Contextualized Learning Packet Anchored in the Tuba-Making: Effects on Engagement and Conceptual Understanding of Chemical Reactions among Challenged Learners

Hubert Jason T. Matrido[1] & Douglas A. Salazar, Ph.D.[2]

[1]Ph.D. Student, Mindanao State University-Iligan Institute of Technology, Department of Science and Mathematics Education, 9200, Philippines

[2]Professor, Mindanao State University-Iligan Institute of Technology, Department of Science and Mathematics Education, 9200, Philippines

DOI: https://dx.doi.org/10.47772/IJRISS.2025.91100563

Received: 09 December 2025; Accepted: 15 December 2025; Published: 24 December 2025

ABSTRACT

Tuba making, a traditional Filipino coconut wine, was integrated into the development of a contextualized learning packet on chemical reactions. This study investigated the effectiveness of the developed learning packet anchored in the tuba-making process on the engagement level and conceptual understanding of chemical reactions among academically challenged Grade 10 learners through a pretest-posttest quasi-experimental research design. The Wilcoxon signed-rank test result revealed that the engagement level of the learners significantly improved after the intervention (p=.000-.001, r=0.60-.075). In terms of conceptual understanding, the pretest scores were comparable among the groups. After using the contextualized learning packet, the posttest scores demonstrated a substantial improvement in both experimental groups compared to the control group. The data was found to be non-normally distributed through the Shapiro-Wilk test and non-parametric tests were employed. The Wilcoxon signed-rank test confirmed the statistically significant improvements within the group (p=.000-.003), with a large effect size. Kruskal-Wallis analysis demonstrated significant differences among the groups (H=15.491, p=.000). The post-hoc comparisons showed that the experimental groups outperformed the control group. No significant difference was observed in the two experimental groups. The contextualized learning packet was highly acceptable and highly usable in terms of its alignment with curriculum standards, appropriateness to learners' understanding, and effectiveness in explaining chemical reactions, particularly through tuba making. However, minor improvements may be done to the organization of the activities and accommodation of the material to the diverse needs of the students.

Key Words: Contextualized Teaching, Chemical Reactions, Learning Packets, Tuba Wine-making

INTRODUCTION

Background of the Study

Chemistry is considered one of the indispensable branches of science. Mandal (2023) noted that it is relevant in the fields of agriculture, industry, and medicine, which makes it useful to real-world needs. Additionally, it provides basic chemical principles necessary to discover new things. As the central science, chemistry promotes an interdisciplinary approach among sciences (Bertozzi, 2015). It links all other fields to further understand complex chemical concepts, promoting chemical literacy (Moju et al., 2025). Chemistry remains a challenging subject, especially at the secondary level, despite its importance and relevance.

Kausar et al. (2022) revealed that learners encounter learning difficulty due to the complexity of chemistry content and assessment strategies. Pratomo (2025) added that scientific language, mathematical skills, teachers' competence, and learners' lack of interest are some of the factors that contribute to students' learning difficulty. In the Philippines, these observations are similar, as secondary learners often struggle due to

inadequate instructional resources (Garingo & Cajucom, 2022), lack of laboratory apparatuses and equipment (Mangarin & Macayana, 2025), complexity of scientific concepts (Ortencio et al., 2025), and traditional approaches (Ho et al., 2024) that may impede learners' engagement and conceptual understanding of chemistry concepts.

Filipinos' difficulty in science is reflected in the international assessments, such as the Program for International Student Assessment (PISA) and the Trends and International Mathematics and Science Study (TIMMS). Among the 81 participating countries, the Philippines got the 79th rank, indicating poor performance of Filipino learners in science in terms of literacy, problem-solving, and critical thinking skills (OECD, 2023). On the other hand, the score of the Philippines in science was 249, making it the lowest out of 58 participating countries during the TIMMS (2019) (Magas, 2023). With these dismal results, Acido and Caballes (2024) recommended that the Philippine educational sectors must establish focused interventions and provide cutting-edge pedagogical strategies to improve the country's standard of education.

Filipino students have been doing poorly in school, especially when it comes to learning difficult chemistry topics like chemical reactions, which require combining symbolic representation, understanding, and quantitative reasoning. Studies revealed that secondary learners demonstrate low mastery in learning the types of chemical reactions, examples of chemical reactions, and balancing equations (Jariun et al., 2025). Similar results were obtained in the study of Verangel and Prudente (2022), where students initially had poor conceptual understanding in balancing chemical equations, as shown in the pre-test mean score of 4.2 out of 10, which indicates learners' difficulty in visualizing the chemical concepts. The nature of the task and the learners' training level can influence their reasoning on chemical reactions (Yan & Talanquer, 2015). These studies indicate that learners' difficulty is often rooted in abstract and theoretical manners, where chemistry lessons lack meaningful links to learners' everyday experiences. Hence, contextualized instruction is a significant approach, which bridges abstract chemical concepts to students' real-life contexts (Mundy & Nokeri, 2024).

Contextualization is an approach characterized by the integration of learners' everyday life experiences and prior knowledge in learning a new concept (Tshojay & Giri, 2021). Making connections between chemical principles and learner's interests promotes learning in chemistry (Webster, 2023). Several studies revealed various ways of incorporating the approach, including its impact on students' engagement level and understanding. Ho et al. (2024) employed CLEAR (chemistry learning via experiential academic reflection) to contextualize storytelling as a pedagogical approach in learning general chemistry. Though learners' confusion arises due to the unfamiliarity of the approach, students are able to see the connection between chemistry concepts and real-life contexts, resulting in an increase in students' engagement level. Similarly, Malagday et al. (2024) confirmed that contextualized lessons incorporated with multimedia improve learners' academic performance, interest, engagement, and learning experience. For instance, the study of Salamat (2024) showed a significant difference in learners' performance, from 62.50% to 90.60%, through a contextualized e-learning module. Contextualized learning packets have also been explored and developed in teaching science concepts. Several studies developed contextualized learning packets for the following topics: Ecosystems for Grade 7 students (Manseguiao et al., 2025), Biodiversity for Grade 10 Learners (Domato et al., 2024), and Inequalities in Triangle for Grade 8 Learners (Hadji Said et al., 2024). These studies demonstrated not only how a contextualized approach impacts students' learning, but can also how it can be incorporated into various instructional strategies.

