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# LABORATORY EXPOSURE AND LEARNERS' CONCEPTUAL RETENTION IN GENERAL CHEMISTRY

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**ABSTRACT**

***This study examines the relationship between laboratory exposure and conceptual retention in general chemistry among Grade 11 STEM learners at Kalilangan National High School during the 2024-2025 academic year. In light of the significant deficiencies in science proficiency revealed by the 2023 PISA results, this research investigates the impact of laboratory experiences on students' ability to understand, apply, and recall key chemistry concepts. Using a descriptive-correlational research design, the study involved 85 learners and employed two survey questionnaires: one measuring laboratory exposure (safety awareness, engagement, and skills development) and the other assessing conceptual retention (understanding, application, and recall). Data were analyzed using descriptive statistics and Pearson's Product-Moment Correlation. The results revealed that laboratory exposure had a significant positive correlation with conceptual retention (r = 0.522, p = 0.000), suggesting that increased hands-on learning experiences improve retention of core chemistry concepts. Engagement in laboratory activities was identified as the most influential factor, followed by safety awareness and skills development. While learners demonstrated strong recall abilities, they showed moderate performance in applying knowledge and understanding foundational concepts. These findings highlight the importance of laboratory exposure and practical application in science education. The study recommends making functional laboratories, enhancing laboratory activities and integrating project-based learning strategies to further improve learners' retention and mastery of general chemistry.***

***Keyword: Correlational, Laboratory Exposure, Conceptual Retention, General Chemistry***

## 1. INTRODUCTION

The increasing demand for science proficiency emphasizes the need to enhance learners' conceptual retention in subjects like general chemistry. Retention plays a vital role in equipping learners with the knowledge and skills needed to navigate complex scientific concepts and real-world applications. Retention is especially significant in general chemistry, where understanding foundational principles is critical for success in advanced studies and careers in science, technology, engineering, and mathematics (STEM). In 2023, the Programme for International Student Assessment (PISA) revealed significant deficiencies in science performance among Filipino students, ranking the country 77$^{th}$ among eighty-one participating nations. This alarming result underscores a gap in the delivery and effectiveness of science education in the country, particularly in fostering understanding and retention of key concepts. Laboratory exposure, encompassing safety awareness, engagement in activities, and skills development, is pivotal in science education. It bridges theoretical concepts with practical application, offering a dynamic environment for learners to engage in active learning and inquiry. Learners who actively engage in laboratory activities show better application and problem-solving skills, crucial for addressing complex scientific challenges (Shana & Abulibdeh, 2020).

This study explores the relationship between laboratory exposure and conceptual retention in general chemistry, focusing on Grade 11 STEM learners at Kalilangan National High School. It seeks to determine learners' levels of laboratory exposure in safety awareness, engagement, and skills development, and how these factors correlate with their retention of core concepts, application, and recall. The findings aim to address the gap in the existing literature, providing evidence-based insights into the role of laboratory

activities in improving retention in general chemistry concepts.

### *1.1 Statement of the Problem*

This study sought to investigate the Grade 11 STEM learners in Kalilangan National High School, Kalilangan Bukidnon School year 2024- 2025. Specifically, it sought to find answers to the following questions:

1. What level of laboratory exposure in general chemistry do learners experience in terms of:
   1.1 safety awareness;
   1.2 engagement in laboratory activities; and
   1.3 skills development
2. What level of retention in general chemistry do the learners have in the aspect of:
   2.1 understanding of core concepts;
   2.2 application of knowledge; and
   2.3 retention and recall
3. Is there a significant relationship between laboratory exposure and conceptual retention among grade 11 STEM learners?

## 2. MATERIALS AND METHODS

### *2.1 Research Design*

This study employed a descriptive-correlational research design to examine the relationship between laboratory exposure and conceptual retention of learners. Descriptive statistics, including mean, is utilized to characterize the population and phenomena under investigation. Furthermore, the Pearson Product-Moment Correlation Coefficient was applied to determine the association between the dependent and independent variables. The study adopted a survey approach, considered the most suitable method as it involved an assessment survey.

