Mastery and Confidence Level of Grade 11 Stem Learners in General Chemistry

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ABSTRACT

General Chemistry is a foundational subject that most STEM students are required to take at some point in their academic careers. However, many learners struggle with mastery and confidence in Chemistry due to its abstract nature and mathematical requirements. This study aimed to determine the mastery level and confidence level of Grade 11 STEM learners in General Chemistry competencies as a basis for strategic intervention. Utilizing a descriptive-correlational research design, the study examined the relationship between learners' mastery and confidence levels and identified least mastered competencies. Data were collected through standardized achievement tests and confidence level surveys to Seventy-Six (76) Grade 11 STEM learners purposively sampled from a selected public senior high school in the Philippines. Results revealed a lack of mastery based on their test score. The competencies under the following topics: calculating empirical and molecular formulas, molecular geometry, gases, writing and balancing chemical equations, and stoichiometry were identified as "Least Mastered". These topics were noted as a challenge because they often require mathematical reasoning and conceptual clarity due to the abstract nature of representing molecules' valence electrons. However, learners revealed a "High Confidence" in their confidence level. The analysis using the Spearman correlation test revealed a p= 0.1274, indicating no significant relationship between mastery and confidence level. The results suggest that learners' mastery was low, yet their level of confidence was high. Hence, it can be said that students' academic mastery cannot be only attributed to their confidence because other aspects influence students' mastery in chemistry. According to the findings, students' levels of confidence may not significantly affect their performance in chemistry if other important aspects of studying the subject are neglected.

Keywords: Chemistry, Competencies, Grade 11 STEM

INTRODUCTION

To promote the holistic development and worldwide competitiveness of Filipino students, the Philippines initiated an educational reform known as the K–12 Program in 2012 (Campos, 2023). Despite this, according to a recently introduced global benchmarking test, Filipino learners rank among the lowest worldwide in creative thinking skills. In the 2022 cycle of the Programme for International Student Assessment (PISA), the 15-year-old learners from the Philippines achieved an average score of 14 points on the newly added creative thinking assessment, positioning the country among the bottom four out of 64 participating nations (Chi, 2024).

According to Torres & Calim (2024) STEM learners find it extremely challenging to comprehend the primary subjects of general chemistry or to apply the concepts they have learned. The Grade 11 learners may be unable to perform to their full potential, which worries the researchers more and more. The chemistry topics that STEM learners will require for their future education and occupations must be learned and mastered. It may be more difficult for these learners to succeed in their occupations and lives if teachers do not allow them to learn chemistry.

As sustained by similar researches, the learners' perspectives on chemistry differ from those of chemists after taking general chemistry. After taking general chemistry classes, learners' motivation to continue their chemistry studies is lower than before. High school teachers who learned a lot of their basic chemistry in college courses may spread misconceptions about general chemistry (Balazs, 2018).

Nonetheless, many learners are afraid and ignorant of the factors that affect their performance in general chemistry. Chemistry classes at any level can open up a wide range of employment and research prospects. Even though they may have the aforementioned in mind when they start their chemistry classes, many learners lose faith and become demoralized after just a few class sessions. Learners frequently feel disoriented and eventually disheartened, even with the greatest of intentions. Although there are many reasons why learners start to feel this way, some of the most significant ones are learning styles, teaching techniques, prior educational chances and experiences, self-confidence, and environmental influences. However, examining and addressing the factors that affect learners' outcomes is crucial for learners' performance (Swoope, 2020).

Self-efficacy is the belief in one's own capacity to do specific tasks or find solutions to issues that may arise in one's own life. In this regard, self-efficacy is crucial for encouraging academic success in chemistry classes. Chemistry learners can only succeed academically if they practice daily (Odedokun et. al, 2023). Learners must have a high sense of self-efficacy in order to succeed in school chemistry. Learners' perceptions of their own abilities to complete particular chemistry tasks are known as chemistry self-efficacy (Cheung , 2015). Despite numerous efforts to make STEM education more effective, educators face great difficulties in finding suitable teaching strategies. Many educators not only lack knowledge, but they are also unaware of effective teaching strategies (Çevik & Bakioğlu, 2022).

