Experimental Skills and Self-efficacy on the Academic Performance in Chemistry of Senior High School Students

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Abstract

Persistent underperformance of Filipino students in international science assessments necessitates an examination of factors influencing chemistry achievement. Despite the recognized importance of laboratory work and student confidence in science learning, limited local research has simultaneously investigated experimental skills and self-efficacy as joint predictors of academic performance in General Chemistry I among senior high school STEM students. This quantitative correlational study, grounded in Bandura's Social Cognitive Theory and von Glasersfeld's Radical Constructivism, employed simple random sampling to select 116 Grade 12 STEM students from a public secondary school in Leyte Division. Data were gathered using the experimental skills and science self-efficacy scale, alongside students' final grades, and analyzed using descriptive statistics and Spearman's rank-order correlation at a 0.05 level of significance. The results revealed that students demonstrated high levels of experimental skills ($M = 4.170$) and self-efficacy ($M = 4.033$), with academic performance concentrated in the above-average bracket. Spearman's correlation analysis indicated statistically significant positive relationships between experimental skills and academic performance ($rho = 0.569$, $p < .001$) and between self-efficacy and academic performance ($rho = 0.617$, $p < .001$). These findings affirmed that both variables were significantly associated with students' chemistry achievement. The study contributed evidence-based insights that guided the development of Project IGNITE, a 10-week intervention program targeting laboratory competencies and confidence-building. The findings benefited teachers, administrators, curriculum developers, and future researchers in strengthening science education quality within the Philippine STEM program.

Keywords: Experimental skills; science self-efficacy; academic performance; chemistry

1. Introduction

Science education plays a pivotal role in equipping learners with the knowledge, skills, and dispositions necessary to participate meaningfully in a rapidly evolving, technology-driven world. Among the natural sciences, chemistry occupies a central position in the curriculum, as it underpins advances in medicine, materials science, environmental management, and numerous other fields that shape modern society. Despite its significance, student performance in chemistry and the sciences in general remains a pressing concern in many educational systems, particularly in developing countries. In the Philippines, the results of the 2022 Programme for International Student Assessment (PISA) revealed that Filipino learners ranked 80th out of 81 participating countries and economies in science, obtaining a mean score of 356 points—far below the Organisation for Economic Co-operation and Development (OECD) average of 485 points (OECD, 2023). These figures underscore the urgency of examining the factors that influence academic performance in science, especially at the senior high school level, where subject-specific competencies are most intensively developed.

The Philippine K–12 Enhanced Basic Education Curriculum, implemented through Republic Act 10533, introduced two additional years of senior high school (SHS) that include specialized strands, among which the Science, Technology, Engineering, and Mathematics (STEM) strand is designed to cultivate analytically proficient graduates who areprepared for tertiary-level science and research courses (Torres & Calim, 2024). General Chemistry 1 and 2 are among the core subjects in the STEM strand, and their mastery is deemed essential for students aspiring to pursue careers in science-related fields. However, studies have documented that Filipino STEM learners frequently struggle with chemistry concepts, with diagnostic test results revealing least-mastered competencies across multiple content areas (Borillo, 2025). This underperformance signals the need to investigate domain-specific variables that either facilitate or impede chemistry learning among senior high school students.

Experimental skills—the psychomotor, cognitive, and procedural competencies demonstrated during laboratory investigations—are widely regarded as indispensable to science education, as they provide students with opportunities to observe phenomena, manipulate variables, record data, and draw evidence-based conclusions, thereby bridging the gap between theoretical knowledge and practical understanding (Agustian et al., 2024; Gericke et al., 2022; Achuthan et al., 2023). In chemistry specifically, the development of experimental skills is integral to the discipline's epistemology, as it is through doing chemistry that students begin to think and reason like chemists. Beyond skill development, the affective dimensions of learning—particularly students' beliefs about their own capabilities—have been identified as powerful

determinants of academic achievement, with self-efficacy, rooted in Bandura's (1977) Social Cognitive Theory, referring to an individual's belief in their capacity to organize and execute the actions required to produce a desired outcome. In academic contexts, self-efficacy has been consistently recognized as a key predictor of student motivation, persistence, goal-setting, and performance, with students high in self-efficacy more likely to demonstrate proactivity and effective use of learning strategies, while those with low self-efficacy tend to avoid challenges and disengage from difficult tasks (Schunk & DiBenedetto, 2020; Moussa, 2023; Hinduja et al., 2024). In the context of chemistry education, self-efficacy shapes not only students' willingness to engage with demanding content but also their confidence when performing complex laboratory procedures and problem-solving tasks.

