics classes. For the students, two from each of the three Grade 12 STEM sections participating in the pilot REFLECT-designed laboratory experiments were chosen as interviewees. Although limited in number, these student interviewees were selected to capture perspectives across sections. Their feedback provided complementary insights into students' experiences and perceptions of the designed activities.

Data Collection

Data were collected from several qualitative sources to provide a holistic perspective of physics teaching and the application of the REFLECT model. Semi-structured interviews and focus group discussions were done with the seven physics teachers to document their practices, strategies, and problems in teaching physics.

During the pilot testing of the REFLECT-designed lab experiments, six STEM students—two for each of the three Grade 12 STEM classes—were purposively chosen to be interviewed. Interviews were guided by a perception survey questionnaire used as the basis for guided discussions. The students' data were not intended to represent the entire population but to provide additional, representative information on how the designed experiments affected motivation, comprehension, and general learning experiences.
Ethical principles such as voluntary participation, confidentiality, and the right to withdraw at any time were followed diligently during the data collection process.

Data Analysis

Thematic analysis was applied to analyze the qualitative data gathered from focus group discussions and teacher interviews. Interview and FGD transcripts, along with field notes, were analyzed to identify recurring patterns and categories in instructional practices and teaching challenges in physics. Emerging themes were refined through comparison across participants to make them more consistent and reliable. To further establish the credibility of the results, the themes that were found were cross-checked using expert reviewers to ensure their correctness and appropriateness. For the student interviews, answers facilitated by the perception survey questionnaire were also explored thematically. The analysis centered on repeated insights into the effectiveness, clarity, and influence of the REFLECT-designed experiments in the laboratory on their learning experience. These student voices were additional data complementing teacher themes extracted from teacher inputs to classroom realities.

RESULTS AND DISCUSSION

Instructional Practices of Teachers

The analysis of teacher interviews revealed several recurring instructional practices in the teaching of physics. These practices reflect both traditional and innovative approaches that teachers employ to help students engage with complex concepts.

A recurring theme was **objective-driven physics lesson design,** where instructors stressed the alignment of their daily instructional approaches with the most critical learning competencies. Lessons were frequently designed around clearly articulated objectives, which directed the selection of instructional strategies. Teachers noted that alignment produced coherence and consistency in classroom delivery.

Teachers highlighted the value of linking lesson planning with curriculum requirements and learning goals. They use hands-on experiments, demonstrations, and simulations to engage students actively and improve learning outcomes. Effective time management and organized deployment of lesson plans are among the priorities. According to Pols & Dekkers (2024), linking objectives with procedural as well as conceptual knowledge enhances the conceptual grasp of physics among students. An objective-based methodology facilitates systematic and meaningful experimental learning.

Another routine practice was **planning and instructing laboratory activities**. Teachers reported that despite limited resources, they intentionally planned experiments and demonstrations ahead of time. Laboratory planning was seen as a necessary activity to anticipate likely problems and to ensure the smooth implementation of activities. This practice indicates the teachers' dedication to offering realistic experiences despite the absence of complete resources. Successful laboratory teaching involves meticulous planning of equipment and materials to eliminate inefficiencies and disruptions. Teachers may encounter equipment failure or scarce resources but improvise through alternative materials. Appropriate preparation guarantees productive and beneficial laboratory sessions.

An organized approach guarantees thorough pre-lab preparation, following safety protocols, and engaged student participation. Instructors use inquiry-based and collaborative learning techniques, and guided demonstrations prior to and during experiments. These techniques allow students to master challenging concepts and use them appropriately. (Lahme et al., 2023) recommend designing experimental tasks that facilitate inquiry-based learning and engage students in experiment design, data collection, and analysis.

The use **of hands-on learning in physics** was also emphasized. Various teachers supported laboratory experiments that involved students manipulating apparatus, taking observations, and drawing conclusions. All these activities were regarded as necessary in enhancing understanding by relating theoretical knowledge to real-world application. Likewise, organizing and conducting physics labs became an essential practice, as teachers mentioned the necessity of organizing experiments to optimize both learning and safety. Teachers aligned experimental procedures to learning objectives, ensure proper instructions, and impose safety protocols. Experiments are performed stepwise: preparation, performance, observation, and interpretation. Teachers also introduce real-world applications to contextualize experiments and connect them to students' lives. Alemani (2024) adds that scaffolded approaches to lab courses improve the skills of students to design and perform experiments, facilitating incremental skill acquisition and more elaborate scientific inquiry.