In contextualizing chemistry lessons, local practices may be integrated into the curriculum, such as tuba making, which is a cultural and local practice in Eastern Visayas, particularly in Leyte (Agaton, 2022). Traditionally, the making of tuba starts with the gathering of coconut sap placed in a bamboo tube. It is then mixed with barok, tannin-rich bark obtained from mangrove trees. The mixture is sealed in a container until the fermentation process starts (Ongy & Molleno, 2024). Tuba is usually prepared during special occasions like annual fiesta folk celebrations, baptisms, or even simple gatherings. It is also considered a cultural artifact. Prior to colonization, tuba symbolized pride and resistance and was consumed during shamanic ceremonies (Woolsey, 2023). Aside from its cultural relevance, tuba making is also considered a source of livelihood in Leyte (Germo, 202; Ongy and Molleno, 2024). These highlight the practical importance of tuba making to the

community, which makes it relevant to be incorporated in formal learning as students engage more in a context that is familiar and meaningful to them.

Tuba making contains several chemical processes, such as pH changes, ethanol formation, and fermentation (Khadka et al., 2024). The freshly gathered coconut sap contains high amounts of sucrose, glucose, and fructose with a neutral pH (6.0-7.0) (Saraiva et al., 2023). Its sugar content decreases as time goes by due to the conversion of sugar to ethanol. Over time, its ethanol content progresses with an alcohol concentration of 10-13%, depending on how it is stored (Gregorio et al., 2020). On the other hand, the pH and acidity are other important parameters in tuba wine-making. During the fermentation, the pH declines as organic acids like acetic and lactic acids are formed. Its pH level may range from 3.7 to 2.8, thereby increasing the acidity of tuba (Melgar et al., 2019). This data is consistent with the study of Khadka et al. (2024), confirming that as acidity increases, the pH level declines.

Though traditional tuba making has scientific significance, this local practice is rarely integrated into the secondary school chemistry curriculum, resulting in a mismatch of classroom learning and local experiences. Moreover, a thorough literature survey revealed that there is no published study that has yet been conducted on the use of the tuba-making process as the main input in discussing chemical reactions. Thus, this study implemented a contextualized learning packet based on the tuba-making process to determine its effects on the engagement levels and conceptual understanding of chemical reactions among academically challenged Grade 10 learners.

Objectives of the Study

The study was conducted to investigate the effects of the contextualized learning packet developed for the tuba-making process on the engagement level and conceptual understanding of chemical reactions among academically challenged Grade 10 learners. Specifically, it sought to:

1. Determine the learners' engagement level and conceptual understanding of chemical reactions before and after using the contextualized learning packet;

2. Assess the difference in mean scores of learners' engagement level before and after using the contextualized learning packet;

3. Assess the difference in mean scores of learners' conceptual understanding of chemical reactions before and after using the contextualized learning packet; and

4. Evaluate the acceptability and usability of the contextualized learning packet among academically challenged Grade 10 learners.

Hypotheses:

•Ha: There is a significant difference in the mean scores of learners' engagement level before and after using the contextualized learning packet.

•Ha: There is a significant difference in the mean scores of learners' conceptual understanding of chemical reactions before and after using the contextualized learning packet.

MATERIALS AND METHODS

This study employed a pretest-posttest quasi-experimental research design to investigate the effects of the developed contextualized learning packet anchored in the tuba-making process on learners' engagement level and conceptual understanding of chemical reactions among academically challenged Grade 10 learners. This research design measures the dependent variable both before and after the intervention (Stratton, 2019). In this study, the design included two experimental groups, one of whom used the developed contextualized learning packet, while the other was the control group, who were taught with the same content using

conventional instruction. Non-random assignment was utilized due to the schedule constraint of the participants. All groups were given a pre-test to establish baseline data on learners' engagement levels and conceptual understanding of chemical reactions. The post-test was then administered after the intervention to determine its effects.

The following was the structure of the pre-test post-test quasi-experimental design used in this study:

$$\frac{O_1 \quad X \quad O_2}{O_1 \quad - \quad O_2}$$

where:

O_1 refers to the observations made during the pretest measures. Both groups were given the Conceptual Understanding Questionnaire as pretest measure.

X was the treatment to assess the effects of the developed contextualized learning packet anchored in the tuba-making process on learners' engagement level and conceptual understanding of chemical reactions. The experimental groups were taught using the developed contextualized learning packet, while the control group learned chemical reactions through conventional instruction.

O_2 were the observations made during the post-test. Both experimental and control group were given with the Conceptual Understanding Questionnaire as post-test measures. The results of the pre-test and post-test within and between groups were compared to arrive at findings on the effect of the intervention.

The participants of this study were the selected Grade 10 learners of Alangalang National High School (ANHS) in Alangalang, Leyte, Philippines. The selection was done through purposive sampling with the following criteria: a Grade 10 learner who is officially enrolled in the academic year 2025-2026, taking a science subject, whose previous science grade was below 85, and who is willing to participate in the study. Learners who were recommended by their science teacher and that may benefit from the study were also considered.

In this study, the term "academically challenged learners" refers to students whose academic performance is below the expected mastery level. According to the Department of Education's Policy Guidelines on Classroom Assessment for the K to 12 Basic Education Program (DepEd Order No. 8, s. 2015), the learners whose grade is below 85 may demonstrate understanding of the concepts. However, their performance may be insufficient to master the learning competencies, resulting in poor retention and comprehension. The poor understanding of learners is associated with their weak academic performance across subject areas (Madrid et al., 2025). These cognitive challenges of students result in difficulty in retaining and applying even previously taught concepts (Department of Education Region VIII, 2022). Thus, an intervention is necessary to address these challenges.

On the other hand, three sections, all under the guidance of the same science teacher. A total of 60 students, with 20 learners from each section, qualified as participants of the study. These learners were considered as academically challenged learners due to their prior science performance and teacher's recommendations, establishing homogeneity.

This study used different research instruments to determine the effects of the contextualized learning packet anchored in the tuba-making process on learners' engagement level and conceptual understanding of chemical reactions among Academically Challenged Grade 10 learners. To assess the learners' engagement level, a four-point Likert scale was used. The instrument underwent expert validation and obtained a Content Validity Index (CVI) rating of 3.50 out of 4.0, and demonstrated excellent internal consistency with Cronbach's Alpha of 0.94. Furthermore, the acceptability and usability instruments, respectively, acquired a CVI rating of 3.67 and 3.71 and a Cronbach's alpha of 0.96 and 0.93.