Within the Philippine educational context, a growing body of local research has begun to explore the factors influencing chemistry achievement among SHS learners. Torres and Calim (2024) highlighted that STEM-strand students face significant difficulties in mastering General Chemistry content, calling for targeted interventions that address both cognitive and affective learning dimensions. Bernardo et al. (2023) profiled low-proficiency science students in the Philippines using machine learning and identified that motivational and self-regulatory variables—closely related to self-efficacy—were among the most discriminating features distinguishing low from high achievers. Despite these emerging contributions, there remains a dearth of local studies that simultaneously examine experimental skills and self-efficacy as joint predictors of chemistry academic performance, particularly among Grade 12 STEM students—a gap that the present study seeks to address.

Grounded both on von Glasersfeld's Radical Constructivism and Bandura's Social Learning Theory, this study aims to fill the gap in the lack of literature focusing on the relationship between experimental skills and academic performance in chemistry, and self-efficacy and academic performance in chemistry of senior high school students in the school year 2025-2026. Specifically, this study aimed to answer the following research objectives:

1. determine the academic performance in terms of the final grade of Grade 12 STEM students in General Chemistry I;
2. determine the level of experimental skills of Grade 12 STEM students;
3. determine the level of self-efficacy of Grade 12 STEM students;
4. determine if there is a significant relationship between experimental skills and the academic performance of Grade 12 STEM students;
5. determine if there is a significant relationship between self-efficacy and the academic performance of Grade 12 STEM students in General Chemistry I; and
6. develop an intervention based on the findings of the study.

The significance of this study lies in its potential to provide empirical evidence that can inform curriculum development, laboratory instruction, and student support programs at the senior high school level. By establishing the extent to which experimental skills and self-efficacy predict or correlate with academic performance in chemistry, the findings can guide educators, school administrators, and policymakers in designing more responsive and evidence-based approaches to science instruction. The study also contributes to the growing body of literature on chemistry education in the Philippines by providing locally grounded data on two underexplored but theoretically significant predictors of achievement. Ultimately, this research addresses the specific problem of identifying the relationship among experimental skills, self-efficacy, and the academic performance in chemistry of senior high school students. The study is premised on the thesis that both experimental skills and self-efficacy are significant predictors of academic performance in chemistry, and that strengthening these variables through intentional instructional strategies will lead to measurable improvements in student achievement.

2. Methodology

This chapter presents the research design used in the study, the research locale, the respondents of the study, the research instrument, the data gathering procedure, the analysis of data, and ethical considerations.

2.1 Research Design

This study used a correlational research design. Putri et al. (2025) state that this design is a methodological approach that aims to identify and analyze the relationship between two or more variables without manipulation. It focuses on exploring the extent to which variables are related and the direction and strength of that relationship. It helps identify associations and patterns between variables. In this study, the relationships among experimental skills, self-efficacy, and academic performance in General Chemistry I.

2.2 Research Local

The research was conducted at a public secondary school in the Philippines. This was a public school in the Leyte Division in Eastern Visayas that offers the academic strand of Science, Technology, Engineering, and Mathematics. The

Department of Education, Leyte Division, has been actively involved in research initiatives, particularly in the field of education. One of the initiatives is the Eastern Visayas Basic Education Research and Innovation Forum. It is anchored on the theme of advancing education through research and innovation. Its research initiatives demonstrate its commitment to improving the quality of education in the region and contributing to the advancement of knowledge in various fields, including Science education.

2.3 Research Respondents

The respondents of this study were Grade 12 STEM students aged 16–18 years old, enrolled in a selected secondary public school in Leyte, Philippines, offering the Science, Technology, Engineering, and Mathematics strand for the academic year 2025–2026. These students were deemed optimal for this study given that General Chemistry is embedded in their curriculum and that they are preparing for future careers as scientists, engineers, information technologists, and other science-related professionals who rely heavily on experimental skills and self-efficacy. Out of the 165 enrolled Grade 12 STEM students, a sample of 116 was determined using the RaoSoft sample size calculator. The respondents were selected through simple random sampling, a probability sampling method in which each member of the population has an equal chance of being chosen through a single random selection process. This method was deemed most appropriate for the study, as its use of randomization enhances both internal and external validity while minimizing the risk of sampling bias and selection bias.

