Issues and Challenges in Teaching the Mole Concept in Grade 9 Science: A Research Proposal

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DOI: https://doi.org/10.47772/IJRISS.2026.100601135

Received: 21 June 2026; Accepted: 26 June 2026; Published: 13 July 2026

ABSTRACT

The mole concept is widely recognized as one of the most challenging topics in secondary chemistry due to its abstract nature and the mathematical reasoning required for its understanding. This research proposal aims to investigate the issues and challenges encountered by Grade 9 science teachers in teaching the mole concept using the Department of Education Self-Learning Modules. Specifically, the study seeks to explore teachers' experiences, identify the factors that hinder effective instruction, and examine the strategies employed to address these challenges. Guided by a qualitative descriptive research design, the study will involve eight Grade 9 science teachers from selected public secondary schools in Davao City. Data will be gathered through focus group discussions and analyzed using thematic analysis. The findings are expected to provide insights into the instructional difficulties associated with teaching the mole concept and serve as a basis for developing appropriate interventions and instructional materials to enhance students' conceptual understanding and learning outcomes in chemistry.

INTRODUCTION

Background of the Study

The mole concept is one of the most fundamental yet challenging topics in chemistry because it requires students to integrate mathematical reasoning with abstract scientific concepts. Mastery of this concept is essential for understanding stoichiometry, chemical equations, and quantitative relationships in chemistry. Despite the Department of Education (DepEd) providing Self-Learning Modules (SLMs) to support science instruction, many Grade 9 learners continue to experience difficulty in understanding the mole concept, particularly when solving quantitative problems and relating symbolic representations to real-world chemical phenomena. These learning difficulties often result in poor academic performance and limited conceptual understanding.

Several factors contribute to these persistent challenges. Self-Learning Modules primarily emphasize independent learning and frequently provide limited opportunities for interactive instruction, guided problem-solving, and hands-on laboratory experiences. Consequently, many students struggle to develop higher-order thinking skills necessary for solving chemistry problems. Furthermore, differences in students' mathematical abilities, scientific literacy, and reading comprehension make learning the mole concept even more difficult. Teachers also encounter challenges in providing differentiated instruction because of limited instructional time, inadequate laboratory facilities, and insufficient teaching resources.

International studies likewise report similar concerns. In Germany and Sweden, Li et al. (2024) found that rigid curricula and limited opportunities to connect chemistry concepts with real-life applications hinder students' conceptual understanding. Likewise, Mammino (2020) reported that insufficient instructional time and variations in students' foundational scientific knowledge remain barriers to learning calculation-intensive chemistry topics. In the United States, Alberto (2020) observed that many students rely heavily on memorizing formulas instead of developing a conceptual understanding of the mole, making it difficult to apply the concept in problem-solving situations. Collectively, these studies suggest that improving instructional approaches, learning resources, and teacher support can enhance students' understanding of complex chemistry concepts.

In the Philippines, science education continues to face significant challenges. Results from the 2022 Programme for International Student Assessment (PISA) revealed that Filipino learners ranked among the lowest-performing countries in science, obtaining an average score of 356, which is substantially below the Organisation for Economic Co-operation and Development (OECD) average. Similarly, Department of Education reports indicate persistent difficulties in science achievement, particularly in topics requiring analytical thinking and quantitative reasoning (DepEd, 2020). These findings highlight the need to strengthen instructional practices that support meaningful learning of abstract chemistry concepts such as the mole.

The situation is also evident in Davao City, where many public schools continue to experience shortages in laboratory facilities, instructional materials, and other resources needed for effective science instruction. Caballes et al. (2024) reported that several schools in Davao Region lack adequate laboratory facilities, limiting opportunities for practical learning experiences. Berame (2022) likewise emphasized that inadequate instructional resources negatively influence students' academic achievement in science. These conditions create additional challenges for teachers who facilitate chemistry instruction using Self-Learning Modules.