Teachers also indicated using **interactive, collaborative methods**, including small groups and peer teaching. Such practices enabled students to collaborate, share thoughts, and summarize ideas in their own words. Consistent with this, the cultivation of **scientific inquiry and critical thinking** was stressed, as teachers involved students in problem-solving activities, guided inquiry, and reflective questioning. Teachers acknowledge that lab experiments improve students' critical thinking and problem-solving capabilities. In analyzing data, interpreting results, and guided questioning, scientific reasoning skills are developed by students. Facilitated discussions trigger curiosity and further inquiry into physics topics. (Dounas-Frazer and Lewandowski 2018) presented the Physics Lab Inventory of Critical Thinking (PLIC), an instrument measuring students' critical thinking in physics labs, reaffirming the need for inquiry-based instruction.

Taken as a whole, these results show that while lectures and demonstrations continue to be the foundation, educators increasingly incorporate laboratory-based and student-centered approaches to practice. This trend is consistent with previous Philippine research estimating that student engagement is best achieved where educators marry systematic lesson planning with hands-on procedures (Merciales, 2016; Lumampao, 2023). Literature worldwide further supports that inquiry-based and collaborative practices promote higher-order thinking and enrich conceptual understanding (De Jong et al., 2013; Wieman & Holmes, 2020).

These findings indicate that physics teaching is most advantaged when objective-based planning is supplemented with laboratory preparation, interactive approaches, and critical thinking opportunities. These practices form a firm basis for the construction of instructional models, like the REFLECT model, that further facilitate student participation and conceptual understanding.

Challenges Faced in Teaching Physics

Alongside their instructional practices, teachers also identified several challenges that affect the delivery of physics lessons and laboratory activities. These challenges highlight both systemic and classroom-level concerns that constrain effective teaching.

One of the dominant themes was **challenges in lesson planning and delivery.** Teachers described that planning physics lessons required substantial time and energy because the concepts are abstract. They reported that balancing conceptual depth while dealing with time limitations made it impossible to guarantee mastery. Lesson planning was frequently further complicated by the necessity of incorporating experiments within already stringent timetables. As reported by Mergler and Spooner (2012), well-being has a direct impact on the capacity of teachers to plan and teach lessons. High workload and stress can hinder teachers' ability to develop effective lesson plans. (Gutierez, 2015) also determined that resource shortages, training, and time are hindrances to teaching using inquiry-based science, and proposed collaborative lesson study as an alternative.
Teachers also reported difficulty in presenting complicated physics ideas in a captivating, understandable way—especially in situations of resource scarcity and classroom limitations. The inability to make changes to lessons because of strict curriculum requirements adds to the difficulty. Poor pacing may leave students overwhelmed or apathetic. Effective physics teaching is then dependent upon carefully sequenced lessons, interactive approaches, and efficient time management in order to maximize student understanding.

Another routine problem was **difficulties in conducting hands-on activities**. Although laboratory experiments were acknowledged by teachers as a vital learning component for students, they also indicated that implementation in practice was not always easy. Constraints such as the absence of full equipment, inadequate lab space, and safety concerns were common enough to constrain the number and extent of activities they could perform. Varying degrees of preparedness among students also influence the success of lab work. (Abrahams & Millar 2008) indicated that most science practical work place more emphasis on procedures than understanding, restricting their learning potential. Likewise, (Trowbridge et al. 2000) listed major challenges like safety issues, facility constraints, and prolonged preparation times for instructors. Institutional support is needed to counteract these challenges.

Teachers also grappled with **addressing diverse student needs**. They reported that students entered in physics classes with different prior knowledge, motivation, and readiness. This diversity created difficulty in crafting lessons that were both accessible to all students and challenging enough for more capable students. Gay (2018) highlighted that culturally responsive teaching promotes engagement and achievement. Teachers should to take students' cultural backgrounds into consideration when preparing instruction to provide relevance and inclusiveness.

Assessing student learning was another hurdle. Teachers reported that although procedural knowledge was assessed through written tests and problem-solving drills, it did not always reflect conceptual knowledge or critical thinking. Creating authentic assessments aligned with inquiry learning or lab activities remained a priority concern. Brookhart (2017) prescribed the application of grading and assessment as instructional tools, rather than just measures of judgment. Clear rubrics, constructive feedback, and varied assessments enhance student engagement and attainment.