2.4 Research Instrument

Academic performance was measured using the first quarter grades in General Chemistry, while experimental skills were assessed through a survey questionnaire adapted from Khaparde and Shaker (2020), designed to capture laboratory techniques, safety practices, problem-solving abilities, and data analysis skills across six sections: knowledge and theoretical understanding, psychomotor skills, health and safety, measurements and instrumentation, cognitive and processing abilities, and communication and reporting of scientific work. Science self-efficacy was measured using the Science Self-Efficacy Scale developed by Hu et al. (2022), a 24-item instrument validated through face, content, construct, and predictive validity using mixed methods and grounded in the Rasch model. Both instruments underwent face and content validation by three Chemistry experts using the Content Validity Rating Scale adapted from Waltz and Bausell (1983), with results interpreted following Lynn (1986), and subsequent revisions were made based on the validators' feedback. A pilot test was then conducted on at least 30 Grade 12 STEM students from a selected secondary school in Leyte, as recommended by Bolarinwa (2018), with the collected data analyzed using JASP to establish instrument reliability. The Cronbach's alpha coefficients obtained were 0.883 for experimental skills and 0.906 for science self-efficacy, both indicating strong internal consistency and confirming the instruments' reliability for use in the main study.

2.5 Data Gathering Procedure

The data gathering procedure was divided into three phases, beginning with Phase 1, wherein the researcher secured formal approval from the Leyte Normal University Research Ethics Committee, the division superintendent of Leyte Division, and the school principal, before coordinating with head teachers, focal persons, and teachers to schedule the data collection at the identified STEM-offering secondary school. In Phase 2, the researcher personally administered the questionnaires to all participants, conducting a brief orientation session explaining the study procedures and allotting approximately 30–45 minutes for the completion of the research instruments. Prior to participation, all respondents were required to sign an informed consent form detailing the study's purpose, methodology, confidentiality measures, potential benefits, and the voluntary nature of their involvement, while minor participants were additionally given an assent form. Upon completion of data collection, the researcher expressed gratitude to all respondents for their participation in the study. In Phase 3, the gathered data were sorted and tabulated in preparation for statistical analysis, with access to all respondent data strictly limited to the researcher to ensure confidentiality and data security.

2.6 Data Analysis

Both descriptive and inferential statistical methods were employed to analyze the data. Descriptive statistics, including mean and standard deviation, were used to determine the levels of the study variables. Spearman's rank-order correlation was used to determine whether a significant relationship exists between experimental skills and academic performance in General Chemistry, and between self-efficacy and academic performance in General Chemistry. Unlike measures of linear relationship, Spearman's rank-order correlation assesses how well an arbitrary monotonic function describes the relationship between two variables, without making any assumptions about the frequency distribution of the variables (Bocianowski et al., 2023).

2.6 Ethical Considerations

This study strictly adhered to the ethical policies and approval processes of the Leyte Normal University Research Ethics Committee, with ethical clearance secured prior to data collection in full compliance with national and institutional standards, including the Data Privacy Act of 2012 (Republic Act No. 10173), and guided by the principles of respect for persons, beneficence, and justice. Before participation, all respondents were provided with sufficient and comprehensible information about the study's purpose, procedures, and expected duration of approximately 30 to 45 minutes, after which written informed consent was obtained from participants of legal age, while informed assent was secured from minors. Participation was entirely voluntary, with respondents free to withdraw at any time, refuse to answer any question, and assured that their involvement would not affect their academic standing, grades, or relationship with their teachers. The study posed minimal risk, and strict confidentiality measures were implemented, including the use of code numbers in place of names, storage of data in password-protected digital files and locked printed storage, restriction of data access solely to the researcher, and presentation of all findings exclusively in aggregate form to ensure anonymity. Participants received material benefits such as snacks, and the study's findings are expected to yield broader educational benefits by providing insights that may improve chemistry instruction and laboratory practices for future learners and educators.

3. Results and Discussion

This section presents the findings of the study along with the analysis and interpretation of the data gathered.