The conceptual understanding questionnaire was composed of a 30-item multiple-choice test focusing on chemical reactions. Each question contained four choices aligned with different cognitive levels of Bloom's taxonomy. The instrument was validated by experts, obtaining a CVI of 3.59 out of 4.0. The instrument also obtained a reliability coefficient of 0.8280 for the Kuder-Richardson Formula 20 (K-20), which suggests a high internal consistency. Item analysis was done to evaluate the quality of each question and to ensure its alignment with the research objectives. The test's difficulty index was 0.4226, which indicates an average level of difficulty. Additionally, the discrimination index of the test has a value of 0.4405, which suggests it is highly discriminating and distinguishes between the low- and high-performing learners. Distractor analysis was also conducted to improve the clarity and evaluate the effectiveness of the distractors in the questionnaire (Thompson, 2021).

On the other hand, the developed contextualized learning packet on chemical reactions anchored in the tuba making process was utilized as the main intervention in this study. The learning material was the output of the researchers' previous study on the Development of Contextualized Learning Packet on Chemical Reactions Anchored in the Ethnochemistry of Tuba Wine-Making. The developed contextualized learning packet obtained an overall average mean of 3.95, which is rated as very satisfactory, from seven in-service science teachers. The acceptability and usability of the material were also assessed and found to be acceptable and useful. Hence, the contextualized learning packet can be used for classroom purposes.

Conceptual Understanding Questionnaire. This instrument is a 30-item multiple-choice test to assess learners' conceptual understanding of chemical reactions, particularly on symbolizing chemical reactions, types of chemical reactions, and balancing chemical equations. It was administered as pre-test and post-test to both control and experimental groups.

Learners' Engagement Level Questionnaire. This is a 10-item four-point Likert scale that was used to assess learners' engagement level before and after the intervention.

Contextualized Learning Packet. This contains contextualized-based readings anchored in tuba-making process on chemical reactions, particularly on symbolizing chemical reactions, types of chemical reactions, and balancing chemical equations. Each topic is composed of contextualized readings grounded in tuba-making process, exercise, hands-on activity, guide questions, self-check. The contextualized learning packet also includes pre-test and post-test aligned with the learning competencies in the DepEd curriculum guide.

Acceptability Instrument. This is a four-point Likert scale used by Grade 10 learners to evaluate the acceptability of the developed contextualized learning packet anchored in tuba-making process.

Usability Instrument. This is a four-point Likert scale to be used by Grade 10 learners to evaluate the usability of the contextualized learning packet developed in the tuba-making process.

The data-gathering procedure underwent three (3) phases: the pre-implementation, implementation, and post-implementation phase to systematically investigate the effects of the developed contextualized learning packet anchored in the tuba-making process on learners' engagement level and conceptual understanding of chemical reactions among academically Challenged Grade 10 learners.

Phase 1: Pre-implementation Phase

This phase was intended for the development of research instruments, the request of permission to conduct the study, and pre-test administration. First, the research instruments, including the learners' engagement level questionnaire, the conceptual understanding questionnaire, and the acceptability and usability questionnaire, were finalized and evaluated by three subject matter experts with at least master's degree holders. After the revisions and incorporation of suggestions, these instruments were pilot tested on 50 Grade 10 learners who were not part of the study for validity and reliability. Second, a letter of request from the course professor prior to conducting the study was secured. A separate letter was given to the principal and relevant authorities of Alangalang National High School. For participants below 18 years old, parental/guardian consent and student assent were asked for ethical considerations.

Through purposive sampling, three sections handled by the same science teacher were included. A total of 60 students, with 20 learners from each section, qualified as participants of the study. These learners were considered as academically challenged learners due to their prior science performance and teacher's recommendations, establishing homogeneity. Then, an orientation about the study was done for all qualified participants. A total of 60 learners had taken the engagement level and conceptual understanding test, which assess students' initial engagement level and conceptual understanding of chemical reactions, respectively. The pretest was administered one week prior to the implementation of the intervention. In addition, the participants were randomly assigned either control or experimental based on intact class sections. Two sections were assigned as the experimental group, who were taught with the developed contextualized learning packet, while one section was assigned as the control group and taught using the traditional way of teaching. The data obtained in this phase served as a baseline in investigating the effects of the intervention.

Phase 2: Implementation Phase

In the implementation phase, the experimental group used the developed contextualized learning packet on chemical reactions anchored in the *tuba*-making process, while the control group was taught chemical reactions using the traditional approach. The contextualized learning packet contained contextualized-based readings anchored in the tuba-making process on chemical reactions, particularly on symbolizing chemical reactions, types of chemical reactions, and balancing chemical equations. Each topic was composed of contextualized readings grounded in the *tuba*-making process, exercise, hands-on activity, guide questions, and self-check. The contextualized learning packet also contained pre-test and post-test aligned with the learning competencies in the DepEd curriculum guide.

The implementation was done over three meetings, one meeting (one hour) for each subtopic of chemical reactions for the experimental groups. During this phase, the researchers facilitated the lesson, guided the learner in performing the activities, and monitored learners' involvement and engagement. On the other hand, the control group was also taught the same topic using a traditional approach for over three meetings (one hour per meeting) in a separate schedule. The outputs of the learners were recorded to track their performance.

Phase 3: Post-implementation Phase

The post-test was administered one week after the implementation. Both the experimental and control groups had taken the post-test to determine the changes in learners' conceptual understanding of chemical reactions. The learners' engagement test, on the other hand, was administered to the experimental group to determine the effects of the contextualized learning packet developed on their engagement level. A post-survey was administered to the participants to assess the acceptability and usability of the developed learning packet on chemical reactions anchored in the tuba-making process. However, only 16 students in the first experimental group, 15 in the second experimental group, and 13 in the control group completed the pre-test and post-test due to attrition. Learners who were unable to complete the post-test were excluded from the analysis. Analyses were conducted with remaining participants, and potential attrition bias was considered when interpreting engagement and conceptual understanding outcomes. Measures such as consistent instructional delivery and controlled assessment procedures were implemented to minimize biases and strengthen the validity of the findings

The data gathered in this study were analyzed qualitatively and quantitatively. Descriptive statistics, particularly mean, median, standard deviation, frequency, and percentage, will be used to analyze the learners' engagement level and conceptual understanding of chemical reactions before and after using the developed contextualized learning packet anchored in the *tuba*-making process. Similarly, the acceptability and usability of the developed learning packet will also be analyzed through mean ratings and frequency distributions.