Although previous studies have extensively examined students' misconceptions, academic performance, and learning difficulties related to the mole concept, relatively few have explored the instructional experiences of Grade 9 Science teachers who implement DepEd Self-Learning Modules. Understanding teachers' perspectives is important because they directly experience the challenges of facilitating problem-solving activities while addressing students' diverse learning needs. Examining their experiences can provide valuable insights into improving instructional practices, learning resources, and professional development programs for chemistry education.

Therefore, this study aims to explore the issues and challenges encountered by Grade 9 Science teachers in teaching problem-solving activities on the mole concept using DepEd Self-Learning Modules. Specifically, it seeks to identify the challenges teachers encounter and the coping strategies they employ to facilitate students' conceptual understanding. The findings of the study are expected to contribute to the improvement of chemistry instruction, strengthen teacher support systems, and provide evidence-based recommendations for enhancing science education. Moreover, the study supports the attainment of the United Nations Sustainable Development Goal 4 (Quality Education) by promoting equitable, inclusive, and effective science teaching practices.

Research Questions/Objectives

This study seeks to answer the following questions:

1. What issues and challenges do Grade 9 Science teachers encounter in teaching problem-solving activities on the mole concept using the Department of Education's Self-Learning Modules?

2. What coping strategies do Grade 9 Science teachers employ to address the challenges encountered in teaching the mole concept using the Department of Education's Self-Learning Modules?

Objectives of the Study

1. To explore the issues and challenges encountered by Grade 9 science teachers in teaching problem-solving activities within the mole concept using DepEd’s Self Learning Module.

2. To determine the coping strategies employed by Grade 9 Science teachers in addressing the challenges encountered in teaching the mole concept using the Department of Education's Self-Learning Module.

Significance of the Study

The results of the study can be beneficial to the following:

Students. Insights gained from the study can contribute to the improvement of instructional practices and learning resources that support students' conceptual understanding of the mole concept, thereby helping them overcome common misconceptions and learning difficulties.

Teachers. This study will provide Grade 9 Science teachers with a deeper understanding of the challenges associated with teaching the mole concept using the Department of Education's Self-Learning Module. The findings may help teachers reflect on their instructional practices, identify effective coping strategies, and enhance their approaches to facilitating students' understanding of this complex and abstract chemistry topic.

School Administrators. This study may provide school administrators with valuable information regarding the instructional challenges faced by science teachers in teaching the mole concept. The findings can serve as a basis for planning professional development programs, strengthening instructional support systems, and improving the availability of learning resources that promote effective chemistry instruction and student understanding.

Future Researchers. This study may serve as a reference for future researchers interested in chemistry education, particularly in exploring factors that influence the teaching and learning of the mole concept. The findings can provide a foundation for further investigations on instructional challenges, teaching strategies, students' conceptual understanding, and the development of interventions aimed at improving chemistry education.

REVIEW OF LITERATURE AND THEORETICAL FRAMEWORK

Related Literature and Studies

This section presents all the relevant and related literature and studies that provide the theoretical and empirical foundation for this research.

Academic Performance in Mole Concept

According to the American Chemical Society (2025), hands-on laboratory experiences contribute to the educational advantages, emphasizing the capacity to significantly enrich learning across all tiers of science education. Nevertheless, according to Shehu et al. (2025), the concept of the mole remains particularly elusive and consistently presents challenges for chemistry students, necessitating the manipulation of exceedingly large numbers and intricate stoichiometric ratios. Thus, according to Rees & Bruce (2022), compounding this issue is the inconsistency in terminology and definitions employed in various educational materials, particularly online, which can lead to considerable confusion for novice chemistry students. This review provides an evidence-based framework for the creation and potential impact of a laboratory activity worksheet designed to improve academic performance in the mole concept through a problem-solving learning approach.

Moreover, the study of Chi et al. (2023) reported that the average National Achievement Test (NAT) score in science for senior high school students was only 34.05%, far below the Department of Education's passing benchmark of 75%. These low scores indicate that traditional instructional methods are insufficient in supporting students' comprehension of complex scientific concepts, including the mole concept. In the same way, according to Gabiazon (2024) high school students performed poorly in science due to several compounding factors, including weak foundational knowledge, low reading comprehension, and limited parental involvement. Teachers cited a lack of resources and the need for more engaging instructional methods.