Table 1

Academic Performance of Grade 12 STEM students in their Final Grade in General Chemistry I

General Average	f	%
98-100	0	0.0%
95-97	6	5.2%
90-94	64	55.2%
85-89	46	39.7%
80-84	0	0.0%
75-79	0	0.0%
Below 75	0	0.0%
Total	**116**	**100%**

Table 1 presents the academic performance of Grade 12 STEM students in their final grade in General Chemistry 1, wherein out of 116 students, the majority obtained grades within the 90–94 range, followed by those in the 85–89 range, and 6 students in the 95–97 range. Notably, no student scored below 85, resulting in a 100% pass rate above the minimum passing grade of 75 set by the Department of Education (DepEd). These findings indicate a commendable level of academic performance among the students, with the bulk of the class demonstrating proficient mastery of General Chemistry 1 concepts. The results are consistent with the findings of San Gabriel and Manalastas (2025), who reported a general weighted mean of 89.80 in General Chemistry 1 among Grade 12 STEM students across multiple public high schools in Bulacan, Philippines during the first quarter of School Year 2024–2025, which falls within the same 85–94 performance bracket where the majority of students in the present study were concentrated. This parallel finding reinforces the notion that Grade 12 STEM students in the Philippine public-school setting are generally capable of achieving satisfactory to proficient levels of performance in General Chemistry 1.

Table 2

Experimental Skills Level

	N	Mean	Std. Deviation	Verbal Interpretation
Experimental Skills	116	4.170	0.389	High

Table 2 presents the experimental skills level of 116 Grade 12 STEM students in General Chemistry 1, revealing a mean score of 4.170 with a standard deviation of 0.389, which carries a verbal interpretation of High, indicating that the students, as a group, demonstrated a strong level of competency in performing laboratory and experimental tasks associated with the subject. This finding is consistent with San Gabriel and Manalastas (2025), who assessed the experimental skills of Grade 12 STEM students in General Chemistry 1 during SY 2024–2025 and found that teachers rated students' experimental skills as "Very High" while students themselves rated their skills as "High," reflecting a similarly elevated level of laboratory competency among senior high school STEM learners. Supporting this, Cruz et al. (2025) found that senior high school STEM students who were regularly engaged in laboratory activities reported improvements in their ability to follow scientific procedures, manipulate variables, and grasp complex concepts, underscoring how consistent exposure to experimental work contributes to higher skill levels. The high experimental skills level observed in the present study may be attributed to the regular conduct of laboratory activities, effective science instruction, and the practical orientation of the STEM strand curriculum, which collectively equip students with both theoretical knowledge and hands-on scientific competencies. These findings affirm that Grade 12 STEM students are adequately prepared not only in content mastery, as reflected in their General Chemistry 1 grades, but also in the practical application of scientific methods and laboratory procedures essential for higher-level science coursework.

Table 3
Self-efficacy Level

	N	Mean	Std. Deviation	Verbal Interpretation
Self-efficacy	116	4.033	0.359	High

Table 3 presents the self-efficacy level of 116 Grade 12 STEM students in General Chemistry 1, revealing a mean score of M = 4.033 with a standard deviation of SD = 0.359, which yields a verbal interpretation of High, indicating that the students generally possessed a strong belief in their own capacity to understand, perform, and succeed in chemistry-related tasks and activities. This finding is supported by Tiangco et al. (2024), who examined the perceived self-efficacy of STEM senior high school students at NU Fairview Incorporated, Quezon City, Philippines, and found that the primary source of their high self-efficacy was mastery experiences, attributed to frequent engagement in activities and success experiences in their specialized subjects. Similarly, Tus (2020) investigated the self-efficacy of Grade 12 Senior High School students at St. Paul College of Bocaue, Bulacan, Philippines, and concluded that the level of self-efficacy of the respondents was high, with students found to be resilient and determined in the face of setbacks, felt assured that they would be able to learn classroom discussions and excel on their assessments, and tended to be more intrinsically motivated to acquire new knowledge. Notably, the self-efficacy mean of 4.033 is slightly lower than the experimental skills mean of 4.170 recorded in Table 2, suggesting that while students demonstrated high confidence in their abilities, their self-belief was marginally more conservative compared to their actual demonstrated experimental performance. Nevertheless, both scores fall within the same High interpretation range, reinforcing the overall picture of a competent and self-assured group of STEM learners who are well-equipped to meet the academic demands of General Chemistry 1.

Table 4
Spearman's Rank-order Correlation Between Experimental Skills & Academic Performance in Gen. Chem. 1

	Rho	*P*	Interpretation
Academic Performance – Experimental Skills	0.569	< .001	Moderate Positive

The analysis revealed a statistically significant positive correlation between experimental skills and academic performance in General Chemistry I among Grade 12 STEM students (*rho = 0.569, p < .001*). This result indicates a moderate positive relationship between the two variables, suggesting that students who demonstrated higher levels of experimental skill proficiency tended to achieve higher academic performance in General Chemistry I, and conversely, students with lower experimental skill levels were more likely to obtain lower academic performance scores.