General Chemistry is a foundational subject that most STEM students are required to take at some point in their academic careers, as such, thousands of learners find themselves in a chemistry classroom every year. It involves understanding key concepts such as properties of matter, atomic theory, chemical bonding, stoichiometry, and reactions. However, many learners struggle with mastery and confidence in Chemistry due to its abstract nature and mathematical requirements (Shultz et al., 2015).

The Philippine K–12 Enhanced Basic Education Curriculum's Science, Technology, Engineering, and Mathematics (STEM) strand aims to create secondary school graduates who will enroll in college courses related to science, research, math, and engineering, thus contributing to the scientific workforce. This demonstrates how important senior high school is to education and how important it is to grasp the ideas in STEM-specific specialty classes (Torres & Calim, 2024).

Science education in the Philippines is still in the developmental age. Changes are constantly introduced to improve the quality of instruction in all levels. The curriculum is revised so often in the hope of unlocking Filipino learners' difficulties in the subject. The third millennium is a witness to the relative advancement of science and technology and has introduced enormous changes in our socioeconomic environment. To cope with the tremendous changes of age, science education must be made relevant to cope with these challenges. It is the teacher's task to make science learning an attractive and enjoyable experience for every student (Malana, 2020).

The aforementioned case motivated the researcher to carry out this investigation in order to ascertain the degree of mastery and confidence in General Chemistry as well as to identify the competencies that are not mastered, least mastered, nearly mastered, and mastered. These findings might be used as the foundation for the development of instructional and remediation materials as well as the proposal of strategic intervention programs.

This study aimed to evaluate the mastery and confidence levels of Grade 11 STEM learners in General Chemistry Specifically, it aims to determine the mastery level of Grade 11 STEM students in General Chemistry; determine the confidence level of Grade 11 STEM students in terms of their ability to apply General Chemistry concepts and examine the significant relationship between mastery level and confidence level.

METHODOLOGY

This study employed a descriptive-correlational research design to evaluate learners ' mastery level and confidence levels and determine their relationship in General Chemistry. A purposive sampling technique was implemented in determining participants to be included in both the try-out and implementation phases. The research instruments consisted of a validated 45-item General Chemistry 1 Achievement Test (GCAT) aligned to the DepEd Most Essential Learning competencies in General Chemistry. The data collection procedures

involved administering the said instruments to participants. Mean and standard deviation were used to analyze the overall results of the Assessment. To identify the relationship between mastery and confidence level, Spearman's Rank-order correlation was used. This analysis shed light on the relationship between mastery and confidence level.

The subjects of the study were determined by purposive sampling approach which is a non-probability sampling method for choosing subjects according to specific characteristics relevant to the research objectives. This technique ensures that the respondents chosen are those most relevant to the study enabling a deeper exploration of the phenomena being studied.

Two (2) sections of the Grade 12 STEM learners and one (1) section of the Grade 12 GAS for a total of 120 learners participated during the try-out phase of the General Chemistry 1 Achievement Test. After careful evaluation of test items against the criteria for difficulty and discrimination indices, some items that were considered good were selected for the final version of the test. Two sections of the Grade 11 STEM for a total of Seventy-Six (76) took the final version of the needs assessment questionnaire and confidence level questionnaire in a pen and paper approach.

A researcher-made General Chemistry 1 Achievement Test consisting of a fifty (50)-item test aligned with the Department of Education's Most Essential Learning Competencies for General Chemistry. The questionnaire went through rigorous face and content validation by the thesis adviser and three (3) external experts in content and method. After considering the revisions, the try-out was made. An item analysis was conducted. Hence, the difficulty index and discrimination index were calculated. Consequently, the 50-item was trimmed down to 45-item and prepared for the implementation phase.

To establish the reliability of the test, the 50-item GCAT was administered for try-out to eighty (80) Grade 12 STEM learners and 40 Grade 12 GAS who previously took General Chemistry in one of the public high schools in Lanao del Norte Schools Division. The calculated Cronbach alpha was 0.6652 (reliable). The Discriminating Index of 0.2491 implies that the test questions are average and the Difficulty Index of 0.3840 implies that the questions are average.

