Grade 11 Stem Learners' Learning Competencies and Their Motivation in General Chemistry

Threcia C. Poblete, Edna B. Nabua*, Mudjahid M. Abdurahman, Eduardo R. Navalta Jr., Rey Paolo G. Micutuan

Mindanao State University -Iligan Institute of Technology, Philippines

***Corresponding Author**

DOI: https://dx.doi.org/10.47772/IJRISS.2025.9010294

Received: 13 January 2025; Accepted: 17 January 2025; Published: 20 February 2025

ABSTRACT

This study examines the mastery level in the learning competencies and motivation level of Grade 11 STEM learners in General Chemistry which will serves as a basis for the development of a Strategic Intervention Material (SIM). This is to identify the un-mastered, the least mastered, and nearly mastered learning competencies in General Chemistry. The study anchored on cognitive theory and motivation theory that specifically aimed to examine learners' motivation levels, and evaluate their mastery level in General Chemistry learning competencies. Using a descriptive-survey research design, the study was conducted in one of the public secondary schools in Northern Mindanao Philippines during the 2024–2025 academic year. The instruments were validated by experts in content and methods. To assure reliability of the instruments, the reliability coefficient of the instruments was sought. Data collection involved administering validated achievement test and motivation questionnaires to a sample of Thirty-Three (33) learners which was purposively sampled. These samples were assured of data privacy and that their participation was made in voluntary mode. Findings indicated moderate intrinsic and grade-related motivation but revealed challenges of connecting with real-world application of chemistry concepts, and mastering critical competencies. Achievement test results showed a low average performance, with most learners failing to meet the learning competencies required in the General Chemistry. Key areas of difficulty included stoichiometry, balancing chemical equations, and understanding chemical formulas and reactions. The study concludes that a significant gap exists between learners' competency mastery and their motivation levels, emphasizing the need for targeted Strategic Intervention Material (SIM). It is recommended that educators adopt SIMs tailored to learner needs, align teaching methods with real-world applications, and provide additional support to strengthen foundational competencies.

Keywords: Conceptual Knowledge, Chemistry, Motivation

INTRODUCTION

General Chemistry is a critical foundational course for higher education, particularly for learners pursuing degrees in science, engineering, health sciences, and other technical fields. This introductory chemistry course covers essential topics such as atomic structure, chemical bonding, stoichiometry, thermodynamics, and chemical reactions. These concepts are not only important for academic success in chemistry but are also vital for learners' ability to apply scientific principles in real-world contexts. Despite its significance, learners often encounter challenges in mastering certain competencies, which can impede their overall understanding and progression in the course. Identifying the least mastered, not mastered, nearly mastered, and mastered competencies and understanding the factors influencing learners' motivation are crucial steps toward enhancing educational strategies and improving learning outcomes (Adlim, et. al., 2014).

In the Philippines, reports have indicated that students struggle with topics such as atomic structure and chemical bonding, which are fundamental to understanding more advanced concepts. For instance, the resort of Adalla-Raboy (2020) identified the twenty (20) least mastered, not mastered, nearly mastered, and mastered competencies in science among 7th to 10th-grade learners in the Schools Division of Zambales, underscoring

the need for focused educational interventions. Similarly, Lim (2019) from Anao High School reported that learners faced difficulties in topics such as capacitors and solutions during their third-quarter examinations in General Chemistry. According to the 2018 Programmed for International Student Assessment (PISA), Filipino learners achieved an average science score of 357, far below the OECD average of 485, ranking the Philippines last among participating countries. Alarmingly, 78% of Filipino learners scored below the basic proficiency level in science, highlighting substantial deficiencies in foundational scientific knowledge.

Mandina & Enunuwe (2018) determined a prominent challenge that is stoichiometry and chemical calculations, where learners find it difficult to grasp the mole concept, balance chemical equations, and perform related computations. The abstract nature of chemical concepts often makes them hard to visualize and understand. Additionally, a lack of strong mathematical skills can hinder learners' ability to perform necessary calculations in chemistry. Traditional teaching methods that do not cater to diverse learning styles may also play a role in these challenges (Stone, Shaner & Fendrick, 2018).