Lastly, coping with limited resources was a recurring issue. Teachers reported laboratory equipment shortages, insufficiency of consumable materials, and minimal access to current instructional resources such as digital simulations. These resource shortages hindered their capacity to perform meaningful experiments and at times compelled them to resort to greater reliance on teacher demonstrations rather than students' inquiry.

Table 1: Emergent Themes on Teachers' Instructional Practices in Physics

Theme	Description
Objective-Driven Physics Lesson Design	Teachers emphasized designing lessons with clear objectives to guide instruction and assessment.
Preparing and Teaching Laboratory Activities	Laboratory lessons were planned to complement classroom instruction and provide hands-on experiences.
Interactive Collaborative Methods	Group work and peer discussions were encouraged to enhance engagement and understanding.
Hands-On Learning	Students were provided opportunities to manipulate equipment and perform experiments to better grasp abstract concepts.
Laboratory Preparation	Careful preparation of materials and equipment was highlighted as essential for effective laboratory teaching.
Emphasizing the Importance of Laboratory Experiments	Teachers considered laboratory work as central to developing scientific understanding.
Planning and Running Laboratory Experiments	Systematic planning and implementation of laboratory sessions ensured smoother conduct of activities.
Development of Scientific Inquiry and Critical Thinking	Lessons were designed to cultivate questioning, reasoning, and problem-solving skills among students.

Note: Themes were identified through focus group discussions among seven physics teachers.

The findings highlight that teachers base their instruction on explicit goals, which form the context for organizing instruction and assessment. Preparation and implementation of laboratory experiments were highlighted as being at the core of effective instruction, in accordance with the principle that experimentation enhances conceptualization. Teachers also identified the usefulness of cooperative approaches like group work and peer discussions, which facilitate active engagement and peer learning. In addition, the themes indicate the need for proper laboratory preparation and meticulous planning to facilitate effortless activity implementation. Teachers saw laboratory experiments not merely as a means of reinforcing concepts but as a way to develop inquiry, reasoning, and critical thinking among students. Such practices indicate that physics education in the context of this research goes beyond content transmission to the development of higher-order thinking abilities.

Table 2: Emergent Themes on Teachers' Instructional Challenges in Physics

Theme	Description
Challenges in Lesson Planning and Delivery	Teachers face difficulty designing lessons that effectively integrate concepts, activities, and assessments to achieve learning outcomes.
Difficulties in Conducting Hands-On Activities	Implementing practical experiments is challenging due to time constraints, large class sizes, or complex procedures.
Addressing Diverse Student Needs	Teachers struggle to accommodate varied learning abilities, interests, and prior knowledge in a single classroom.
Assessing Student Learning	Evaluating students' understanding accurately is difficult, especially for conceptual or practical skills.
Coping with Limited Resources	Lack of laboratory equipment, instructional materials, or technology hinders effective teaching and learning.

The findings show that lesson planning and teaching are still a critical area of concern for teachers, especially in managing curriculum demands versus learners' diverse learning needs. This is consistent with previous research that physics teaching needs both exactness and responsiveness to keep students interested. In addition, challenges in performing practical activities were often attributed to limited resources, health and safety issues, and classroom management, which tend to force teachers to rely more on theoretical discussions.

Another identified challenge was meeting diverse student needs, mirroring the need for differentiated instruction to meet variations in learning pace, interest, and comprehension. Teachers also indicated challenges with measuring student learning, stating that traditional tests can fail to accurately reflect conceptual mastery, thus necessitating the inclusion of performance-based tasks. Lastly, the insufficiency of the necessary laboratory equipment, the obsolete textbooks, and the limited technological infrastructure appeared as compelling issues that compelled teachers to improvise or reduce experimental work. As a group, these issues underpin the compelling need for specific assistance, resource allocation, and expert training to improve the teaching and learning of physics.