### *2.2 Locale of the Study*

The study, was conducted with the approval of the Secondary School Principal III of Kalilangan National High School, Kalilangan East District of Division of Bukidnon. The study utilized random sampling to select grade 11 STEM learners for the 2024-2025 school year. Before the study commenced, a consent letter for the parents and learners was distributed to the chosen learners notifying them of their selection as potential participants. This letter was accompanied by an informed consent form detailing the purpose and key aspects of the study, allowing participants to make an informed decision about their involvement. Parents and learners who agreed to participate signed the consent form, which was submitted alongside their completed questionnaires.

### *2.3 Research Instruments*

This study utilized two survey questionnaires, each adapted from previous research and content validated by experts. The first questionnaire, patterned from Asiyai, A., (2023), assessed laboratory exposure of the learners, focusing on safety awareness, engagement in laboratory activities, and skills development. It comprised 30 statement indicators and underwent both content validation by experts and pilot testing with 30 learners in Malinao National High School Malinao Kalilangan Bukidnon of Kalilangan West District, Division of Bukidnon, achieving a Cronbach's alpha of 0.814, indicating high reliability. The second questionnaire, patterned from Babafemi AJ, et.al (2019) measured conceptual retention in general chemistry, focusing on the aspect of understanding core concepts, application of knowledge, and retention and recall. This instrument, consisting of 30 indicators, was content-validated by experts and pilot-tested, resulting in a Cronbach's alpha of 0.930, reflecting excellent reliability. The thorough validation and testing processes ensured the instruments' appropriateness and reliability for the study. The following rating scale was used to understand the data better:

| Scale | Range | Descriptive Meaning | Qualitative Interpretation |
|---|---|---|---|
| **1** | 1.00-1.50 | Strongly Disagree (SD) | Very Low |
| **2** | 1.51-2.50 | Disagree (D) | Low |
| **3** | 2.51-3.50 | Neutral (N) | Moderately High |
| **4** | 3.51-4.50 | Agree (A) | High |
| **5** | 4.51-5.00 | Strongly Agree (SA) | Very High |

### *2.4 Statistical Technique*

In analyzing and interpreting the data, descriptive statistics such as mean were used to evaluate the level of laboratory exposure and level of conceptual retention of grade 11 STEM learners. To examine the relationship between the independent and dependent variables, the Pearson Product Moment Correlation was applied.

## 3. RESULTS AND DISCUSSION

This section presents the data collected, discussion, interpretation, and implications of the study's findings. The results are displayed in tables, which are analyzed and interpreted. The presentation follows the sequence of the issues identified in the study.

The first part determines the level of laboratory exposure and learners' conceptual retention. The second part displays the correlation between laboratory exposure and learners' conceptual retention in general chemistry.

### *3.1 Laboratory Exposure of Learners*

The level of laboratory exposure of the learners, particularly in Kalilangan National High School, is presented in Table 1-3. The table shows the indicators, mean scores, descriptive rating, and qualitative interpretation. Every laboratory exposure domain with its corresponding indicators was discussed and interpreted individually.

#### *3.1.1.Safety Awareness*

The assessment of the level of laboratory exposure of learners in terms of safety awareness is shown in Table 1. The table shows the indicators, mean scores, descriptive rating, and qualitative interpretation.

The learners strongly agree on the following indicators, "I believe that safety is a top priority during laboratory work" with a mean of 4.77; I understand the importance of wearing personal protective equipment" with a mean of 4.58.

Moreover, the learners agreed that safety measures are adequately enforced in the lab, and regularly review safety guidelines before starting experiments, with a mean of 4.14 and 3.98. Learners are aware of the safety protocols in the laboratory and know how to respond in case of an emergency in the lab, with a mean of 3.93 and 3.85, respectively. The learners are neutral in the indicator of familiarity with the safety equipment location (e.g., eyewash), also in participating in a safety training session, with a mean of 3.22 and 3.10; feeling confident in identifying hazardous materials and in comfortably reporting conditions in the lab, with a mean of both 3.06. It indicates that learners are aware of safety awareness in the laboratory but may need more laboratory exposure.