Another factor to consider is learner's motivation which plays a pivotal role in the learning process, influencing engagement, persistence, and overall academic achievement. In the context of chemistry education, motivation can be categorized into intrinsic motivation—driven by an inherent interest in the subject—and extrinsic motivation—driven by external rewards or pressures. Research has shown that learners' motivation towards chemistry can fluctuate over time. A study examining intrinsic motivation trends over a semester in an online General Chemistry II course found variations in learner motivation, emphasizing the need for instructional materials that maintain or enhance engagement throughout the course. Additionally, the development of updated instructional materials has been shown to increase learner motivation and help learners recognize the relevance of chemistry in real-world contexts (Liu & Kim, 2024).

To address these challenges, educators have developed targeted interventions aimed at improving both competency mastery and learner motivation. There are so many approaches to deliver and develop a SIM based on the learning competencies of a particular subject and considering the existing modality present in each school. One such approach is the use of Electronic Strategic Intervention Materials (E-SIMs). An instance was the demonstration of an E-SIMs which effectively improved learners' understanding of chemical bonding by providing interactive and engaging content tailored to address specific learning gaps (Rosal, et.al., 2022).

The existing literature and studies presented above prompted the researcher to conduct this study in order to determine the learners least mastered, not mastered, nearly mastered, and mastered competencies in General Chemistry and investigate their level of motivation on the subject matter. The result of this study will serve as the basis for the development and implementation of a strategic intervention material (SIM) that will remediate and supplement knowledge to address the least mastered, not mastered, nearly mastered, and mastered competencies among the STEM learners in General Chemistry.

METHODOLOGY

This study utilized a descriptive-survey research design, utilizing a test questionnaire as the main tool for collecting data on the mastery levels of Grade 11 STEM learners in the General Chemistry learning competencies. The questionnaire assessed competencies categorized as not mastered, least mastered, nearly mastered, and mastered. Additionally, a motivation questionnaire was used to evaluate the learners' motivation learning the competencies required in the subject matter. Descriptive research design aimed to explain the what, how, or why of a phenomenon, while survey research design relies on surveys as the primary data collection method. In this approach, surveys were used to gain a deeper understanding of individual or group perspectives on a specific concept or interest.

Participants

This research utilized a 3:1 ratio sample size in determining the participants of the pilot testing and administration of the final version of the test and survey questionnaire. To select these participants, we utilized a simple random sampling technique from the actual list of each class provided by each of the class advisers with the permission of the school principal. Each specific learner was drawn randomly through computer-generated assistance. The

way of selecting the participants provided a purpose to achieve a true randomness that minimizes predictability and heuristics. The pilot testing was participated by 120 Grade 11 learners coming from three (3) different sections of the STEM strand of one of the public schools in Iligan City. The scores of these learners were used to run the evaluation and item analysis to obtain the final version of the test questionnaire. This questionnaire was then administered to thirty-three (33) Grade 11 STEM learners in one of the public high schools in Kapatagan, Lanao Del Norte. These learners are currently enrolled in General Chemistry for the school year 2024-2025.

Development of the Assessment Instrument

Prior to data gathering was the acquiring of permission from the school principal, classroom adviser, and General Chemistry teacher. The data gathering has begun from the development of the research-made test questionnaire, initially consisted with fifty (50) items that computationally targeted the learning competencies in the General Chemistry through the table of specification (TOS). The initial test served as the first version of the test questionnaire. It was then followed by the face and content validation by the research adviser and three (3) content and construct validators. Upon the returning of the evaluated test questionnaire, it was edited and revised based on the evaluations of the validators. After the revision period was the second version of the test questionnaire that was to be pilot tested. The result of the pilot testing was tallied and analyzed through an item analysis. Items were discarded based on the difficulty and discrimination indices and the item that was revised and accepted will be the third or final version of the test questionnaire. This version was the one to be administered in the main participants of the study with overall forty (40) items multiple choice questionnaire focused on the content of the subject and a twenty-five (25) item adopted motivation questionnaire. The participants were clearly and precisely instructed with the direction of the data gathering to minimize misunderstanding and to effectively guide them through the process of completing the tests. The participants were given one and a half (1:30) hours to do the data gathering. The result of the final version of the test questionnaire was then the basis for analyzing the objectives of this study and to validate the relationship of the variables.

Data Analysis

The data was collected, tabulated, analyzed and interpreted. The tables below were used to have an accurate interpretation of the data. It will serve as the basis for determining the description of the intervals to which they belong.