On the other hand, a non-parametric test was used to assess the mean score difference of learners' engagement level and conceptual understanding of chemical reactions before and after the intervention, considering that the data is not normally distributed. To assess the significant difference between the pre-test and post-test

scores within the same group, the Wilcoxon Signed-Rank Test was employed. To compare the post-test scores of the control and experimental groups, the Kruskal-Wallis H test was utilized.

In conducting this study, the well-being and safety of the participants were treated with utmost attention. A formal letter was given to the principal of Alangalang National High School to ask permission to carry out the research within the school. Upon approval, a separate letter was prepared for the coordinators and advisers of each grade level. An informed consent was provided to the participants after explaining the nature and purpose of the study. For those learners below 18 years old, parental/guardian consent was asked prior to their participation in the study. Their participation is completely voluntary, and they have the right to withdraw at any time without any consequences. The respondents' personal information, assessment results, and outputs were kept with utmost confidentiality and for research purposes only.

Furthermore, the content of the contextualized learning packet was carefully reviewed, ensuring its appropriateness and non-intrusiveness to avoid any psychological harm and discrimination. In case of emotional or physical discomfort during the conduct of the study, the respondents were informed that they have the right to stop participating in the study immediately. Contingency measures were done should any research-related injuries arise.

RESULTS AND DISCUSSION

This chapter discusses the results of the study. The data obtained from the Likert scale and multiple-choice test instruments were processed and analyzed to arrive at the research findings.

Learners' Engagement Level and Conceptual Understanding of Chemical Reactions Before and After Using the Contextualized Learning Packet

The engagement level of the participants was measured through the use of a four-point Likert scale, which contains the behavioral, cognitive, social, and emotional engagement domains. The engagement test was administered to the learners before and after using the contextualized learning packet on chemical reactions anchored in the *tuba*-making process.

The conceptual understanding of students on chemical reactions, on the other hand, was evaluated through the use of a 30-item multiple-choice test. The test includes the questions on symbolizing chemical reactions, types of reactions, and balancing chemical equations. The instrument was administered to both control and experimental groups.

Table 1 Learners' Engagement Level Before Using the Contextualized Learning Packet (N=31)

Statement	**4 (%)**	**3 (%)**	**2 (%)**	**1 (%)**	**M**	**SD**
1. I think I will exert effort to accomplish all the activities in the contextualized learning packet.	6 (19.4%)	9 (29%)	12 (38.7%)	4 (12.9%)	2.55	0.96
2. I think I will pay attention while working with the contextualized learning packet.	7 (22.6%)	14 (45.2%)	8 (25.8%)	2 (6.5%)	2.84	0.86
3. I think I will try to understand the chemical reactions behind *tuba* making using the contextualized learning packet.	8 (25.8%)	10 (32.3%)	10 (32.3%)	3 (9.7%)	2.84	0.93

4. I think I will be interested in the examples in the contextualized learning packet, particularly on the process of *tuba* making.	10 (32.3%)	14 (45.2%)	7 (22.6%)	0	3.10	0.75
5. I think I will feel encouraged to learn and explore more about chemistry lessons using the contextualized learning packet.	5 (16.1%)	12 (38.7%)	7 (22.6%)	7 (22.6%)	2.48	1.03
6. I think I will enjoy learning chemistry through the contextualized learning packet.	6 (19.4%)	17 (54.8%)	8 (25.8%)	0	2.94	0.68
7. I think I will discuss the activities in the contextualized learning packet with my classmates.	2 (6.5%)	9 (29.0%)	14 (45.2%)	6 (19.4%)	2.23	0.84
8. I think I will ask my teacher if I'm confused while using the contextualized learning packet.	3 (9.7%)	16 (51.6%)	11 (35.5%)	1 (3.2%)	2.68	0.70
9. I think I will ask my classmates how will I help during group activities.	4 (12.9%)	8 (25.8%)	9 (29.0%)	10 (32.3%)	2.19	1.05
10. I think I will feel guided by my teacher while using the contextualized learning packet.	12 (38.7%)	10 (32.3%)	9 (29.0%)	0	3.16	0.82

Note. 4-Very High Engagement; 3-High Engagement; 2-Moderate Engagement; 1-Low Engagement; M-Mean; SD-Standard Deviation

Table 1 shows the initial engagement level of the academically challenged Grade 10 learners before using the developed contextualized learning packet on chemical reactions anchored in the tuba making process. As observed, the mean scores ranged from 2.19 to 3.16 on the four-point Likert scale, demonstrating moderate to high engagement levels. The highest engagement among the participants was the guidance of the teacher (M=3.16, SD=0.82) and interest in the culturally connected examples in the material, particularly in the tuba-making process (M=3.10, SD=0.75). On the other hand, the learners' collaboration, which includes the discussion of activities and group tasks was low (M=2.19-2.23). This data indicates less frequent student interaction prior to the use of the contextualized learning packet. These results were consistent with the findings of Li et al. (2021) that most learners lack social interactions, resulting in less participation throughout the class. This low learner engagement is usually associated with the conventional and low task-order tasks of the teachers, indicating the need for an intervention (Reid et al., 2022).