The moderate positive correlation obtained in the present study aligns with the findings of Dolapcioglu and Subaşı (2022), whose meta-analysis of 5,838 samples drawn from 18 studies consistently demonstrated a significant positive relationship between scientific process skills and academic achievement in science, with an average effect size of 0.56—closely mirroring the ρ value obtained in this study. This convergence across different educational contexts reinforces the notion that experimental competencies are not merely supplemental to science learning but are fundamentally intertwined with students' cognitive gains in science subjects. The relationship observed in this study may be attributed to the nature of chemistry as a discipline that requires both conceptual understanding and hands-on application. Experimental activities in chemistry classrooms provide students with opportunities to observe chemical phenomena, handle laboratory equipment, and translate theoretical knowledge into concrete procedural knowledge (Bernardo et al., 2023). Students who are proficient in experimental skills—such as accurate measurement, proper handling of apparatus, systematic observation, and data recording—are better equipped to understand and apply chemistry concepts, which may consequently translate into higher academic performance.

Bernardo et al. (2023) further noted that Filipino students' low proficiency in scientific inquiry and practical skills contributes significantly to their underperformance in international science assessments. Given this national context, the statistically significant correlation found in this study underscores the importance of ensuring that STEM students in the Philippines receive adequate laboratory instruction and experimental training as part of their chemistry education. Schools and teachers must, therefore, prioritize practical work not merely as a supplementary activity but as a core component of General Chemistry I instruction.

Table 5
Spearman's Rank-order Correlation Between Self-efficacy and Academic Performance in Gen. Chem. 1

	Rho	*P*	Interpretation
Academic Performance – Self-efficacy	0.617	< .001	Moderate to Strong Positive

The Spearman's rank-order correlation analysis was conducted to assess the relationship between self-efficacy and academic performance in General Chemistry I among Grade 12 STEM students. The results revealed a statistically significant positive correlation (*rho = 0.617, p < .001*). According to the correlation interpretation guidelines established in educational research, a coefficient of 0.617 reflects a moderate to strong positive relationship between the two variables (Alhadabi & Karpinski, 2019). This finding indicates that students who reported higher levels of self-efficacy tended to obtain higher academic grades in General Chemistry I. The result is statistically significant at the .001 level, suggesting that the observed relationship is unlikely to be due to chance. This result supports the central premise that students who believe in their ability to perform academic tasks tend to achieve better outcomes in science subjects, particularly in chemistry. The moderate to strong correlation found in this study aligns with the foundational claims of Bandura's Social Cognitive Theory, which posits that self-efficacy — the individual's belief in their capacity to execute behaviors necessary to produce specific outcomes — serves as a critical determinant of academic motivation and performance (Schunk & DiBenedetto, 2020).

Within the context of STEM education, the significance of self-efficacy is particularly pronounced. Alhadabi (2021) explored associations among science-related variables among high school students and found that science self-efficacy served as a sequential mediator between science interest and academic achievement. This finding resonates with the current study's results, which suggest that Grade 12 STEM students' confidence in their chemistry-related abilities is associated with their actual performance in General Chemistry I. Students with higher self-efficacy may be more inclined to engage with challenging chemistry concepts, persist in the face of difficulty, and employ more effective learning strategies — all of which contribute to better academic outcomes.

The present findings are also consistent with research conducted among Filipino STEM students. Tiangco et al. (2024) investigated the relationship between perceived self-efficacy and academic performance among senior high school STEM students in the Philippines and found a significant positive association between the two variables. The results of the current study further corroborate this finding within the specific subject area of General Chemistry I, adding to the growing body of literature on the role of self-efficacy in the Philippine educational context. This is particularly meaningful given that the K to 12 curriculum introduced specialized science subjects in senior high school, placing greater demands on students' beliefs in their academic capabilities.