In general, the overall mean score of 3.77 from Table 1 indicates a general agreement among learners regarding their safety awareness, categorized as "Agree" with a rating of "High exposure." This score reflects a positive attitude towards safety practices and protocols in the laboratory setting, but it also reveals areas that require further attention. This result was supported by the study of Leung, H.H. (2021) that continuous education on safety protocols is vital for reinforcing knowledge and ensuring that all are updated on best practices and that regular training significantly enhances safety awareness.

#### *3.1.2. Engagement in Laboratory Activities*

Level of laboratory exposure in terms of Engagement in laboratory activities. This indicates that hands-on experience enhances understanding of chemistry concepts, with the highest mean being 4.60. Next is believing that laboratory activities are essential for my overall learning experiences with a mean of 4.39, followed by feeling motivated to learn new techniques in the lab and enjoying collaborating with peers during the experiment, with a mean of 4.36 and 4.06.

However, indicators that learners are eager to conduct experiments, when possible, actively participate in laboratory discussions, and take initiative to lead group projects in lab setting gained neutral descriptive ratings with a mean of 3.45,3.42 and 2.89.

Overall, the level of laboratory exposure in terms of engagement in laboratory activities had an overall mean of 3.82 the findings suggest that hands-on experiences are crucial for enhancing understanding and motivation in learning. This aligns with previous research that emphasizes the effectiveness of experiential learning in science education. For instance, a study by Celestin, N., Iyamuremye, A., Nsabayezu, E., & Hagenimana, F. (2023) found that practical laboratory work

significantly improves students' engagement and academic performance by allowing them to apply theoretical knowledge in real-world contexts. The study highlights that when students actively participate in laboratory activities, they develop critical thinking and problem-solving skills, which are essential for scientific inquiry.

### *3.1.3. Skills Development*

Level of Laboratory exposure in terms of skills development. The highest mean score of 4.35 reflects students' strong belief in the necessity of continuous practice for skill enhancement, aligning with research by Pritasari, O.K., Puspitorini, A., & Dewi, L. (2021) which emphasizes that regular practice is crucial for mastering laboratory techniques. Feedback from instructors also plays a significant role, receiving a mean score of 4.02. Learners reported a mean score of 3.69 regarding the development of critical thinking skills through experimental design and analysis, which is consistent with findings by Pritasari et al. (2021). Additionally, hands-on practice was acknowledged as beneficial for improving laboratory skills, with a mean of 3.64, and confidence in conducting experiments safely received a mean score of 3.53.

However, students expressed a neutral stance on applying theoretical knowledge to practical tasks with a mean of 3.64 indicating a need for better integration of theory and practice (Arnejo, B., 2021). The indicator regarding seeking additional training opportunities scored 3.92, showing a proactive approach among students, while independent work in the lab received a neutral rating of 3.27, suggesting room for improvement in this area. Finally, troubleshooting problems during experiments had the lowest mean score of 3.02, indicating a need for enhanced support in developing these skills.

Overall, the level of laboratory exposure in terms of skills development had an overall mean of 3.63 students perceive high exposure to skills development, strategies are needed to improve specific areas such as troubleshooting and independent work.

**Table 4. Summary of Laboratory Exposure in terms of Self-Awareness, Engagement in Laboratory Activities, and Skill Development.**

| Sub-Variables | Mean | Descriptive Rating | Qualitative Interpretation |
|---|---|---|---|
| Engagement in Laboratory Activities | 3.82 | Agree | High |
| Safety Awareness | 3.77 | Agree | High |
| Skill Development | 3.63 | Agree | High |
| Overall Mean | 3.74 | Agree | High |

Table 4 summarizes the level of laboratory exposure of learners in general chemistry. As shown in the table Engagement in Laboratory Activities has the highest mean of 3.82. Followed by Safety Awareness with a mean of 3.77. Meanwhile, Skills Development has the lowest mean of 3.63. Generally, the overall mean of laboratory exposure is 3.74. The table implies that learners have a high level of laboratory exposure.