In addition, the GCAT includes 30% for the easy (remembering and understanding), 40% for average questions (applying and analyzing), and 30% for difficult (evaluating and creating). A researcher-made confidence level questionnaire was developed for this study. The sixteen (16) item instrument is intended to assess the confidence level of the students in General Chemistry. The statements of this questionnaire were used to assess students' confidence levels in specific topics in General Chemistry 1. The instrument was validated by 2 experts in content and methods.

This study was conducted to seventy-six (76) Grade 11 STEM learners in one of the public high schools who recently finished General Chemistry. In accordance with research ethics, a letter of intent was given to the office of the school principal for approval. A consent form for learners was also included. Participation in this study was completely voluntary. Coding was used to assure confidentiality of their identity. The questionnaires were checked and data obtained were tabulated and analyzed with descriptive statistics such as mean and percentage. The performance of the respondents was interpreted with the remarks in Table 1. The interpretations were based on DepEd K to 12 Grading System (DepEd Order No. 8 s. 2015).

Table 1 Interpretation on Learners Performance on the Assessment

Score Range	Descriptors	Range	Interpretation
41-45	Outstanding	90-100	Passed
39-40	Very Satisfactory	85-89	Passed
36-38	Satisfactory	80-84	Passed
34-35	Fairly Satisfactory	75-79	Passed
0-33	Did Not Meet Expectations	74 Below	Failed

Reference: DepEd Order No. 8, s. 2015

RESULTS AND DISCUSSION

The majority of the respondents scored in the range of 31% to 76%, with only one student achieving a passing grade classified as "Fairly Satisfactory." Most respondents are categorized as "Did Not Meet Expectations" under the descriptor, indicating a failed interpretation of the assessment. The scores revealed that the current level of mastery is below expectations for most learners.

Table 2 Summary of the Assessment

Index	Frequency (n)	Percentage (%)	Interpretation	Interpretation
41-45	0	0	Outstanding	Passed
39-40	0	0	Very Satisfactory	Passed
36-38	0	0	Satisfactory	Passed
34-35	1	1	Fairly Satisfactory	Passed
0-33	75	99	Did Not Meet Expectations	Failed
Total	**76**	**100**		
	Mean24.42	**Std. Dev.4.4579911**	**Interpretation Did Not Meet Expectations**	**Failed**

Moreover, a standard deviation of 4.46 indicates that, on average, learners' scores deviate by approximately 4.46 points from the mean score of 24.42. Most learners scored between 19.96 and 28.88, which is relatively close to the mean, indicating moderate consistency in their performance. A few learners might have scores outside this range (extremely low or high), which could indicate outliers or learners requiring additional attention. Since the mean is 24.42, a standard deviation of 4.46 shows that the distribution of scores is neither extremely tight nor overly spread. This showed some variability in the dataset, though it is not excessively high.