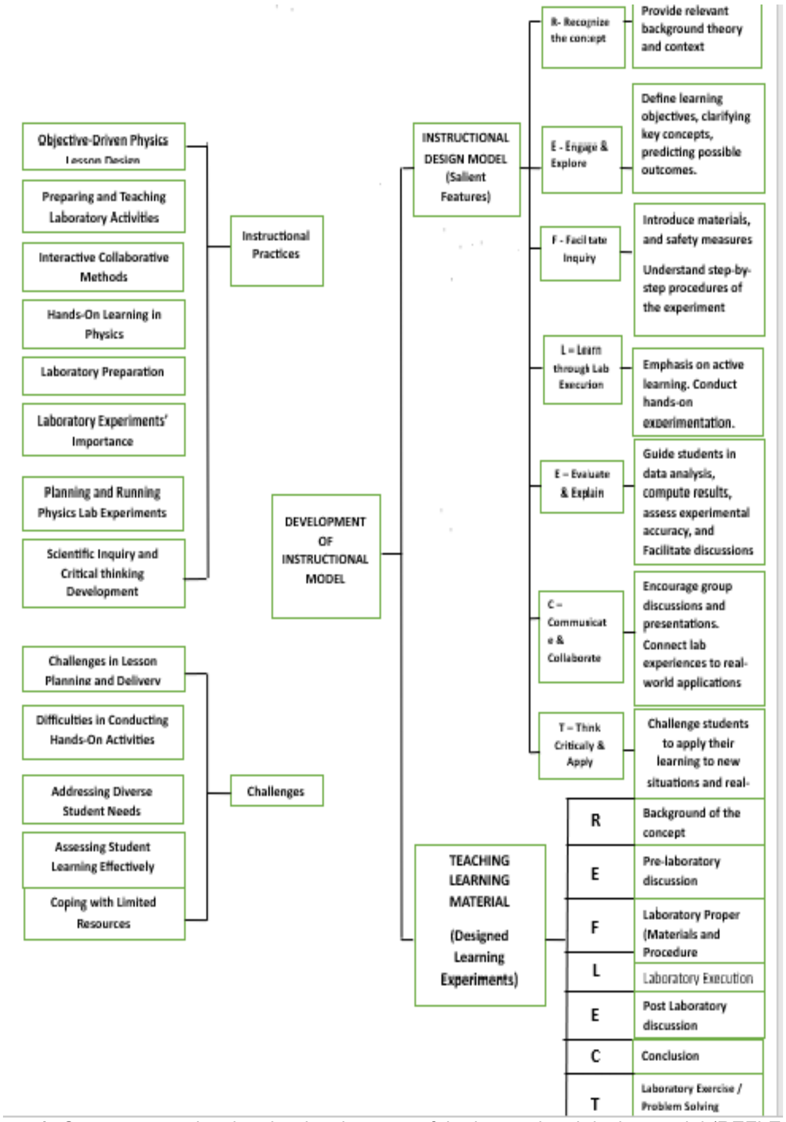

Figure 1: Concept map showing the development of the instructional design model (REFLECT)

Development of the REFLECT Model

The analysis of instructional practices and challenges formed the foundation for the development of the REFLECT instructional design model. The practices identified—such as objective-driven lesson design, collaborative methods, hands-on learning, and critical thinking development—highlighted the strengths already present in teachers' approaches. At the same time, the challenges—particularly in lesson planning, conducting laboratory activities, addressing diverse learners, assessing learning, and coping with limited resources—revealed significant gaps that needed to be addressed through a structured framework.

The REFLECT model was conceptualized to integrate these insights into a systematic, learner-centered cycle. Each component of the model responds directly to the realities faced by teachers in the classroom and laboratory:

Figure 2: The Instructional Design Model (REFLECT)

The REFLECT Model consists of seven elements, each contributing to a systematic, student-centered learning process.

This model is a comprehensive instructional design framework for laboratory experiments, encouraging inquiry-based learning, collaboration, and critical thinking. The stages of the model include

R: Recognizing the Concept – Derived from teachers' emphasis on objective-driven lesson planning, this stage ensures that learning goals are clear, achievable, and aligned with essential competencies.

E: Engaging in Discussions – This stage responds to the need for collaborative and interactive strategies, encouraging peer-to-peer exchange and teacher-guided dialogue.

F: Facilitating Inquiry – Emerging from both the value teachers placed on inquiry and the challenges in conducting hands-on activities, this phase structures opportunities for guided exploration even in resource-limited contexts.

L: Learning through Execution – Directly tied to hands-on learning and laboratory experimentation, this phase encourages active participation through practical tasks.

E: Evaluating Results – Addressing the challenge of assessing student learning, this stage emphasizes evaluation of experimental outcomes and conceptual understanding.
C: Communicating Findings – Aligned with collaborative practices, this stage develops students' ability to present, explain, and justify their work.