This study's results support Asiyai, A., (2023) finding that active engagement in laboratory activities significantly enhances students' self-awareness and practical skills, leading to higher overall performance in scientific education. This aligns with the mean score of 3.82 for engagement, indicating a strong agreement among participants regarding the importance of hands-on experiences in laboratories. Additionally, a report from the World Health Organization (2024) indicates that safety awareness in educational settings is crucial for effective learning. Their findings suggest that environments promoting safety led to better engagement and skill acquisition, correlating with the mean score of 3.77 for safety awareness.

Furthermore, the overall mean of 3.74 reflects this trend of positive outcomes associated with laboratory exposure. Supported the PISA assessments result (2022) that skill development is fostered through structured laboratory experiences, as students who engage actively in such settings tend to perform better academically.

### *3.2 Conceptual Retention of Learners*

The level of retention of the learners, particularly in Kalilangan National High School, is presented in Table 5-7. The table shows the indicators, mean scores, descriptive rating, and qualitative interpretation. Every retention domain with its corresponding indicators was discussed and interpreted individually.

### *3.2.1. Understanding of Core Concept*

The level of retention in the aspect of understanding the core concept. The highest mean scores were observed for understanding chemical bonding (4.08) and the periodic table (3.87), both categorized as high retention. This aligns with findings from Oludipe, B., Owodunni, S.A.,& Awolo, B.O, (2021) which emphasize the importance of foundational concepts in chemistry, where students who grasp core ideas tend to perform better academically and retain knowledge more effectively over time. The lowest mean was recorded for explaining fundamental principles (2.92) and thermodynamics (2.86), both categorized as moderate retention. This highlights a potential area for instructional improvement, as students may lack the necessary connections between concepts to fully understand them. A research study by King, S. et.al, (2019) indicates that integrating contextual learning can enhance comprehension and retention of complex topics like thermodynamics.

Overall, the level of retention in the aspect of understanding of core concepts in general chemistry had an overall mean of 3.35 with a descriptive rating of neutral this indicates that while there is some level of understanding among learners regarding core chemistry concepts, there is significant room for enhancement in teaching methods and student engagement strategies to improve overall retention. This result is supported by the study of Oludipe et.al (2021) students who engage in active learning strategies, such as problem-solving tasks, show improved long-term retention, and implementing collaborative learning environments can improve retention rates of students.

### *3.2.2. Application of Knowledge*

The level of retention in the aspect of application of knowledge. Mean scores of conceptual retentions in terms of the application of knowledge The highest-rated indicator is "I can conduct experiments following safety protocols" with a mean of 3.88. This indicates that students are relatively confident in applying knowledge related to lab safety, which is a crucial aspect of chemistry education. This aligns with previous studies that emphasize the importance of safety in science education and the development of responsible practices in laboratory settings (Fu, D., Yan,P., & Zhu, K. 2023). Ensuring students are well-versed in safety protocols not only enhances their practical skills but also helps build a foundation for more advanced scientific learning. Another finding is that learners reported moderate success in connecting chemistry concepts to other scientific fields, with a mean score of 3.64. The ability to integrate chemistry with other disciplines reflects a deeper understanding of the subject and its relevance in real-world applications. This finding is consistent with research by Roehrig, G. (2023), who found that interdisciplinary teaching approaches in chemistry can enhance students' ability to apply knowledge across fields, promoting a more comprehensive understanding of science.