Table 2 Learners' Engagement Level After Using the Contextualized Learning Packet (N=31)

Statement	**4**	**3**	**2**	**1**	**M**	**SD**
1. I exerted effort to accomplish all the activities in the contextualized learning packet.	21(67.7%)	10 (32.3%)	0	0	3.68	0.48
2. I stayed focused while completing the activities in the contextualized learning packet.	20 (64.5%)	11 (35.5%)	0	0	3.65	0.49

3. I tried to understand the chemical reactions behind *tuba* making using the contextualized learning packet.	24 (77.4%)	7 (22.6%)	0	0	3.77	0.43
4. I found the *tuba* making process interesting and relatable in the contextualized learning packet.	28 (90.3%)	3 (9.7%)	0	0	3.81	0.40
5. I was encouraged to learn and explore more about chemistry lessons.	25 (80.6%)	6 (19.4%)	0	0	3.65	0.49
6. I enjoyed learning chemistry through the contextualized learning packet.	23 (74.2%)	8 (25.8%)	0	0	3.71	0.46
7. I discussed the activities in the contextualized learning packet with my classmates.	17 (54.8%)	14 (45.2%)	0	0	3.55	0.51
8. I asked my teacher if I'm confused with the content and activities in the contextualized learning packet.	23 (74.2%)	8 (25.8%)	0	0	3.42	0.50
9. I asked my classmates how could I help them while performing the group activities in the learning packet.	13 (41.9%)	15 (48.4%)	3	0	3.65	0.49
10. I felt guided by my teacher while using the contextualized learning packet.	27 (87.1%)	4 (12.9%)	0	0	3.87	0.34

Note. 4-Very High Engagement; 3-High Engagement; 2-Moderate Engagement; 1-Low Engagement; M-Mean; SD-Standard Deviation

Table 2 demonstrates the level of engagement of the participants who used the developed contextualized learning packet on chemical reactions anchored in the tuba-making process. The mean scores ranged from 3.42 to 3.87 on the four-point Likert scale. It was also notable that no responses were observed on the moderate and low engagement levels. The highest engagement levels were on the learners' feeling of being guided by the teacher (M=3.87, SD=0.34) and learners' interest in tuba making as the main input in discussing chemical reactions, which implies the cultural relevance of the practice in the chemistry lesson. In addition, the majority of the learners showed strong personal engagement, particularly in exerting effort in doing the tasks (67.7%), staying focused on the activities (64.5%), and having fun while learning them (74.2%). The post-survey revealed that the developed contextualized learning packet enhanced learners' engagement. The study of Ho et al. (2024) confirmed that learners' engagement level improved once exposed to context-based and culturally relevant learning activities. Students participate in tasks and accomplish assignments meaningfully if real-world contexts are integrated into chemistry lessons compared to students taught through traditional methods (Demelash et al., 2024). Agwu and Nmadu (2023) added that the use of interactive and cooperative learning strategies may promote engagement among learners.

Table 3 Mean Score Difference of Learners' Engagement Levels Before and After Using the Contextualized Learning Packet (N=31)

Statement	**Pretest Mean ± SD**	**Posttest Mean**	**Mean Difference**	***p-value***	***r***
1. I exerted effort to accomplish all the activities in the contextualized learning packet.	2.55 ± 0.96	3.68 ± 0.48	1.13	.000	0.74

2. I stayed focused while completing the activities in the contextualized learning packet.	2.84 ± 0.086	3.65 ± 0.49	0.81	.000	0.63
3. I tried to understand the chemical reactions behind *tuba* making using the contextualized learning packet.	2.84 ± 0.93	3.77 ± 0.43	0.93	.000	0.67
4. I found the *tuba* making process interesting and relatable in the contextualized learning packet.	3.10 ± 0.75	3.81 ± 0.40	0.71	.000	0.67
5. I was encouraged to learn and explore more about chemistry lessons.	2.48 ± 1.03	3.65 ± 0.49	1.17	.000	0.68
6. I enjoyed learning chemistry through the contextualized learning packet.	2.94 ± 0.68	3.71 ± 0.26	0.77	.000	0.71
7. I discussed the activities in the contextualized learning packet with my classmates.	2.23 ± 0.84	3.55 ± 0.51	1.32	.000	0.75
8. I asked my teacher if I'm confused with the content and activities in the contextualized learning packet.	2.68 ± 0.70	3.42 ± 0.50	0.74	.001	0.61
9. I asked my classmates how could I help them while performing the group activities in the learning packet.	2.19 ± 1.05	3.65 ± 0.49	1.46	.000	0.75
10. I felt guided by my teacher while using the contextualized learning packet.	3.16 ± 0.82	3.87 ± 0.34	0.71	.001	0.60

The mean score difference of learners' engagement level before and after using the contextualized learning packet is shown in Table 3. The differences of mean ranged from 0.71 to 1.46, which implies an increase in the participants' engagement after the intervention. Significant changes were also observed through the Wilcoxon signed-rank test, with the p-values between .000 and .001. The effect size through rank-biserial correlations (r) was also measured. It ranged from 0.60 to 0.75, showing a large effect of the intervention. The integration of contextualized learning through culture-based strategy significantly increased students' engagement (Ferri & White, 2024). Demelash et al. (2024) also discovered that real-world contexts in chemistry lessons enhanced the learners' overall engagement.

Table 4 Comparison of Conceptual Understanding across the Group (Pretest vs. Posttest)

Group	**N**	**Pretest Mean ± SD**	**Posttest Mean ± SD**
Control Group	13	7.23 ± 3.70	12.62 ± 3.80
Experimental Group A	16	7.88 ± 2.96	18.38 ± 3.24
Experimental Group B	15	7.33 ± 3.90	18.13 ± 2.56

The conceptual understanding of chemical reactions across the group is shown in Table 4. As revealed, the pre-test mean scores in all groups were similar. This result implies the comparable baseline of the learners' conceptual understanding of chemical reactions. The control group obtained a pretest mean score of 7.23, with a standard deviation of 3.70. The experimental groups A and B, respectively, had pretest mean scores of 7.88 and 7.33, with standard deviations of 2.96 and 3.90. After using the contextualized learning packet anchored

in the tuba-making process, both the experimental groups demonstrated an increase in the posttest mean scores to 18.38 (Group A) and 18.13 (Group B). This increase in posttest mean scores suggests the use of contextualized learning packet enhanced the learners' conceptual understanding of chemical reactions compared to traditional teaching. The control group also improved to 12.62, with a standard deviation of 3.80. Contextualized tasks significantly enhanced chemistry concepts in comparison to traditional instruction (Gecolea & Amon, 2019). Barrun and Cajurao (2025) noted that learners who are able to receive contextualized lesson demonstrate significant higher posttest scores in terms of conceptual understanding. Such an approach leads to meaningful learning, making abstract chemistry concepts more comprehensible and relatable (Ho et al., 2024).