T: Thinking Critically and Applying – Reflecting the teachers' goal of fostering higher-order thinking, this stage encourages learners to apply their knowledge to novel situations and real-world problems.

The model then becomes an integration of best practices by teachers and their stated challenges, turned into a cycle of clarity, inquiry, collaboration, and critical thinking. Notably, the REFLECT model was not developed to supplant current strategies but to be an adaptable guide and one that teachers can modify based on their context. The construction of REFLECT follows the general literature on science education instructional design models. Research underscores that meaningful models are developed through frameworks supported by theory and actual teacher experiences (De Jong et al., 2013). Local research likewise underscores the necessity for context-based designs solving real-world limitations while encouraging active learning (Merciales, 2016; Lumampao, 2023). Through addressing the gaps encountered in this research directly, the REFLECT model provides a research-informed and practical framework for improving teaching and learning of physics in senior high school.

Evaluation of the REFLECT Model by Expert Validators
Although classroom teachers did not directly evaluate the REFLECT model during implementation, three expert validators in physics education reviewed the model and provided comprehensive feedback regarding its usability and instructional value. Their comments were analyzed thematically and organized according to ease of use, enhancement of laboratory activity design, and capacity to address challenges in planning physics experiments.

1. **Ease of Use.** The validators described the REFLECT model as systematic and "easy to follow," noting that its structured phases guide both teachers and students through the laboratory process with minimal ambiguity. They emphasized that the instructions and illustrations embedded in the model are clear and user-friendly, allowing teachers to apply each phase with confidence. One validator highlighted that the model "directs the learning process in a productive manner," reinforcing its practicality for instructional use.

2. **Enhancement of Laboratory Activity Design.** Validators reported that the REFLECT model significantly enriched the process of designing laboratory activities. They noted that the model ensures logical sequencing—moving from conceptual grounding to inquiry, execution, evaluation, and communication—which strengthens both the pedagogical flow and student engagement. One validator explained that the activity sequence helps students "gain hands-on experience and critical thinking along with inquiry-based exploration," demonstrating that the model encourages deeper and more structured learning experiences.

3. **Addressing Challenges in Designing Laboratory Activities**. The validators also recognized the model's potential in assisting teachers with common challenges, such as aligning experiments with learning goals and ensuring coherence between concepts and practical tasks. They found that the content was "well-organized in relation to physics concepts and learning goals," making the model an effective reference for teachers who struggle with planning comprehensive laboratory lessons. Additionally, the clarity of procedures helps reduce confusion and supports both novice and experienced teachers in implementing laboratory activities effectively.

Designed Laboratory Experiments in Physics
The REFLECT instructional model provides a systematic approach to conducting laboratory experiments in Physics, transforming them into a progressive and meaningful learning experience. Each element of the model is aligned with a specific phase of laboratory teaching, from conceptual foundation to practical application.

R – Recognize the Concept (Background of Concepts). This phase familiarizes the students with the fundamental principles, theories, and concepts involved in the experiment. It offers preliminary background information, such as real-world applications, historical background, and foundational knowledge required to understand the experiment. This step guarantees that students acquire a strong conceptual foundation prior to moving to practical activities. Bybee (2015) highlighted that teachers must capture students' interest and enable them to make connections between prior and present learning, establishing a basis for subsequent concepts.

E- Engage and Explore (Pre-Laboratory Discussion). The pre-lab discussion was concerned with the learning objectives and desired results of the experiment. It made students predict outcomes, anticipate difficulties, and make sense of concepts around the activity. This stage promotes inquiry and critical thinking, setting students up for the process of experimentation. Gholam (2019) emphasizes active engagement and problem-solving by students, challenging students to question, investigate, and build their own knowledge by discovery.

F – Facilitate Inquiry (Materials and Procedure). This phase involves demonstrating the materials required for the experiment and explaining the procedures step by step. It includes proper introduction to laboratory equipment and emphasizes safety measures. Students are guided on how to set up the experiment to ensure data accuracy and reliability.

L – Learn Through Lab Execution (Laboratory Proper). Students participated actively in the experiment, using procedures defined in the prior stage. They manipulated materials, documented observations, and interpret time-dependent data. Collaboration and teamwork enabled students to practice inquiry-based learning and experimentation of physical phenomena. Bybee (2015) emphasizes hands-on experience, which enhances active involvement and curiosity.