However, the least-rated indicators, including "understanding how to manipulate variables in experiments" with a mean of 3.19 and "designing an experiment to test a hypothesis in chemistry" with a mean of 2.93, suggest that students face challenges in applying more complex experimental techniques. These lower scores indicate areas for improvement, as students may struggle with the more technical aspects of experimental design. This observation is consistent with findings from Kranz et al. (2023), who reported that students often have difficulty understanding experimental design and manipulating variables, which are key skills in scientific inquiry. These findings underline the importance of providing more hands-on, practical opportunities to engage with the process of experimental design, as well as focusing on the critical thinking skills required to manipulate variables effectively.

The conceptual retentions in terms of the application of knowledge had an overall mean of 3.43, with a descriptive meaning of neutral and indicating moderate retention of general chemistry concepts. This implies that students can recall and apply the chemistry concepts to a certain extent, but there is significant room for improvement.

### *3.2.3. Retention and Recall*

The level of retention in the aspect of retention and recall. Mean scores of conceptual retentions in terms of retention and recall. The highest-rated indicator, "I often teach others what I've learned in chemistry, which helps me remember it better," with a mean of 3.98, underscores the benefits of peer teaching and collaborative learning. Research

supports the idea that teaching others enhances conceptual understanding and retention. According to Jarrett (2018), the act of teaching others encourages students to organize and clarify their thoughts, making the learned material more memorable. Similarly, teaching integrates active engagement and retrieval practice, both of which are critical for improving retention. The second-highest indicator, "I frequently review my notes from chemistry lessons," with a mean of 3.85, highlights the role of repeated exposure and review in memory retention. Dunlosky et al. (2019) emphasize that reviewing notes and employing distributed practice—spreading study sessions over time—significantly improves long-term recall. This finding suggests that encouraging students to consistently revisit their notes can enhance their mastery of chemistry concepts. Conversely, the least-rated indicators, "I can recall definitions of important chemistry terms easily" (mean = 3.36) and "I use mnemonic devices to aid my memory in chemistry topics" (mean = 3.31), reveal potential areas for instructional improvement. The descriptive meaning of "neutral" for these indicators suggests variability in students' confidence and effectiveness in using these strategies. Mnemonic devices are well-documented as effective tools for memory enhancement (Siagian et al., 2023), yet their underutilization might indicate either a lack of familiarity or difficulty applying them in the context of chemistry.

The level of conceptual retention in terms of recall and retention in general chemistry had an overall mean of 3.64, indicating an overall high level of retention among learners. Its descriptive interpretation of "agree," suggests that students generally retain chemistry concepts effectively. The results imply that instructional strategies should promote active learning techniques, such as teaching others and consistent review. Additionally, there is a need to integrate explicit instruction on mnemonic devices and their applications in chemistry. Results suggest that teachers might consider modeling the use of mnemonics during lessons or incorporating activities that encourage students to create and share their own mnemonics. Furthermore, activities that explicitly connect chemistry terminology to real-world applications could improve students' ability to recall definitions.

**Table 8. Summary of Learners' Conceptual Retention in the Aspect of Understanding of Core Concepts, Application of Knowledge and**

| Indicators | Mean | Descriptive Rating | Qualitative Interpretation |
|---|---|---|---|
| Retention and Recall | 3.64 | Agree | High |
| Application of Knowledge | 3.43 | Neutral | Moderately High |
| Understanding of Core Concepts | 3.35 | Neutral | Moderately High |
| Overall Mean | 3.47 | Neutral | Moderately High |

Table 8 summarizes the level of retention of learners in general chemistry. As shown in Table 8 retention and recall had the highest mean score of 3.64, with a descriptive rating of "Agree" and a qualitative interpretation of "High." This implies that learners demonstrate strong abilities to retain and recall information. Studies have emphasized the importance of engaging learning strategies, such as active recall and spaced repetition, in improving retention rates (Brown et al., 2014). While application of knowledge scored 3.43, receiving a "Neutral" descriptive rating and a "Moderately High" qualitative interpretation. This indicates that learners are moderately capable of applying their knowledge to practical or real-world scenarios. Research suggests that while traditional teaching methods focus heavily on content delivery, incorporating problem-based learning and real-world tasks can significantly enhance students' ability to apply knowledge (Hmelo-Silver, 2004). The lowest score of 3.35, categorized as "Neutral" and "Moderately High," pertains to understanding core concepts. This result suggests a potential gap in learners' foundational understanding, which could hinder their overall academic progress.