Proposed Intervention Plan Based on the Results of the Study

The Project IGNITE is a 10-week, evidence-based intervention program designed for Grade 12 STEM students enrolled in General Chemistry I. Grounded in Bandura's Social Cognitive Theory and driven by research findings that experimental skills ($\rho = 0.569$) and self-efficacy ($\rho = 0.617$) are both significantly correlated with academic performance, the program simultaneously targets these two dimensions to help students improve their chemistry outcomes. The program operates through two integrated components. The first focuses on experimental skills development, progressing from structured laboratory skill sessions in Weeks 1–4 — covering equipment handling, precise measurement, systematic observation, and data interpretation — to peer-assisted laboratory practice in Weeks 5 7, and culminating in individual performance-based assessments in Weeks 8–10. The second component addresses self-efficacy enhancement through four evidence-based strategies drawn from Bandura's framework: scaffolded mastery experiences, vicarious learning and peer modelling, specific and constructive verbal feedback, and stress and anxiety reduction techniques. Key program tools include a personal Goal Card, a Chemistry Confidence Journal, and bi-weekly teacher check-ins for students with low confidence.

Progress is monitored through pre- and post-program assessments of both experimental skills and self-efficacy, weekly low-stakes quizzes, and ongoing teacher observation. Success is measured against clear targets, including at least a 10% improvement in experimental skills scores, a statistically significant gain in self-efficacy, and at least 80% of students reaching proficiency in the practical skills rubric. IGNITE will be implemented collaboratively by chemistry teachers, school administrators, and the students themselves, and may be delivered in-school or through a blended setup. It is designed not only to build competence in the laboratory but to equip students with the confidence and mindset they need to thrive in General Chemistry I and beyond.

Conclusion

The academic performance of Grade 12 STEM students in General Chemistry I was generally high, with all 116 students surpassing the minimum passing standard and the majority (55.2%) concentrated in the 90–94 grade bracket, while students likewise reported high levels of both experimental skills ($M = 4.170; SD = 0.389$) and science self-efficacy ($M = 4.033; SD = 0.359$), reflecting the effectiveness of the STEM strand curriculum in cultivating competent and practically engaged chemistry learners. Both experimental skills and self-efficacy demonstrated statistically significant positive relationships with academic performance in General Chemistry I, with experimental skills yielding a moderate positive correlation ($rho = 0.569, p < .001$) and self-efficacy yielding a moderate to strong positive correlation ($rho = 0.617, p < .001$), thereby confirming both research hypotheses at the 0.05 level of significance. These findings are firmly anchored in Bandura's Social Cognitive Theory, which posits that an individual's belief in their capacity to execute goal-directed behaviours—such as performing laboratory procedures and solving chemistry problems—serves as a critical determinant of motivation and academic achievement, while von Glasersfeld's Radical Constructivism further explains how hands-on experimental engagement enables students to construct deeper conceptual understanding through active, experience-based learning. Self-efficacy emerged as the stronger predictor of the two, underscoring that students' beliefs in their own capabilities are as essential as their technical laboratory competencies and must be given equal priority alongside hands-on instruction in chemistry education. These findings address a gap in the local research literature by providing simultaneous empirical support for both variables within the Philippine senior high school context and contribute a practical intervention framework through Project IGNITE that holistically targets both the psychomotor and affective dimensions of student learning in General Chemistry I.

Recommendations

Chemistry teachers are encouraged to incorporate regular and structured laboratory activities as a core instructional strategy in General Chemistry I, designing experiments that progressively develop students' competencies in measurement, observation, data recording, and interpretation, while intentionally adopting self-efficacy-building strategies such as scaffolded tasks, proximal goal-setting, performance-specific verbal feedback, peer modeling, and a supportive learning environment. School administrators should invest in improving science laboratory facilities and support professional development programs that equip chemistry teachers with evidence-based strategies for laboratory instruction and self-efficacy promotion, while also allocating dedicated time within the academic calendar for the pilot implementation of the

proposed Project IGNITE intervention program in Grade 12 STEM classes. Curriculum developers and education policymakers should review and strengthen the laboratory component of the General Chemistry I curriculum in the STEM strand, ensuring that experimental skills development is integrated within the formal curriculum and that laboratory-based assessment and performance tasks in chemistry grading are sustained and reinforced. Future researchers are encouraged to replicate this study across other schools, divisions, and regions in the Philippines using larger and more diverse samples and to examine additional variables such as instructional quality, laboratory resource availability, motivation, academic resilience, and socioeconomic background through multivariate or structural equation modeling approaches. Longitudinal research designs are likewise recommended to track the development of experimental skills and self-efficacy over time and to assess the sustained impact of interventions such as Project IGNITE through pre- and post-intervention studies that include comparison groups, thereby generating stronger evidence for laboratory-based and self-efficacy-focused instructional programs in improving academic outcomes in General Chemistry I.

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