E – Evaluate and Explain (Post-Laboratory Discussion). After completing the experiments, students compared and analyzed their results with theoretical predictions. They made inferences from data, detected inconsistencies, and adjusted sources of error. Guided questions encourage students to think about their results and make meaningful conclusions. According to Bybee (2015), this evaluation stage allows both instructors and students to determine comprehension and progress, promoting an occasion for reflection and added understanding.

C – Communicate and Collaborate (Conclusion). During this stage, the students summarized their findings, connected them with theoretical principles, and determined practical applications. They are motivated to give a clear presentation of their findings using lab reports, presentations, or discussions. This process solidified learning as well as improved scientific communication. Le et al., (2017) pointed out that cooperative learning approaches enhanced student communication and interaction, creating improved learning outcomes through verbal communication in discovery learning.

T – Think Critically and Apply (Laboratory Exercise or Problem-Solving Application)
The last stage called on students to use the learned knowledge through problem-solving exercises, simulations, or practical applications. They can be provided with computational problems, extension activities, or design problems that enhance the understanding and encourage further investigation. Gholam (2019) highlighted that inquiry-based learning improves critical thinking through making students ask their own questions, pursue evidence, and justify their explanations, resulting in higher understanding and application of knowledge.

Application of the REFLECT Model in the Projectile Motion Laboratory Activity
The Projectile Motion experiment clearly demonstrates how each stage of the REFLECT instructional model is embedded in the laboratory design and contributes to deeper student learning.

Recognize the Concept (Background section): The activity begins with a concise explanation of projectile motion, introducing students to key ideas such as trajectory, gravity, launch angle, and independent horizontal and vertical motions. This section ensures that students have a clear conceptual foundation before manipulating variables in the investigation.

Engage and Explore (Pre-Laboratory Discussion): Students examine essential concepts through guiding questions that prompt them to think about the relationship between launch angle, trajectory, and distance traveled. This stage activates prior knowledge and prepares students to make predictions during experimentation.

Facilitate Inquiry (Materials and Procedure): The Ramp and Ball Challenge allows students to conduct hands-on inquiry by adjusting the ramp height, modifying launch angles, and observing resulting trajectories. The simple, low-cost materials enable students to explore projectile motion authentically while collecting measurable data across multiple trials.

Learn Through Execution (Laboratory Proper): Students carry out repeated launches, record distances, measure angles, and observe variations in landing points. This stage emphasizes accurate data gathering, organization in tables, and recognition of patterns emerging from the trials.

Evaluate and Explain (Post-Laboratory Discussion): Students analyze the relationship between ramp angle and distance, examine inconsistencies in landing points, and reflect on factors affecting the results. Guiding questions lead them to interpret their data and explain how the theoretical concepts of projectile motion align with their experimental findings.

Communicate and Collaborate (Computations, Interpretations & Conclusions): Students compute numerical values, interpret results, and formulate conclusions. They are encouraged to articulate explanations based on evidence collected during the experiment, fostering scientific communication.

Think Critically and Apply (Lab Exercise): Higher-order application problems require students to use projectile motion equations in new contexts, extending their understanding beyond the ramp experiment. This demonstrates the transfer of learning from hands-on exploration to mathematical problem solving. This demonstrates transfer of learning and supports collaborative reasoning.

Overall, this experiment shows how the REFLECT model transforms a simple projectile motion activity into a structured, inquiry-based, and conceptually rich learning experience.

Student Perceptions of the REFLECT-designed Experiments
The perceptions of selected STEM students provided additional insights into the effectiveness and impact of the REFLECT-designed laboratory experiments. Three themes emerged from their feedback, reflecting how the model influenced their learning experience.

Enhanced learning through hands-on and accessible materials. Students shared that using locally sourced and improvised materials made the activities both practical and relatable, allowing them to connect abstract physics concepts with real-life applications. The affordability and accessibility of these materials also reduced barriers to participation, enabling all learners to engage meaningfully in the experiments.

Conceptual understanding through visual and interactive simulations. Simulations were particularly useful in illustrating complex phenomena that were difficult to observe directly. Learners explained that visual models and interactive tools supported their exploration of concepts, deepened their comprehension, and allowed them to extend their understanding beyond textbook explanations.

Skill development and accuracy in laboratory work. Students expressed that the experiments improved their ability to conduct measurements, troubleshoot errors, and analyze data systematically. Beyond technical skills, students also reported increased confidence in problem-solving and collaboration, as the REFLECT activities often required group work and peer discussions.