The overall mean of 3.47 reflects a need for balanced and effective teaching strategies to improve learners' conceptual retention, particularly in the areas of applying knowledge and understanding core concepts. Inquiry-based learning, active engagement, and integrating technology are promising approaches to address these challenges. These findings are consistent with research that emphasizes the need for student-centered and experiential learning

methods to enhance science education outcomes (Dzaiy, A.H.S. & Abdullah, S.A., (2024).

**Table 9. Correlation Analysis between laboratory exposure and learners' retention**

| | | Laboratory Exposure | Learners' Retention |
|---|---|---|---|
| Laboratory Exposure | Pearson Correlation | 1 | .522(**) |
| | Sig. (2-tailed) | | .000 |
| | N | 85 | 85 |
| Learners' Retention | Pearson Correlation | .522(**) | 1 |
| | Sig. (2-tailed) | .000 | |
| | N | 85 | 85 |

** Correlation is significant at the 0.01 level (2-tailed).

The correlation analysis presented in Table 9 investigates the relationship between laboratory exposure and learners' retention. The results demonstrate a statistically significant positive correlation, as indicated by a Pearson correlation coefficient r=.522 and a p-value of .000. This suggests that as laboratory exposure increases, learners' retention also tends to improve.

The Pearson correlation coefficient r value of .522 indicates a moderate positive relationship between laboratory exposure and learners' retention. This means that while laboratory exposure does not completely determine retention, it is a substantial contributing factor. The significance level p=.000 indicates that the probability of this result occurring by chance is extremely low, confirming the reliability of the relationship.

These findings imply that laboratory exposure is an important component of science education and has a meaningful impact on learners' ability to retain information. Laboratories offer hands-on experiences that allow students to engage with scientific concepts more actively, reinforcing their understanding and memory of the material. This aligns with existing research emphasizing active learning strategies, including laboratory activities, are more effective than traditional lectures in promoting retention and comprehension (Freeman et.al 2014).

## 4. CONCLUSION

This study highlights the fundamental role of laboratory exposure in enhancing learners' conceptual retention in general chemistry. The findings reveal a significant correlation between hands-on laboratory experiences and learners' ability to retain and apply complex concepts. While learners demonstrate high engagement and awareness in laboratory settings, the research identifies critical areas for improvement, including familiarity with safety protocols, development of troubleshooting skills, and a deeper understanding of challenging topics. The gaps in safety awareness highlight the need for comprehensive safety training programs, encompassing hands-on practice with safety tools and regular safety drills. Addressing these gaps will not only improve learners' confidence but also ensure a secure and productive learning environment. Moreover, fostering initiative and problem-solving skills requires a shift towards inquiry-based and project-based learning strategies. These approaches can empower students to take ownership of their learning, collaborate effectively, and build essential leadership and troubleshooting capabilities. The study also emphasizes the importance of connecting theory to practice through contextual learning and real-world applications. This interdisciplinary approach can significantly enhance learners' ability to understand and retain complex concepts by making chemistry more relatable and engaging.

## 5. RECOMMENDATION

The demonstrated positive link between laboratory exposure and retention reinforces the necessity for well-equipped laboratories and structured, inquiry-based activities that complement theoretical instruction. The Department of Education in the Philippines must prioritize investments in functional laboratory resources and teacher training to provide a rich, hands-on learning environment that supports conceptual understanding and long-term retention. Thus, laboratory exposure is a critical component of effective chemistry education. By addressing gaps in safety, engagement, and teaching methodologies, educators can create an enriched learning experience that not only bridges

skill gaps but also fosters deeper understanding and academic success in general chemistry.

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