Table 5 Normality Test Results Across Groups

Pre-test	**Shapiro-Wilk**		
	Statistics	**df**	***p-value***
Control Group	0.858	13	0.036
Experimental Group A	0.841	16	0.010
Experimental Group B	0.865	15	0.028
Post-test	**Statistics**	**df**	***p-value***
Control Group	0.850	13	0.028
Experimental Group A	0.865	16	0.023
Experimental Group B	0.877	15	0.043

Table 5 shows the normality test results of the conceptual understanding of the participants across the groups using the Shapiro-Wilk test. As observed, the control group (W=0.858, p=0.036), experimental group A (W=0.841, p=0.010), and experimental group B (W=0.865, p=0.28) obtained p-values that are less than 0.05. This indicates that the pretest scores across the groups are non-normally distributed. The posttest scores, on the other hand, also violated the assumptions of normality, with p-values less than 0.05 for the control (W=0.850, p=0.028), experimental group A (W=0.865, p=0.023), and experimental group B (W=0.877, p=0.043). Since both the pretest and posttest scores were not normally distributed, nonparametric tests should be employed to analyze the differences among and within groups (Tapio, 2025).

Table 6 Mean Difference in Conceptual Understanding Scores Within the Group (Pretest vs. Posttest)

Group	**N**	**Pretest Mean ± SD**	**Posttest Mean ± SD**	**Mean Difference**	***p-value***	***r***
Control Group	13	7.23 ± 3.70	12.62 ± 3.80	5.39	.003	0.83
Experimental Group A	16	7.88 ± 2.96	18.38 ± 3.24	10.50	.000	0.88
Experimental Group B	15	7.33 ± 3.90	18.13 ± 2.56	10.80	.001	0.88

The mean differences in conceptual understanding scores within the group are shown in Table 6. The control group obtained a mean difference of 5.39. The experimental groups A and B, respectively, had mean differences of 10.50 and 10.80, which indicates an increase of conceptual understanding after using the contextualized learning packet on chemical reactions anchored in the tuba making process. Statistical analysis

was done through the Wilcoxon signed-rank test, showing statistically significant differences, with p-values ranging from .000 to .003, which are less than 0.05. The table also revealed a large effect size through rank-biserial correlation, which implies a large effect of the intervention on the learners' conceptual understanding of chemical reactions. Since the posttest groups' scores were non-normally distributed, the Wilcoxon signed-rank test was used to compare two related samples to identify if significant differences in median ranks exist (Nahm, 2016; Orcan, 2020; Tapio, 2025).

Table 7 Comparison of Learners' Conceptual Understanding of Chemical Reactions Among Groups

Group	**N**	**Pretest Mean ± SD**	**Posttest Mean ± SD**	***Mean Rank (Pretest)***	***Mean Rank (Posttest)***	***H***	***p-value***
Control Group	13	7.23 ± 3.70	12.62 ± 3.80	13.5	13.5		
Experimental Group A	16	7.88 ± 2.96	18.38 ± 3.24	15.0	24.0		
Experimental Group B	15	7.33 ± 3.90	18.13 ± 2.56	14.0	23.0		
Kruskal-Wallis H						**15.941**	**.000**

To determine the differences of learners' conceptual understanding of chemical reactions among groups, the Kruskal-Wallis test was performed as revealed in Table 7. Notably, the mean ranks of the three groups were relatively close. The control group ranked 13.5, while experimental A and B ranked 15.0 and 14.0, respectively. On the other hand, the posttest rank showed a higher ranking, particularly indicating that the participants who received the intervention performed better than the control group. The Kruskal-Wallis test obtained H=15.491, with a p-value of .000, demonstrating a significant difference in posttest scores among the three groups. Hence, the use of contextualized learning packet helped improve learners' conceptual understanding of chemical reactions compared to students taught with traditional methods (Agwu & Nmadu, 2023). In addition, the Kruskal-Wallis test was performed to compare significant differences in the median ranks of the three independent variables in the study (Orcan, 2020; Tapio, 2025).

Table 8 Post-hoc Pairwise Comparisons (Bonferroni) for Posttest Scores

Group	**Z**	**p-value (unadjusted)**	**p-value (Bonferroni Adjusted)**
Control vs. Experimental Group A	-3.464	.001	0.003
Control vs. Experimental Group B	-3.513	0.000	0.000
Experimental vs. Experimental Group B	-0.40	.986	1.000

Table 8 shows the post-hoc pairwise comparison with Bonferroni correction for posttest scores. This was done after the significant Kruskal-Wallis test to identify which among the groups differed in the conceptual understanding of chemical reactions. As revealed in the table, both experimental groups significantly performed better compared to the control group. The comparison of the control group and experimental group A obtained a Z value of -3.464 (unadjusted p-value=0.001, Bonferroni correction=0.003), which indicates the improvement of the experimental group. The comparison between the control group and experimental group B, on the other hand, demonstrated a Z value of -3.513 (unadjusted p-value=0.000, Bonferroni correction=0.000). This further implies the effectiveness of the developed contextualized learning packet on chemical reactions anchored in the tuba-making process. The comparison between the two experimental groups demonstrated a Z value of -0.40 (unadjusted p-value=0.986, Bonferroni correction=1.0). Hence, no

significant difference was observed. The results confirmed the effectiveness of the intervention in enhancing academically challenged learners' conceptual understanding of chemical reactions compared to traditional teaching. Furthermore, the performance of both experimental groups was comparable. The use of developed and validated contextualized lessons significantly improved the learners' conceptual understanding compared to those students taught with the traditional method (Majid & Rahaeti, 2018; Barrun & Cajurao, 2025).

Acceptability and Usability of the Contextualized Learning Packet Among Experimental Groups

The acceptability and usability of the developed contextualized learning packet were also evaluated among learners under the experimental group. The acceptability and usability instruments were administered to the participants who used the contextualized learning packet. These instruments measured how the learning material supported the students' learning, including its alignment to their needs in a classroom setting. This section not only discussed the learners' satisfaction in using the contextualized learning packet but also the practicality, clarity, ease, and the learning material's strength in terms of facilitating conceptual understanding of chemical reactions.