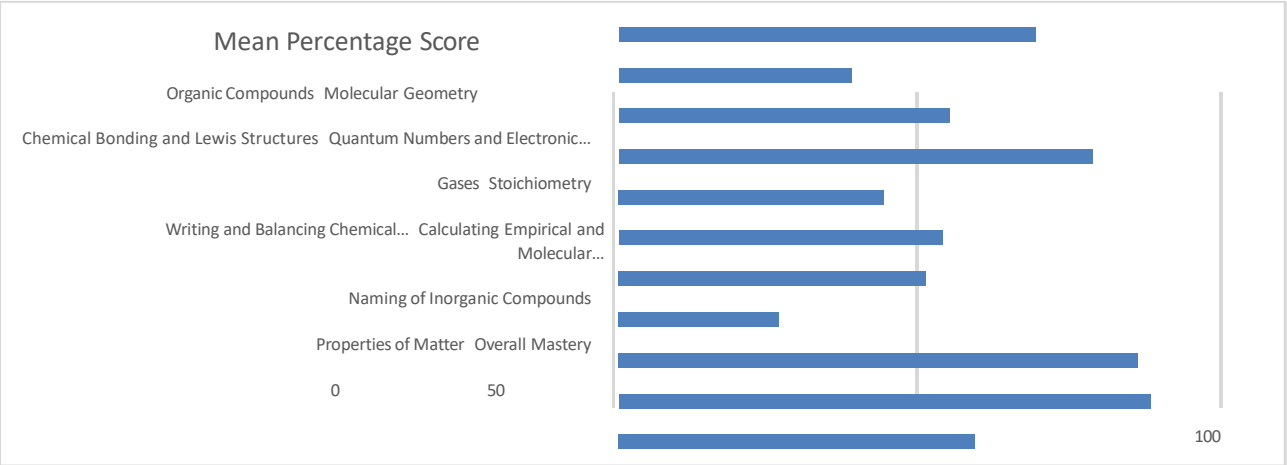

Figure 1. Grade 11 STEM Learners in the Competencies in General Chemistry

Figure 1 summarized the mastery levels. It revealed critical implications about the Grade 11 learners' performance in General Chemistry. In general, a mean percentage score of 52.12% placed the learners in the "Least Mastered" classification. This calls for pedagogical intervention in respect to their inadequate understanding of the subject's key competencies. The highest mastery of the learners in the "Nearly Mastered" category was demonstrated through Properties of Matter (77.75%) and Naming of Inorganic Compounds (76%). This suggests that instructional strategies for these topics have been relatively effective, and students feel more confident in these areas. However, as these are fundamental topics, maintaining and building on this foundation is crucial. Areas of "Not Mastered" include calculating Empirical and Molecular Formula was at the bottom in terms of mean percentage with 23.5, topping the list of those not mastered. Other challenging topics included Molecular Geometry, Gases, and Writing and Balancing Chemical Equations at 34, 38.8%, and 45%, respectively. This indicates that important concepts involving abstract thinking, as well as calculations are not adequately understood. Moderate Proficiency included Quantum Numbers and Electronic Configuration was 69.33% and Organic Compounds was 61%. Competencies here are considered as "Least Mastered," but scores

are still a bit above the other competencies, indicating partial mastery that would benefit from focused support and scaffolding instruction.

