

Analyzing the Least Mastered Competencies in Chemical Reactions Among Grade 10 Learners

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ABSTRACT

This study aimed to analyze the least mastered competencies in chemical reactions among Grade 10 learners. Specifically, it sought to determine the learners' performance in chemical reactions, and identify the least mastered competencies in a chemical reaction. The study employed a quantitative descriptive research design using a competency-based questionnaire developed from the Most Essential Learning Competencies (MELCs) in Chemical Reactions. The questionnaire covered balancing chemical equations, types of chemical reactions, examples of chemical reactions, and the law of conservation of mass. A total of 150 Grade 10 learners from different sections one of a public school in Jolo, Sulu participated in the study during the School Year 2025–2026. Data were analyzed using frequency, percentage, mean, standard deviation, and Mean Percentage Score (MPS). The results revealed that most learners (96.67%) obtained scores within the “Did Not Meet Expectation” level, indicating low mastery of chemical reaction competencies. Among the competencies assessed, Balancing Chemical Equations was identified as the least mastered competency, with an MPS of 22.31. This was followed by Types of Chemical Reactions (24.62) and Examples of Chemical Reactions (24.67), both interpreted as Low Mastery. Conservation of Mass obtained the highest MPS of 25.07 and was interpreted as Average Mastery. The study concludes that Grade 10 learners demonstrated limited mastery of competencies in chemical reactions, particularly in balancing chemical equations. The results emphasize the need for strategic instructional support and targeted intervention to enhance learner understanding in these critical areas of chemistry.

Keywords: balancing chemical equation, chemical equation

INTRODUCTION

Chemical reactions were among the fundamental topics in chemistry, as they explained how substances interacted and transformed into new products. Understanding chemical reactions required learners to develop conceptual knowledge and problem-solving skills related to balancing chemical equations, identifying types of reaction, recognizing examples of chemical reactions, and applying the law of conservation of mass. However, many learners experienced difficulties in mastering these competencies due to the abstract nature of chemistry concepts and the cognitive demands involved in understanding symbolic representations and scientific reasoning (Johnstone, 2000).

Identifying learners' least mastered competencies was essential in determining specific learning gaps and understanding areas where learners encountered difficulties. Competency assessment provided valuable information regarding learners' strengths and weaknesses across various learning domains. According to Martin and Mullis (2013), analyzing learners' performance among competencies enabled educators and researchers to identify areas of low mastery and gain a deeper understanding of learners' academic needs.

The Trends in International Mathematics and Science Study (TIMSS) and the Programme for International Student Assessment (PISA) were internationally recognized assessment programs that evaluated learners' knowledge, skills, and competencies in science and other subject areas. TIMSS primarily assessed learners' understanding of curriculum-based science and mathematics concepts, while PISA focused on the application of

knowledge and skills in real-world contexts (Mullis et al., 2012; OECD, 2013). Both assessment frameworks contributed significantly to the assessment of learners' achievement and competency development across educational systems.

In this study, a TIMSS- and PISA-based questionnaire was utilized as the assessment instrument to measure learners' competencies in chemical reactions. The instrument assessed learners' understanding and application of key concepts related to chemical reactions, including conservation of mass, types of reactions, balancing chemical equations, and examples of chemical reactions. Through the use of assessment items patterned after internationally recognized frameworks, the study obtained data on learners' competency mastery among the identified content areas.

Although numerous studies examined learners' achievement in science, limited research focused specifically on identifying learners' least mastered competencies in chemical reactions using competency-based assessment tools. Furthermore, there remained a need to determine which competencies learners found most challenging in order to provide a clearer picture of their learning difficulties. Therefore, this study was conducted to analyze learners' least mastered competencies in chemical reactions.

Objectives of the Study

The main objective of this study was conducted to analyze the least mastered competencies in chemical reactions among Grade 10 learners. Specifically, it aimed to:

1. determined the learners' scores on chemical reaction
2. determined the least mastered competencies in Grade 10 high school learners

METHODOLOGY

This study employed a quantitative descriptive research design to analyze the least mastered competencies in chemical reactions among Grade 10 learners. A competency-based questionnaire consisting of 50 multiple-choice items was developed based on the Most Essential Learning Competencies (MELCs) in Chemical Reactions prescribed by the Department of Education (DepEd). The instrument covered four competencies: Balancing Chemical Equations, Types of Chemical Reactions, Examples of Chemical Reactions, and the Law of Conservation of Mass.