These results validate the efficacy of the REFLECT model to develop both conceptual knowledge and practical skill. As with previous research in the Philippines, the incorporation of practical learning and simulation has been validated to improve students' interest and performance in science (Lumampao, 2023). Studies abroad also attest to the notion that inquiry and lab-based approaches develop process skills and higher-level thinking (Wieman & Holmes, 2020). In general, student responses show that REFLECT-designed experiments met their need for equitable, meaningful, and skill-based learning experiences. This highlights the model's ability to enhance physics education by cementing theoretical concepts with practical implementation.

These results have significant implications for physics instruction. For instructors, the model provides an organized but adaptable template for planning lessons and facilitating laboratories, even under limited resources. For learners, it offers purposeful avenues to integrate theory and practice, collaborate, and acquire important scientific competencies. Institutionally, REFLECT provides an appealing model that schools can pick up or modify in crafting laboratory-based activities aligned with senior high school competencies.

The students' outputs revealed clear qualitative evidence of improved conceptual understanding and performance after engaging with the REFLECT-guided laboratory activities. Responses in the earlier laboratory activities often consisted of brief or incomplete explanations, whereas submissions in later activities demonstrated more structured reasoning and clearer articulation of scientific ideas. For example, several students shifted from simple observations such as "It changed" or "It moved faster" to more elaborated explanations that referenced underlying principles and patterns observed during the activity. Reflection sheets showed similar growth, with students describing how the experiments helped them "understand the process better" and "see how the ideas apply in real situations," indicating increased ability to connect classroom concepts with everyday experiences.

Additional evidence came from students' lab reports, where they demonstrated improved analytical and communication skills. Many were able to identify sources of error, justify their interpretations with specific observations, and propose modifications to strengthen the experimental procedure—an indication of emerging critical thinking. Performance tasks also showed richer descriptions and more accurate use of scientific vocabulary. In group presentations and practical demonstrations, students were able to explain their procedures and findings more confidently and with greater clarity. Collectively, these qualitative indicators from worksheets, reflections, lab reports, and performance outputs provide concrete evidence that the REFLECT model supported deeper understanding, enhanced academic performance, stronger real-life application, and more critical analysis during laboratory work.

CONCLUSION

This research investigated the teaching practices and challenges of physics teachers and incorporated student perspectives in developing the REFLECT instructional design model. The results indicated that although teachers are highly involved in lesson preparation, laboratory planning, and collaborative learning approaches, they still have persistent challenges including limited resources, time pressures, and challenges in dealing with diverse learners. Student responses also verified the importance of practical exercises, readily available materials, and simulations in enhancing conceptualization and skill acquisition.

The REFLECT model, developed from the above findings, presents a systematic yet flexible model that supports clear learning objectives, questioning, teamwork, assessment, communication, and analysis. As it combines the views of teachers and students, the model gives concrete recommendations for planning efficient laboratory-based physics teaching in the Philippine senior high school setting. Subsequent studies could build on this research by extending the model testing to different school environments and investigating whether effects endure in the long term for students and teachers.

The experiments conducted utilizing the REFLECT model had appeared to have a positive influence on the learning of physics among students. Through identification of concepts and class discussion, the students were able to easily relate the hands-on materials and use them in practical situations. Interactive simulations promoted inquiry and hands-on experience, enabling them to grasp tough concepts easily. Laboratory work enabled students to analyze results, report findings, and be critical, thus reinforcing their skills, precision, and confidence. As a whole, students found the exercises pleasant and believed that they really improved both their knowledge and working competencies, demonstrating that the REFLECT model can direct learning design.

The study concludes that the REFLECT model offers a structured and teacher-informed approach to designing physics laboratory activities. Through qualitative validation, the model was found to be clear, usable, and responsive to the instructional challenges identified by teachers. While the findings do not measure effectiveness quantitatively, the qualitative evidence from validators, teachers, and student outputs demonstrates the model's potential to guide the development of meaningful and conceptually grounded laboratory experiences.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

CONTRIBUTIONS OF INDIVIDUAL AUTHORS

The first author (M.R.S.) designed the study, developed the learning activities, collected and analyzed the data, and drafted the manuscript. The co-author (D.G.C.) provided guidance during the research process, contributed to the interpretation of findings, and helped refine and finalize the manuscript. Both authors reviewed and approved the final version of the paper.

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