Table 2. Motivation Level Classification

Scale	Description	Percentage Range (%)	Motivation Level Interpretation
4	Strongly Agree	76-100	Very Motivated
3	Agree	51-75	Motivated
2	Disagree	26-50	Less motivated
1	Strongly Disagree	0-25	Not Motivated at All

Table 3. Interpretation on Students' Performance on the Achievement Test

Percentage	Remarks
90-100	Passed
85-89	Passed
80-84	Passed
75-79	Passed
Below 75	Failed

Reference: DepEd Order No. 8 s, 2015

Table 4. Mastery levels and percentage equivalent

Mastery Level	Percentage Equivalent
Mastered	80-100
Nearly Mastered	75-79
Least Mastered	51-54
Not Mastered	50 and below

Reference: DepEd PPST - Module 11

RESULTS AND DISCUSSION

Level of Motivation Results

Table 5. Motivation Level of the Respondents (N=33)

Statements	Very Motivated (%)	Motivated (%)	Less Motivated (%)	Not Motivated at All (%)
Intrinsic Motivation				
1. I enjoy learning General Chemistry.	9 (27%)	22 (67%)	2 (6%)	0 (0%)
2. I am curious about the discoveries in General Chemistry.	12 (36%)	18 (55%)	2 (6%)	1 (3%)
3. Learning General Chemistry makes my life more meaningful.	4 (12%)	23 (70%)	6 (18%)	0 (0%)
4. Learning General Chemistry is interesting.	13 (39%)	18 (55%)	2 (6%)	0 (0%)
5. The concepts I learned in General Chemistry are relevant to my life.	4 (12%)	20 (61%)	8 (24%)	1 (3%)
Career Motivation	**Very Motivated (%)**	**Motivated (%)**	**Less Motivated (%)**	**Not Motivated at All (%)**
6. I will use General Chemistry problem-solving skills in my future career.	7 (21%)	17 (52%)	8 (24%)	1 (3%)
7. My future career will involve chemistry.	6 (18%)	14 (42%)	12 (36%)	1 (3%)
8. Understanding General Chemistry will benefit my future career.	7 (21%)	20 (61%)	5 (15%)	1 (3%)
9. Knowing General Chemistry will give me a career advantage in the future.	9 (27%)	21 (64%)	3 (9%)	0 (0%)
10. Learning General Chemistry will help me get a good job.	7 (21%)	21 (64%)	5 (15%)	0 (0%)
Self Determination	**Very Motivated (%)**	**Motivated (%)**	**Less Motivated (%)**	**Not Motivated at All (%)**
11. I study hard to learn General Chemistry.	9 (27%)	18 (55%)	6 (18%)	0 (0%)
12. I prepare well for General Chemistry tests and laboratories.	6 (18%)	16 (48%)	11 (33%)	0 (0%)

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume IX Issue I January 2025

13. I spend a lot of time learning General Chemistry.	2 (6%)	13 (39%)	18 (55%)	0 (0%)
14. I use strategies to learn General Chemistry well.	4 (12%)	24 (73%)	5 (15%)	0 (0%)
15. I put enough effort into learning General Chemistry1.	5 (15%)	24 (73%)	4 (12%)	0 (0%)
Self-Efficacy	**Very Motivated (%)**	**Motivated (%)**	**Less Motivated (%)**	**Not Motivated at All (%)**
16. I am sure I can understand General Chemistry.	5 (15%)	24 (73%)	4 (12%)	0 (0%)
17. I believe I can earn a grade of 90 and above in General Chemistry.	5 (15%)	20 (61%)	7 (21%)	1 (3%)
18. I believe I can master General Chemistry knowledge and skills.	4 (12%)	15 (45%)	14 (42%)	0 (0%)
19. I am confident I will do well on General Chemistry laboratories and projects.	2 (6%)	20 (61%)	11 (33%)	0 (0%)
20. I am confident I will do well on General Chemistry tests.	1 (3%)	15 (45%)	17 (52%)	0 (0%)
Grade Motivation	**Very Motivated (%)**	**Motivated (%)**	**Less Motivated (%)**	**Not Motivated at All (%)**
21. Having an 80% and above on General Chemistry tests and laboratories matters to me.	13 (39%)	15 (45%)	4 (12%)	1 (3%)
22. I think about the grade I will get in the General Chemistry subject.	14 (42%)	15 (45%)	4 (12%)	0 (0%)
23. It is important that I get a grade 0f 90 and above in the General Chemistry subject.	17 (52%)	14 (42%)	2 (6%)	0 (0%)
24. Getting a grade of 90 and above boosts me to be consistently better in General Chemistry.	19 (58%)	12 (36%)	2 (6%)	0 (0%)
25. I like to do better than other learners in General Chemistry tests.	6 (18%)	14 (42%)	12 (36%)	1 (3%)