The questionnaire underwent content validation by three in-service science teachers to ensure the relevance, clarity, and alignment of the items with the intended competencies. Revisions were incorporated based on the validators' recommendations. The reliability of the instrument was determined using Cronbach's alpha, which yielded a coefficient of 0.74, indicating acceptable internal consistency.

The participants of the study consisted of 150 Grade 10 learners from different sections of a public school in Jolo, Sulu during the School Year 2025–2026. The respondents were selected through purposive sampling based on their enrollment in Grade 10 at the time of the study. Data collection was conducted through the administration of the validated competency-based questionnaire during regular class hours.

The data were analyzed using frequency, percentage, mean, standard deviation, and Mean Percentage Score (MPS) to determine learners' performance and mastery levels in each competency.

The following tables present the interpretation of data gathered in this study. To determine learners' least mastered competency, the Department of Education's (DepEd) Mastery Level Scale, based on the Mean Percentage Score (MPS), was utilized. Additionally, summary scores were interpreted using DepEd's performance index system.

Table 1 Mastery/Achievement Level

Mean Percentage Score (MPS)	Descriptive Equivalent
96-100%	Mastered
86-95%	Closely Approximating Mastery
66-85%	Moving Towards Mastery
35-65%	Average Mastery
15-34%	Low Mastery
5-14%	Very Low Mastery

Table 1 presents the classification of learners' mastery levels. MPS was computed by dividing the total number of correct responses per topic by the total possible score (i.e., number of test items per topic multiplied by the number of respondents), and then multiplying the result by 100.

Table 2 Interpretation of Learners' Performance

Index	Description	Range	Interpretation
45-50	Outstanding	90-100	Passed
40-44	Very Satisfactory	85-89	Passed
35-39	Satisfactory	80-84	Passed
30-34	Fairly Satisfactory	75-79	Passed
0-29	Did Not Meet Expectation	74 Below	Failed

The table 2 provides a summary interpretation of learners' overall performance based on the DepEd's performance index.

RESULTS AND DISCUSSION

This section presents the results and discussion of the data gathered from the competency-based questionnaire administered to 150 Grade 10 learners from one of a public school in Jolo, Sulu. The analysis focuses on determining learners' performance in chemical reactions, identifying the least mastered competencies, and examining the differences in learners' performance among the competencies assessed.

The results are presented through summary tables showing the distribution of learners' performance and the mastery levels of the competencies assessed. Frequency, percentage, mean, standard deviation, and Mean Percentage Score (MPS) were utilized to describe learners' performance and competency mastery. These data provide an overview of learners' achievement and serve as the basis for determining the competencies in which learners experienced the greatest difficulty.

The table below presents the summary of learners' performance based on their assessment scores in chemical reactions. The results are organized according to frequency and percentage distributions, with performance levels categorized as Outstanding, Very Satisfactory, Satisfactory, Fairly Satisfactory, and Did Not Meet Expectations. This presentation provides a general description of learners' performance and their level of competency mastery in chemical reactions.

Table 3 Summary of Assessment Results

Index	Frequency	Percentage	Interpretation	Remark
45-50			Outstanding	Passed
40-44			Very Satisfactory	Passed
35-39	1	0.66%	Satisfactory	Passed

30-34	4	2.67%	Fairly Satisfactory	Passed
0-29	145	96.67%	Did Not Meet Expectation	Failed
Total	150			
Mean	Standard Deviation		Interpretation	Failed
0.24	0.04		Did Not Meet Expectation	

Table 3 presents the summary of assessment results of the competency-based questionnaire administered to the 150 Grade 10 learners. A total of 145 learners fell within the 0–29 score range, four learners were in the 30–34 range, and one learner was in the 35–39 range, with no learners achieving higher performance levels. These results indicate that only four learners attained a Fairly Satisfactory level, while one learner reached a Satisfactory level and passed. The mean score of 0.24 and the standard deviation of 0.04 indicate that the learners generally demonstrated low competency mastery in chemical reactions, with relatively little variation in their performance. The majority of the learners did not meet the expected master competencies, suggesting difficulties in the competencies covered by the questionnaire. These findings provide an initial overview of the learners' competency mastery in chemical reactions and serve as a basis for determining the least mastered competencies among Grade 10 learners. The results further support the need to examine learners' performance in each competency, as presented in the succeeding tables.