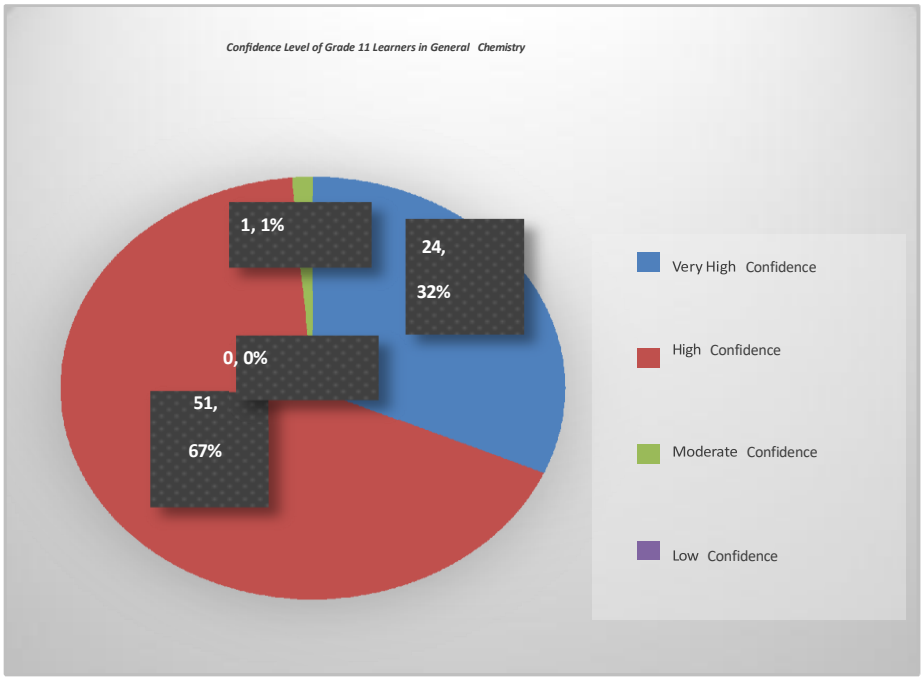

Figure 2 summarized the confidence level of earners in General Chemistry. The majority of the learners, accounting for 67% or 51 learners, reported a high level of confidence in General Chemistry 1. This indicates that a significant proportion of learners feel assured in their ability to understand and apply the subject's concepts. However, it is essential to explore whether this confidence is consistent across different topics or influenced by other factors such as teaching methods or prior knowledge. About 32% or 24 learners expressed very high confidence, and perceived themselves as highly proficient in the subject, suggesting room for improvement in fostering mastery and deep understanding among learners. Only 1% or only one learner had moderate confidence. This small percentage highlights that very few students feel somewhat competent, there might be areas of the subject where they lack complete assurance. This group represents an opportunity to enhance confidence levels through targeted interventions like additional practice or focused support on challenging topics. Interestingly, no learners reported low confidence. This absence could reflect a baseline level of familiarity with General Chemistry concepts among learners or the effectiveness of existing instructional strategies in preventing a lack of confidence.

Table 3 Spearman Rank-Order Correlation Between Mastery and Confidence Level

Parameter	Value
Spearman's rank correlation (rs)	0.1764
r^2	0.03112
P-value	0.1274
Covariance	85.5233
Sample size (n)	76
Statistic	1.5416

Results of the Spearman correlation indicated that there is a non-significant relationship between X and Y, ($r(74) = .176$, $p = .127$). Since the p-value > α, H0 cannot be rejected. Hence, there is no significant relationship between the mastery level and confidence levels of Grade 11 STEM students in General Chemistry. The study Baanu & Oyelekan (2016) showed that there was no meaningful correlation between the chemistry students' academic success and their level of self-efficacy. The study concludes that for students to succeed academically in

chemistry, their self-confidence must be supported by a variety of other elements. Combining these factors leads to high academic accomplishment in Chemistry, thus, attention be made to other factors that are required for better learners' achievement in Chemistry to supplement learners' strong self-confidence.

Based on the data on mastery and confidence in this study, it was found that learner's mastery was low yet their level of confidence was high. According to Baanu & Oyelekan (2016) it can be said that students' academic success cannot be only attributed to their self-efficacy because other aspects influence students' performance in chemistry. According to this study's findings, students' confidence levels may not significantly affect their performance in chemistry if other important aspects of studying the subject are neglected.

CONCLUSION

The study determined the mastery and confidence level of Grade 11 STEM learners in General Chemistry 1. The mastery level of the learner respondents was "Did Not Meet Expectation" with an interpretation of "Failed". The competencies under the following topics: calculating empirical and molecular formula, molecular geometry, gases, writing and balancing chemical equations, and stoichiometry were identified as "Least Mastered". These topics were noted as a challenge because it often requires mathematical reasoning and conceptual clarity and likely due to the abstract nature of representing molecules' valence electrons. However, learners revealed a "High Confidence" in their confidence level. The analysis using the Spearman correlation test revealed a p= 0.1274, indicating no significant relationship between mastery and confidence level. The results suggest that learners' mastery was low yet their level of confidence is high, it can be said that students' academic mastery cannot be only attributed to their confidence because there are other aspects that influence students' mastery in chemistry. According to the findings, students' levels of confidence may not significantly affect their performance in chemistry if other important aspects of studying the subject are neglected. Moreover, there are strategic interventions that could increase the mastery and confidence of the learners such as contextualized tutorials, scaffolding practice problems, simulation software, peer tutoring and collaborative learning, teacher-made video lessons, game-based learning, laboratory works, and project-based learning to name a few.

In this light, these strategic interventions may be adapted as effective intervention strategies for better mastery of competencies. A more thorough collection of questions in different test formats would better capture the learners' learning than the multiple-choice method. In order to confirm the consistency of the findings, it could be beneficial to expand the study's scope to include additional senior high schools, both public and private. The results of the study are only applicable to the population being studied it does not represent the general population.

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