In addition, the study of Boctot, (2025), showed that poor reading comprehension and limited scientific vocabulary negatively impact students' performance in science-related problem-solving. Also, the study of Alburo, (2025) found that many Grade 9 students did not meet expected proficiency in literal, critical, and inferential reading comprehension. Also, Mingoa & Abocejo, (2021) reported a strong relationship between Grade 9 learners' reading comprehension scores and their science performance, indicating that reading skills significantly influence success in science. Teachers also stated that students lack the basic mathematical skills necessary to perform quantitative problem-solving tasks in Chemistry (Linuhung, 2025).

Furthermore, in the study of Baste, (2025) it was found out that students struggle with scientific problem-solving and multi-step calculations likely stem from weak mathematical foundations. Similarly, this aligns with the study of Vo, et. al. (2024), who emphasized that students' difficulties in Chemistry often stem from inadequate conceptual understanding and weak mathematical reasoning, even when instructional scaffolds are provided. Also, students' difficulties in independent learning are often linked to literacy gaps, and structured interventions can scaffold their understanding, improve engagement, and facilitate meaningful learning (Flores and Adiong, 2023).

In connection, a study of Reyes and Santos (2023) emphasizes that addressing these issues requires a multi-faceted approach involving policy reforms, teacher training, and community engagement. Additionally, a study conducted by Von Secker (2022) found that science educators have a clear preference for inquiry-oriented teaching approaches, as opposed to the more conventional teacher-centered approaches that heavily rely on scientific knowledge, textbooks, and lectures. These strategies aim to actively involve students in science by providing them with chances to practice laboratory procedures, apply logical reasoning and evidence-based problem-solving, conduct further research for a more comprehensive understanding, and emphasize the importance of writing scientific explanations backed by evidence.

Further, in the contemporary learner-centered educational environment, science instruction increasingly necessitates active participation, contextual learning, and structured problem-solving experiences. However, the transition toward flexible learning marked by the Department of Education's (DepEd) use of Self-Learning Modules (SLMs) has posed significant challenges in delivering complex scientific concepts such as the mole concept (Lopez & Marquez, 2025). While SLMs provide structured content aligned with the K to 12 curriculum, many teachers find that these modules do not offer the depth, interactivity, and guided practice necessary for students to fully grasp abstract chemical relationships (Dizon & Reyes, 2022).

Similarly, the participants stated that students benefit from hands-on and interactive experience which increase engagement and reinforce understanding. The participants likely gave these responses based on repeated classroom observations where students struggled with purely text based modules but showed improvement when lessons were contextualized and interactive (Buenviaje, et. al., 2021).

Additionally, according to the study of Anderson & Krathwohl (2020), academic performance in the field of science frequently serves as a valuable indicator of students' understanding and proficiency in essential scientific concepts and skills. Moreover, according to Alatli (2023), science education aims to cultivate scientific literacy, encompassing the understanding of scientific concepts, the comprehension of research methodologies, and the acknowledgment of the profound influence of science on society. Also, a crucial component in fulfilling this objective is the provision of hands-on experiences, which play a vital role in bridging theoretical knowledge with practical application, thereby transforming abstract concepts into tangible problem-solving capabilities (Li et al., 2023).

Furthermore, according to Hattie (2019), a range of factors contributes to academic performance, including teaching methodologies, student engagement, and the effectiveness of hands-on experiences. Also, the study of Nieminen et al. (2021) indicates that strategically designed laboratory activities that emphasize critical thinking and problem-solving skills can significantly improve students' academic performance. Hence, assessing academic performance can be effectively done using the grade point average (Lamas, 2015). In addition to regular quizzes, tests, and examinations in the classroom, it is common for school-age children to take official academic tests based on academic performance. These assessments evaluate the effectiveness of the instructor, curriculum, educational institution, and students (Grier-Reed & Chahla, 2015). Also, many authors believe that achieving academic performance is a direct outcome of effective teaching and active student engagement.