Table 5 shows the summary of the motivation level among thirty-three (33) respondents. It was revealed that learners demonstrate moderate to high intrinsic motivation, with 67%-70% expressing enjoyment in learning General Chemistry and finding it interesting. Their curiosity about the subject is particularly strong, as evidenced by 36% being "Very Motivated" and 55% "Motivated." However, their motivation diminishes when the subject is tied to personal relevance, with only 12% believing that learning chemistry makes their life more meaningful or connects to their real-world experiences. This drop in motivation highlights a need to make the subject more relatable and practical, as the lack of connection to everyday life could hinder sustained engagement.

In terms of career-related motivation, learners display promising yet uneven levels of enthusiasm. While 61%-64% are motivated to learn chemistry for its career benefits, only 18%-21% feel strongly about applying chemistry or its problem-solving skills in their future careers. Moreover, 36% express minimal or no motivation regarding chemistry's relevance to their professional goals, reflecting a gap between the course content and its perceived utility in diverse career paths. Addressing this gap by aligning chemistry with broader career opportunities could enhance learners' engagement and inspire those who do not plan to pursue chemistry-specific professions.

Self-determination is evident in the effort learners put into their studies, with 73% agreeing that they use strategies and exert sufficient effort to learn chemistry. However, time management presents a challenge, as only 6% are "Very Motivated" to dedicate substantial time to studying, and 55% are "Less Motivated." Additionally, while two-thirds prioritize preparation for tests and labs, a significant portion reports a lack of motivation in this area. These trends suggest a need for structured support to help learners manage their time effectively and maintain consistent study habits.

Learners' self-efficacy, or motivation in mastering General Chemistry, varies significantly. While 73% feel confident in their understanding of the subject, only 45% believe they can achieve a grade of 90 or higher. Furthermore, confidence in excelling in tests and labs is low, with 33%-52% reporting reduced motivation. Targeted interventions, such as providing practice tests and personalized feedback, could strengthen learners' self-belief and performance in these areas.

Grade motivation emerges as a strong driver, with 58% "Very Motivated" and 36% "Motivated" to achieve high scores. However, competitive motivation is less pronounced, as only 18% are strongly driven to outperform peers. This indicates that learners are more focused on personal achievement than on comparison or competition. Encouraging collaborative activities, such as group projects or peer-led discussions, could foster a more balanced and engaging learning environment.

Overall, while learners exhibit strong intrinsic and grade-related motivation, the challenges of connecting chemistry to real-world relevance, aligning it with career goals, and building confidence in assessments indicate areas for improvement. Integrating practical applications of chemistry, providing career-oriented guidance, and offering support for self-efficacy and time management are essential steps to address these challenges. By focusing on these areas, educators can enhance learners' overall motivation, engagement, and success in General Chemistry.