Table 9 The Acceptability of the Contextualized Learning Packet Among Grade 10 Learners (N=31)

Statement	**4**	**3**	**2**	**1**	**M**	**SD**
1. The content of the contextualized learning packet is aligned with what we are learning in Grade 10 science curriculum.	25 (80.6%)	6 (19.4%)	0	0	3.81	0.40
2. The content is appropriate to my level of understanding.	24 (77.4%)	6 (19.4%)	1 (3.2%)	0	3.74	0.51
3. The activities clearly explain the concepts of chemical reactions.	25 (80.6%)	5 (16.1%)	1 (3.2%)	0	3.77	0.50
4. The activities included are relevant and meaningful.	22 (71.0%)	9 (29.0%)	0	0	3.68	0.48
5. The learning packet helps me integrate chemical reactions to real-life situations.	24 (77.4%)	6 (19.4%)	1 (3.2%)	0	3.74	0.51
6. The activities promote critical thinking and problem-solving skills.	23 (74.2%)	7 (22.6%)	1 (3.2%)	0	3.71	0.53
7. The activities encourage me to actively participate in learning.	24 (77.4%)	7 (22.6%)	0	0	3.77	0.43
8. The contextualized learning packet's activities can support the way I learn best.	23 (74.2%)	8 (25.8%)	0	0	3.74	0.44
9. The flow and structure of the contextualized learning packet are clear, logical, and easy to follow.	21 (67.7%)	9 (29.0%)	1(3.2%)	0	3.65	0.55
10. The contextualized learning packet anchored in *tuba* making is recommendable for future chemistry lessons.	26(83.9%)	5(16.1%)	0	0	3.84	0.37

Note. 4-Highly Acceptable; 3- Acceptable; 2-Slightly Acceptable; 1-Not Acceptable; M-Mean; SD-Standard Deviation

The acceptability of the contextualized learning packet is shown in Table 9. The high mean scores across statements confirmed that the intervention was highly acceptable among academically challenged Grade 10 learners. Most of the learners strongly agreed that the material was aligned to the science curriculum (M=3.81, SD=0.40) and suitable to their understanding level (M=3.74, SD=0.51), which implies that the learning packet was objectively aligned to the science curriculum while making it accessible to learners. It was also revealed that the learning material was effective in terms of explaining chemical reactions (M=3.77, SD=0.50), relevant and meaningful (M=3.68, SD=0.48), and promoted authentic learning such as tuba-making integration (M=3.71, SD=0.51). The recommendation of the contextualized learning packet for future lessons in chemistry obtained the highest rating (M=3.84, SD=0.37), indicating the learning material's cultural relevance and instructional importance. These findings are consistent with the study of Gadia (2023), revealing that contextualized and localized learning material that is aligned to the goals of the curriculum is generally acceptable to science teachers. Benedicto et al. (2025) added that a developed and validated learning material is highly acceptable after systematic evaluation of its content, format, and learners' experience.

Table 10 The Usability of the Contextualized Learning Packet Among Grade 10 Learners (N=31)

Statement	**4**	**3**	**2**	**1**	**M**	**SD**
1. The activities found in the contextualized learning packet anchored in *tuba* making are simple and easy to perform.	20(64.5%)	9(29.0%)	2(6.5%)	0	3.58	0.62
2. The instructions are clearly stated in each activity.	22(71.0%)	7(22.6%)	2(6.5%)	0	3.65	0.61
3. The sequence of activities is logically organized.	19(61.3%)	10(32.3%)	2(6.5%)	0	3.55	0.62
4. The design of the activities helps facilitate learners' collaboration and problem-solving.	22(71.0%)	8(25.8%)	1(3.2%)	0	3.68	0.54
5. The objectives of each concept note and activity are clearly stated.	23(74.2%)	7(22.6%)	1(3.2%)	0	3.71	0.53
6. The activity is suitable for different types of learners.	20(64.5%)	10(32.3%)	1(3.2%)	0	3.55	0.62
7. The pictures, diagrams, and illustrations guide me to use the learning packet easily.	27(87.1%)	3(9.17%)	1(3.2%)	0	3.84	0.45
8. The activities in the contextualized learning packet are appropriate for both individual and teacher-assisted lesson.	22(71.0%)	8(25.8%)	1(3.2%)	0	3.68	0.54
9. The sequence of content is developmentally appropriate.	22(71.0%)	7(22.6%)	2(6.5%)	0	3.65	0.61
10. The overall content and design of the contextualized learning packet anchored in *tuba* making are useful and learner-friendly.	25(80.6%)	6(19.4%)	0	0	3.81	0.40

Note. 4-Highly Usable; 3-Usable; 2-Slightly Usable; 1-Not Usable; M-Mean; SD-Standard Deviation

Table 10 shows the usability of the contextualized learning packet on chemical reactions anchored in the tuba-making process among academically challenged learners. Results revealed that the learning packet was highly

usable, with a consistently high mean rating in all statements. The use of contextualized pictures, diagrams, and illustrations obtained the highest mean rating (M=3.84, SD=0.45), which signifies how the visual elements contribute to learners' conceptual understanding of chemical reactions. The overall design and learner-friendliness of the material were also highly rated (M=3.81, SD=0.40), which indicates the usefulness of the overall layout and ease of use. On the other hand, the logical organization (M=3.55) and the material's appropriateness to diverse learners (M=3.55), but these means still fall in the usable category. These results imply that the contextualized learning packet was generally useful to academically challenged learners, but some activities in the material may need improvement in terms of logical organization and accommodation of diverse learners' needs. A well-designed learning material in chemistry, considering clear and relevant instructional activities, becomes usable and improves learners' learning and engagement (Ramli et al., 2025).

CONCLUSIONS AND RECOMMENDATIONS

The initial engagement level of the academically challenged learners was characterized by their strong reliance on the teacher's guidance and interest in the tuba-making process, but they had shown limited engagement in terms of collaboration with their classmates in doing instructional tasks. Such an outcome implies the need for a learning intervention that may promote active participation during class activities. After the intervention, the academically challenged learners demonstrated a high engagement level, particularly on personal involvement, and greater interest with the integration of the tuba-making process in discussing chemical reactions. Through the Wilcoxon signed-rank test, the mean difference of the learners' engagement level was further confirmed to be significant with p-values ranging from .000 to .001, suggesting the significant increase in terms of learners' engagement. Moreover, the rank-biserial correlation revealed a large effect size (r=0.60-0.75), demonstrating how impactful the intervention was to learners' engagement. These results further confirmed the alternative hypothesis of the study that there is a significant difference in the mean scores of learners' engagement level before and after using the contextualized learning packet.