Apparently, in the study of Garnett et al., (2020) it was found that students often struggle with the mole concept because they lack understanding of its related foundational concepts, such as elements, compounds, chemical bonding and Avogadro's number. This insufficient grasp leads to confusion as the mole concept is abstract and requires linking these underlying ideas in a specific and cohesive way. Standard self-learning modules (SLMs)

are often too broad and insufficiently explanatory, which hinders learners' ability to grasp abstract scientific concepts (Basri et al., 2021). Similarly, Laguador and Cañizares (2022) found that modules lacking sufficient detail tend to promote surface-level learning, where students rely on memorization rather than comprehension because of limited elaborative guidance. Nardo (2021) emphasized that effective self-learning materials should include introductory and contextual sections that activate prior knowledge and provide conceptual coherence. In line with this, Dangle and Sumaoang (2021) noted that modules lacking context and clear explanations increase cognitive load and create greater dependence on teacher assistance.

METHODOLOGY

This chapter discusses the methodologies that will be utilized in the study, such as the research design, sources of data, data gathering instrument, sampling technique, procedure of the study, and the statistical treatment.

Research Design

This study will utilize a qualitative research design, specifically a qualitative descriptive research design (Scribbr, 2025). It will explore the issues and challenges encountered by Grade 9 Science teachers in teaching the mole concept using the Department of Education's Self-Learning Module. Through this design, the study will seek to gain a comprehensive understanding of teachers' experiences, the difficulties they encounter, and the strategies they employ to address these challenges.

Research Instrument

The research instrument for this study will consist of a researcher-made questionnaire designed to collect data related to the teaching of the mole concept. The instrument will undergo content validation by four (4) experts to ensure its relevance, clarity, and appropriateness for the study.

Sources of Data

The study will involve focus group discussions with a total of eight (8) participants, consisting of five (5) Science teachers and three (3) Master Teachers who handle Science subjects. These participants will be selected from one of public secondary schools in Davao City and will have experience teaching the mole concept during the second quarter of the 2025–2026 school year. The focus group discussions will be conducted to gather in-depth insights into the issues and challenges encountered by Grade 9 Science teachers in teaching the mole concept using the Department of Education's Self-Learning Module, as well as the strategies they employ to address these challenges. The data collected will provide a comprehensive understanding of teachers' experiences and instructional practices related to facilitating students' understanding of the mole concept.

Sampling Technique

The study will employ a universal purposive sampling technique for data collection. This sampling technique involves selecting participants based on specific criteria relevant to the study. It can be used if the study requires participants with specific experiences or characteristics related to the study (Scribbr, 2023). According to Nikolopoulou (2023), purposive sampling is described as a set of non-probability sampling methods.

Procedure of the Study

Asking Permission to Conduct the Study. The researcher will formally request permission from the appropriate school authorities to conduct the study and to engage the selected Science teachers and Master Teachers as participants. Upon approval, the participants will be informed about the purpose of the study, and their voluntary participation will be sought through informed consent.

Validation of the Research Instrument. The focus group discussion guide will be subjected to content validation by four (4) experts in the field to ensure its relevance, clarity, and alignment with the objectives of the study.

The experts will evaluate the instrument using an appropriate validation rubric and provide recommendations for its improvement prior to data collection.

Conduct of the Focus Group Discussion. Upon securing the necessary permissions and validating the research instrument, the researcher will conduct focus group discussions with the selected participants. The discussions will focus on the issues and challenges encountered by Grade 9 Science teachers in teaching the mole concept using the Department of Education's Self-Learning Module, as well as the strategies they employ to address these challenges.

Analysis and Interpretation of Data.The data gathered from the focus group discussions will be transcribed, organized, and analyzed using thematic analysis. The identified themes will then be interpreted in relation to the research questions and relevant literature to provide a comprehensive understanding of the participants' experiences and perspectives.

Data Analysis

In this study, thematic analysis guided the process of identifying, analyzing, and presenting themes, subthemes, and codes derived from the data.

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Bionote:

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ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue VI June 2026

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