Learners' Performance in Achievement Test

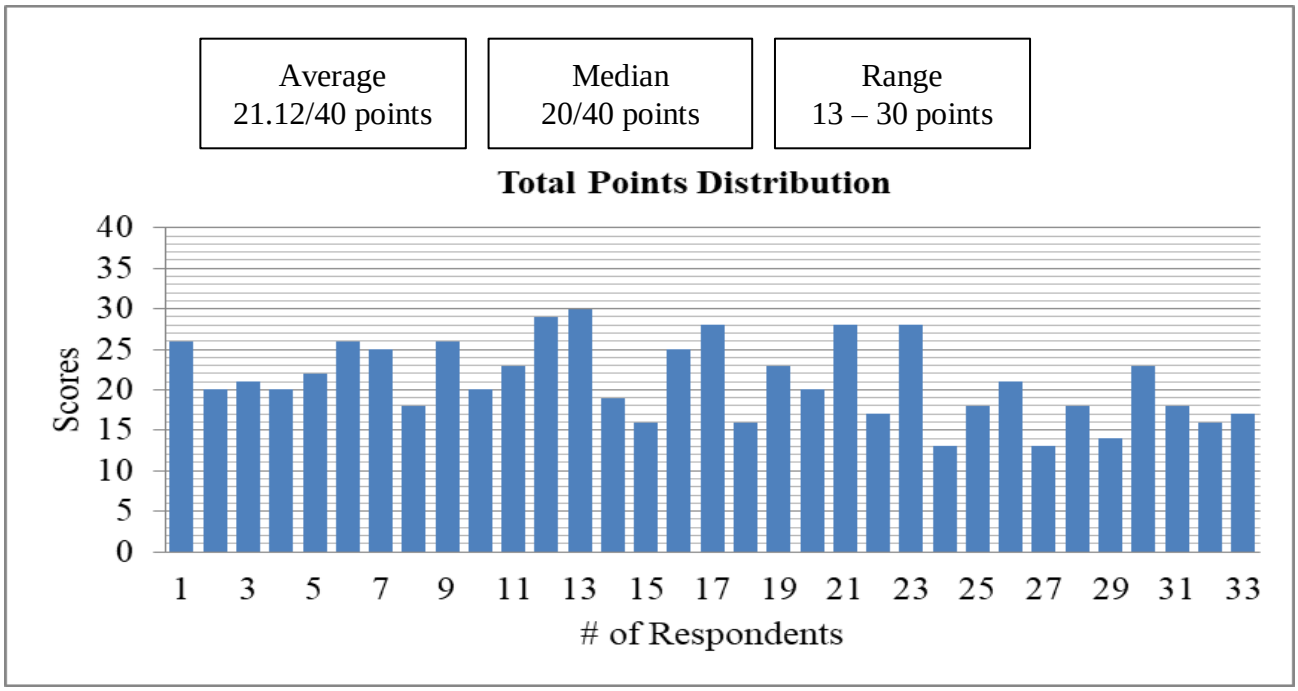

Figure 1. Total Points Distribution

Figure 1 displays the distribution of total points scored by thirty-three (33) respondents, with the scores ranging from 13 to 30 out of a possible 40 points. The statistical summary above highlights an average score of 21.12 points, a median score of 20 points, and a range of 13 to 30 points. The data indicates that scores are fairly spread out but concentrated around the central tendency. The median score of 20 points suggests that half of the respondents scored below this value, and half scored above. The average score being slightly higher than the median implies a slight skew toward higher scores. The range of 17 points (13–30) shows moderate variability

among respondents' scores. Peaks in the bar graph, particularly around respondents with higher scores (e.g., 11th and 15th respondents), suggest some clustering at the higher end of the distribution, whereas some lower score bars (e.g., near the 17th and 27th respondents) show fewer occurrences in those ranges. This data suggests an overall average to moderate performance among the respondents, with a tendency for scores to cluster near the median. The variability across respondents highlights diverse performance levels within the group.

Table 7. Mastery Level of Grade 11 STEM Learners on General Chemistry Competencies

Most Essential Learning Competency	**Item number**	**Frequency of error**	**%**	**No. of correct responses**	**%**	**Mastery Level**
Use properties of matter to identify substances and to separate them	1	5	15.15%	28	84.85%	**Mastered**
Recognize the formulas of common chemical substances	2	26	78.79%	7	21.21%	**Not mastered**
Compare consumer products on the basis of their components for use, safety, quality and cost	3	10	30.30%	23	69.70%	**Least mastered**
Describe various simple separation techniques such as distillation, chromatography	4	22	66.67%	11	33.33%	**Not mastered**
Represent compounds using chemical formulas, structural formulas and models	7	31	93.94%	2	6.06%	**Not mastered**
Name compounds given their formula and write formula given the name of the compound	8	14	42.42%	19	57.58%	**Least mastered**
Calculate the empirical formula from the percent composition of a compound	9	20	60.61%	13	39.39%	**Not mastered**
Calculate molecular formula given molar mass	10	24	72.73%	9	27.27%	**Not mastered**
Write and balanced chemical equations	11	18	54.55%	15	45.45%	**Not mastered**
Construct mole or mass ratios for a reaction in order to calculate the amount of reactant needed or amount of product formed in terms of moles or mass	12, 13	22 19	62.12%	11 14	37.88%	**Not mastered**
Calculate percent yield and theoretical yield of the reaction	14,	11	54.55%	22	45.45%	**Not mastered**