Table 4 Overall Mastery of Competencies

Rank	Topic	Mean Percentage Score	Descriptive Equivalent
1	Balancing Chemical Equation	22.31	Low Mastery
2	Type of Reaction	24.62	Low Mastery
3	Examples of Chemical Reaction	24.67	Low Mastery
4	Conservation of Mass	25.07	Average Mastery

Table 4 presents the mastery of competencies in chemical reactions based on the learners' Mean Percentage Scores (MPS). Among the four competencies assessed, Balancing Chemical Equations obtained the lowest MPS of 22.31, which is interpreted as Low Mastery. This indicates that the learners experienced the greatest difficulty in this competency compared with the other competencies included in the assessment. Therefore, Balancing Chemical Equations was determined to be the least mastered competency among Grade 10 learners. This finding supports the study of Taber (2013) [12], who reported that learners commonly struggle with balancing chemical equations because the competency requires understanding the symbolic representation of chemical reactions and the principle of conservation of matter. Similarly, Johnstone (2000) [4] explained that chemistry concepts are often difficult for learners because they involve abstract ideas that require learners to connect macroscopic observations, microscopic particles, and symbolic representations simultaneously. The competencies Types of Reaction and Examples of Chemical Reaction obtained MPS values of 24.62 and 24.67, respectively, both interpreted as Low Mastery. These results suggest that learners encountered difficulties in recognizing, classifying, and interpreting chemical reactions. The findings are consistent with Nakhleh (1992) [8], who found that misconceptions and incomplete conceptual understanding often affect learners' performance in chemistry. Learners may recognize individual reactions but experience difficulty when required to classify them according to scientific principles and characteristics. Meanwhile, Conservation of Mass obtained the highest MPS of 25.07, with a descriptive equivalent of Average Mastery. This indicates that learners demonstrated relatively better performance in this competency compared with the other competencies assessed. Although this competency showed the highest mastery level, the result suggests that learners still have room for improvement in their understanding of the concept. According to Chang and Goldsby (2014) [3], understanding the law of conservation of mass is fundamental to learning chemical reactions and serves as a basis for balancing chemical equations and explaining chemical transformations. Overall, the results show that most of the competencies were characterized by low mastery levels. The findings suggest that learners experience varying degrees of difficulty across the competencies in chemical reactions. This observation supports the findings of Martin and Mullis

(2013) [6], who reported that learners generally perform better in knowledge-based competencies than in competencies requiring application, reasoning, and conceptual understanding. Likewise, Bybee and McCrae (2011) [2], emphasized that learners often demonstrate lower performance in science competencies that require analysis, reasoning, and the application of scientific knowledge.

CONCLUSION

Based on the findings, the study revealed that Balancing Chemical Equations was the least mastered competency among the Grade 10 learners. The competencies on Types of Reaction and Examples of Chemical Reactions were likewise characterized by low mastery, while Conservation of Mass demonstrated the highest level of mastery among the competencies assessed. These findings indicate that learners experienced varying levels of difficulty in understanding and applying the competencies in chemical reactions.

In conclusion, the study successfully determined the least mastered competencies in chemical reactions among Grade 10 learners and provided valuable information regarding their competency mastery in the identified areas of chemistry.

The results emphasize the need for strategic instructional support and targeted intervention to enhance student understanding in these critical areas of chemistry. Addressing these gaps can contribute to improved academic performance and better preparation for more complex chemistry topics in future learning stages.

RECOMMENDATION

Based on the findings of this study, Chemistry teachers may give additional emphasis to competencies that demonstrated low mastery, particularly Balancing Chemical Equations, Types of Reaction, and Examples of Chemical Reactions, to enhance learners' understanding of chemical reactions.

School administrators and curriculum planners may utilize the findings of the study as a basis for monitoring learners' competency mastery and supporting the improvement of chemistry instruction.

The competency-based questionnaire developed in this study may be used, adapted, or further validated by teachers and researchers for assessing learners' competencies in chemical reactions.

Future researchers may conduct similar studies involving larger populations, different grade levels, and other chemistry topics to further examine learners' competency mastery and compare results across various contexts.

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