	15	25		8		
Explain the concept of limiting reagent in a chemical reaction; identify the excess reagent(s)	16,	8	35.35%	25	64.65%	**Least mastered**
	17,	6		27		
	18	21		12		
Define pressure and give the common units of pressure	19	5	15.15%	28	84.85%	**Mastered**
Use the gas laws to determine pressure, volume, or temperature of a gas under certain conditions of change	20	5	15.15%	28	84.85%	**Mastered**
Use the ideal gas equation to calculate pressure, volume, Temperature, or number of moles of a gas	21	3	9.09%	30	90.91%	**Mastered**
Use Dalton's law of partial pressures to relate mole fraction and partial pressure of gases in a mixture	22	13	39.39%	20	60.61%	**Least mastered**
Apply the principles of stoichiometry to determine the amounts (volume, number of moles, or mass) of gaseous reactants and products	23	29	87.88%	4	12.12%	**Not mastered**
Relate the rate of gas effusion with molar mass	24	28	84.85%	5	15.15%	**Not mastered**
Use quantum numbers to describe an electron in an atom	25	19	57.58%	14	42.42%	**Not mastered**
Determine the magnetic property of the atom based on its electronic configuration	26	1	3.03%	32	96.97%	**Mastered**

Draw an orbital diagram to represent the electronic configuration of atoms	27	10	30.30%	23	69.70%	**Least mastered**
Draw the Lewis structure of ions	28	13	39.39%	20	60.61%	**Least mastered**
Apply the octet rule in the formation of molecular covalent compounds	29	14	42.42%	19	57.58%	**Least mastered**
Write the formula of molecular compounds formed by the non-metallic elements of the representative block	30	27	81.82%	6	18.18%	**Not mastered**
Draw Lewis structure of molecular covalent compounds	31	0	0.00%	33	100.00 %	**Mastered**
Describe the geometry of simple compounds	32	5	15.15%	28	84.85%	**Mastered**
Determine the polarity of simple molecules	33	21	63.64%	12	36.36%	**Not mastered**
Describe the different functional groups	34	23	69.70%	10	30.30%	**Not mastered**
Describe structural isomerism; give examples	35	31	93.94%	2	6.06%	**Not mastered**
Describe some simple reactions of organic compounds: combustion of organic fuels, addition, condensation, and saponification of fats	36	8	24.24%	25	75.76%	**Nearly mastered**
Describe the formation and structure of polymers	37	16	48.48%	17	51.52%	**Least mastered**
Explain the properties of some polymers in terms of their structure	38	22	66.67%	11	33.33%	**Not mastered**
Describe the structure of proteins, nucleic acids, lipids, and carbohydrates, and relate them to their function	39	9	27.27%	24	72.73%	**Least mastered**
Describe the preparation of selected organic compounds	40	4	12.12%	29	87.88%	**Mastered**
Mean Percentage Score					**52.93 %**	**Least Mastered**

Legend: Not mastered (50 % below); Least mastered (51 - 74%); Nearly Mastered (75 - 79%); Mastered (80 - 100%)

Table 7 indicates varying levels of mastery across different learning competencies in chemistry. Topics such as "Use the ideal gas equation" and "Draw Lewis structures of molecular covalent compounds" are mastered, with over 90% of students answering correctly. Conversely, competencies like "Represent compounds using chemical

formulas" and "Describe structural isomerism" are among the least mastered, with correct response rates below 10%. Most students struggle with topics requiring detailed chemical understanding or advanced calculations, such as stoichiometry, empirical formulas, and gas effusion rates. The overall mean percentage score is 52.93%, classifying the general mastery level as "Least Mastered." Emphasis should be placed on reinforcing foundational concepts and providing targeted interventions for underperforming areas, especially the not mastered and least mastered competencies.

CONCLUSION AND RECOMMENDATION

The respondents displayed moderate to high intrinsic motivation, particularly in enjoying the subject and recognizing its relevance to academic success. However, career-related motivation was uneven, with many learners unable to see the practical applications of chemistry in their future careers. While most learners expressed a desire to achieve high grades, competitive motivation and sustained effort in studying were less pronounced. These trends indicate that while learners value chemistry academically, they struggle to connect it to personal and professional aspirations. The overall performance in the achievement test was below expectations, with an average score of 21.12 out of 40, and only one respondent achieving a passing grade. Key areas of difficulty included stoichiometry, balancing chemical equations, and understanding chemical formulas and reactions. These results suggest significant gaps in conceptual knowledge and application skills, which hindered learners' ability to perform well and master critical learning competencies. While learners demonstrated some understanding of basic concepts, such as isotopes and limiting reactants, misconceptions were prevalent in areas like mole ratios, percent yield calculations, and the distinction between chemical and molecular formulas. These knowledge gaps highlight the need for targeted instructional strategies to address these deficiencies. The findings of this study recommend a tailored design Strategic Intervention Materials (SIMs) to target the least mastered competencies, such as stoichiometry, chemical bonding, and balancing equations. These materials should incorporate interactive and engaging activities, such as simulations and problem-solving exercises, to bridge the gaps in conceptual knowledge in General Chemistry and encourage learner motivation in learning the subject matter. By addressing these areas, educators can create a more effective and engaging learning environment that supports both the mastery of competencies and the motivation needed for success in General Chemistry.

ACKNOWLEDGEMENT

The author extends heartfelt gratitude, first and foremost, to God for granting the knowledge, wisdom, and courage needed to undertake this study. The author is also deeply grateful to the school head and General Chemistry teachers for allowing the conduct of this study, the Grade 11 learners for their honest and active participation, and the College of Education at Mindanao State University-Iligan Institute of Technology for their enduring support.

REFERENCES

1. Abdullah, A. H., Abidin, N. L., & Ali, M. (2015). Analysis of Students' Errors in Solving Higher Order Thinking Skills (HOTS) Problems for the Topic of Fraction. Asian Social Science; Vol. 11, No. 21; 2015
2. Adalla-Raboy, M. (2020). 20 Least Learned Competencies in Science For 7th, 8th, 9th, And 10th Grade. Retrieved from https://www.scribd.com/document/518899566/LEAST-LEARNED-COMPETENCIES
3. Adlim, A., et. al. (2014). Assessing Chemistry-Learning Competencies of Students in Isolated Rural Senior High Schools by Using the National Examination: A Case Study of Simeulue Island, Indonesia. International Journal of Science and Mathematics Education. DOI:10.1007/s10763-013-9440-x
4. Arpilleda, A. (2021). Strategic Intervention Material: A Tool in Enhancing Gradenine Students' Mathematical Performance. International Journal of Research Studies in Education 2021 Volume 10 Number 5, 61-72
5. Austin, A. et. al. (2018). Relating motivation and student outcomes in general organic chemistry. Chem. Educ. Res. Pract., 2018,19, 331-341

6. BouJaoude, S. & Barakat, H. (2003). Secondary School Students' Difficulties With stoichiometry. School Science Review, 81, 91-98
7. Chan, J. & Bauer, C. (2016). Learning and Studying Strategies used by General Chemistry Students with Different Affective Characteristics. Chemistry Education Research and Practice 17(4). DOI:10.1039/C5RP00205B
8. Contreras, S. (2018). Utilization of Manipulative and Interactive Strategic Intervention Material (MI-SIM) in Chemistry 9. The ASTR Research Journal. Volume 2 · November 201
9. Danish, J. & Ma, J. (2023). Learning, Cognition, and Human Development. International Encyclopedia of Education (Fourth Edition), 2023
10. Fach, M., de Boer, T. & Parchman, I. (2007). Results of an interview study as basis for the development of stepped supporting tools for stoichiometric problems. Chemistry Education Research and Practice, 2007, 8 (1), 13-31
11. Hartman, J. & Nelson, E. (2021). A Paradigm Shift: The Implications of Working Memory Limits for Physics and Chemistry Instruction. arXiv:2102.00454
12. Hartman, J. & Eichler, J. (2024). Implementing Mastery Grading in Large Enrollment General Chemistry: Improving Outcomes and Reducing Equity Gaps. Educ. Sci. 2024, 14(11), 1224; https://doi.org/10.3390/educsci14111224
13. Huda, N. & Rohaeti, E. (2023). The Factors that Influence the Motivation to Learn Chemistry of Upper-Secondary School Students in Indonesia. Journal of Baltic Science Education, Vol. 22, No. 4, 2023
14. Impas, M. (2021). Effectiveness of Interactive Strategic Intervention Materials in Improving the Least Learned Skills of the Grade IV Pupils in English. International Journal of Advanced Multidisciplinary Studies. Volume 1, Issue 3, ISSN: 2782-893X
15. Lim, P. K. (2019). Report on the Ten Most Mastered and Least Learned Skills. Retrieved from https://www.scribd.com/document/508155893/Most-And-Least-Learned-3rd
16. Liu, Y. & Kim, E. (2024). Investigating Student Intrinsic Motivation Trends Over One Semester in an Online General Chemistry II Course. J. Chem. Educ. 2024, 101, 6, 2175–2187
17. Mandina, S. & Enunuwe, O. C. (2017). Problem Solving Instruction for Overcoming Students' Difficulties in Stoichiometric Problems. Acta Didactica Napocensia, Volume 10, Number 4, 2017
18. Mandina, S. & Enunuwe, O. C. (2018). Recurrent Difficulties: Stoichiometry Problem-Solving. African Journal of Educational Studies in Mathematics and Sciences Vol. 14, 2018.
19. Mandina, S. & Enunuwe, O. C. (2018). Comparative Effect of Two Problem-solving Instructional Strategies on Students' Achievement in Stoichiometry. EURASIA Journal of Mathematics, Science and Technology Education, 2018, 14(12), em1621
20. Mardhiah, M. Z., Mailizar, M., and Elizar, E. (2021). Students' Mathematics Problem-Solving Skills in PISA Problems. AIP Conference Proceedings 2331, 020032 (2021)
21. Mansor, S. N. A., Samsudin, N., & Shukri, F. N. A. (2021). Newman's Error Analysis of Common Errors in Solving Convergence of Power Series Using Ratio Test. International Journal of Academic Research in Business and Social Sciences, 11(9), 888–898.
22. Meydan, E. (2021). Investigating Secondary School Students' Motivation for Chemistry Class in Terms of Various Variables. International Journal of Progressive Education, Volume 17 Number 1, 2021
23. Miterianifa, Ashadi, Saputras, & Suciati. (2020). Critical Thinking Skills Profile of Senior High School students in Learning Chemistry. Humanities & Social Sciences ReviewseISSN: 2395-6518, Vol 8, No 3, 2020, pp 737-744
24. OECD. (2019). https://www.oecd.org/pisa/publications/PISA2018_ CN_PHL.pdf.
25. Sliker, S. Q. (2020). General Chemistry al Chemistry Students' P y Students' Perceived Self-Efficacy after edSelf-Efficacy after Completing Project-Based Service-Learning Activities. Retrieved from https://scholarworks.waldenu.edu/cgi/viewcontent.cgi?params=%2Fcontext%2Fdissertations%2Farti cle%2F10717%2F&path_info=Sliker_waldenu_0543D_25079.pdf&utm_source=chatgpt.com
26. Stone, K. L., Shaner, S. E., & Fendrick, C. M. (2018). Improving the Success of First Term General Chemistry Students at a Liberal Arts Institution. Educ. Sci. 2018, 8, 5; doi:10.3390/educsci8010005

27. Rentillo-Co, W. (2017). Comparison of Students' Perceived Mastery and Teachers' Perceived Competencies in Different Concepts in General Chemistry. International Journal of Humanities Social Sciences and Education (IJHSSE) Volume 4, Issue 10, October 2017, PP 77-80
28. Rosal, G., Aguinaldo, J. C., & Reyes, L. D. (2022). Improving the Least Mastered Competencies of Grade 11 Students in General Chemistry using Electronic Strategic Intervention Material (E-SIM). Kapisanang Kimika ng Pilipinas. Volume 33, Number 2, pp. 59-76 (2022)
29. Urhahne, D. & Wijnia, L. (2023). Theories of Motivation in Education: An Integrative Framework. Educational Psychology Review (2023) 35:45
30. Vaino, K., et. al. (2012). Stimulating Students' Intrinsic Motivation for Learning Chemistry through the Use of Context-Based Learning Modules. Chem. Educ. Res. Pract., 2012,13, 410-419
31. White, A. (2010). A Revaluation of Newman's Error Analysis. Journal of Science and Mathematics Education in Southeast Asia, v33 n2 p129-148 2010