In terms of learners' conceptual understanding, their initial knowledge about chemical reactions was closely similar, indicating comparability among groups. After using the contextualized learning packet, both the experimental groups obtained a substantial increase of scores in the posttest. On the other hand, the control group's posttest scores also showed an observable increase; however, it was noticeably lower compared to the experimental groups. This suggests that the use of contextualized learning packet improves academically challenged learners' conceptual understanding.

The normality of the pretest and posttest scores was also determined through the Shapiro-Wilk test. The results revealed that the p-values across the groups were less than 0.05, indicating that the scores were not normally distributed. The mean score differences within the group's pretest and posttest were also calculated through the use of the Wilcoxon signed-rank test, which is a nonparametric test. Results confirmed the improvements across the groups were statistically significant, with p-values ranging from .000 to .0003. It was also notable to have large effect sizes, indicating the large impact of the contextualized learning packet. With these significant results, the study accepts the alternative hypothesis that there is a significant difference in the mean scores of learners' conceptual understandings of chemical reactions before and after using the contextualized learning packet.

To determine the differences of conceptual understanding across the groups, the Kruskal-Wallis test was used. The result revealed that the posttest scores were significant among the groups (H=15.491, p=.000), confirming that the use of contextualized learning packet enhanced learners' conceptual understanding of chemical reactions compared to those who were taught with the traditional method. Post-hoc pairwise comparison with Bonferroni correction was also performed. This analysis revealed that both of the experimental groups outperformed the control group (p=<.001). Moreover, no significant difference was observed between the two experimental groups, indicating that the impact of the intervention was comparable.

On the other hand, the contextualized learning packet on chemical reactions was highly acceptable and highly usable among academically challenged Grade 10 learners. High mean scores across all indicators were notable. Learners perceived that the learning material was aligned to the curriculum standards, suitable to their level

of understanding, and effective in explaining chemical concepts, particularly the integration of the tuba-making process. The overall design and layout of the learning material further enhanced its usability. However, minor refinements may be done in terms of the organization of the activities in the learning packet and making it more appropriate to diverse kinds of learners.

Future researchers could use the identified findings to create contextualized learning packets that incorporate other culturally relevant local practices into chemistry education. A similar study may be done; however, increasing the number of participants may be considered. The contextualized learning packet may be implemented with other learners to further evaluate its effectiveness in enhancing learners' engagement and conceptual understanding.

ACKNOWLEDGMENT

The author would like to acknowledge the school principal of Alangalang National High School for his approval to conduct this study, the Grade 10 coordinator for the assistance during the respondents' selection, the assigned Grade 10 science teacher for the active support, and the course professor of SED302: Advanced Educational Statistics for the consistent guidance and valuable insights, which greatly contributed to the success of this study.

REFERENCES

1. Acido, J. V., & Caballes, D. G. (2024). Assessing educational progress: A comparative analysis of PISA results (2018 vs. 2022) and HDI correlation in the Philippines. World Journal of Advanced Research and Reviews. Retrieved from https://wjarr.com/content/assessing-educational-progress-comparative-analysis-pisa-results-2018-vs-2022-and-hdi
2. Agaton, S. G. (2022). The Tuba Culture in Leyte, Philippines. Recoletos Multidisciplinary Research Journal. Retrieved from https://rmrj.usjr.edu.ph/rmrj/index.php/RMRJ/article/view/1130
3. Agwu, U., & Nmadu, J. (2023). Students' interactive engagement, academic achievement and self concept in chemistry: An evaluation of cooperative learning pedagogy. Chemistry Education Research and Practice. Retrieved from https://doi.org/10.1039/D2RP00148A
4. Barrun, J., & Cajurao, E. (2025). Development and validation of contextualized lessons in science, technology, and society (STS): Impacts on students' conceptual understanding, science process skills, and attitudes toward science. Pegem Journal of Education and Instruction. Retrieved from https://doi.org/10.47750/pegegog.15.02.04
5. Bertozzi, C. R. (2015). The centrality of chemistry. ACS Central Science. Retrieved from https://doi.org/10.1021/acscentsci.5b00090
6. Demelash, M., Andargie, D., & Belachew, W. (2024). Enhancing secondary school students' engagement in chemistry through 7E context-based instructional strategy supported with simulation. Pedagogical Research. Retrieved from https://www.pedagogicalresearch.com/article/enhancing-secondary-school-students-engagement-in-chemistry-through-7e-context-based-instructional-14146
7. Department of Education. (2015). DepEd Order No. 8, s. 2015: Policy Guidelines on Classroom Assessment for the K to 12 Basic Education Program. Retrieved from https://www.deped.gov.ph/wp-content/uploads/2015/04/DO_s2015_08.pdf
8. Department of Education Region VIII. (2022). Research bulletin: April to June 2022 (Vol. 4, No. 1). Department of Education Region VIII. Retrieved from https://region8.deped.gov.ph/wp-content/uploads/2023/06/Q2-RB_22.pdf
9. Domato, S. A., Salic-Hairulla, M., Dinoro, A., Salazar, D. A., & Adamat, L. A. (2024). Development of contextualized learning activity packets in biodiversity for Grade 10 learners. International Journal of Research and Innovation in Social Science (IJRISS). Retrieved from https://dx.doi.org/10.47772/IJRISS.2024.806166
10. Ferri, J. K., & White, R. (2024). Culturally relevant STEM (CReST): An integrated support curriculum for high school chemistry and world history. Education Sciences. Retrieved from https://doi.org/10.3390/educsci14020182

11. Garingo, A. C., & Cajucom, E. L. (2022). Challenges of junior high school chemistry learners in an enriched virtual mode. International Multidisciplinary Research Journal. Retrieved from https://www.ioer-imrj.com/wp-content/uploads/2023/03/Challenges-of-Junior-High-School-Chemistry-Learners-in-an-Enriched-Virtual-Mode.pdf
12. Gecolea, C., & Amon, M. E. (2019). The use of contextualized activities on acquisition of chemistry concepts in science. International Journal of Research in STEM Education. Retrieved from https://jurnal-fkip.ut.ac.id/index.php/ijrse/index
13. Germo, L. P. (2020). Community-based development plan for small-scale processing of coconut wine (Tuba) in Matalom, Leyte. The University Library, University of the Philippines Los Banos. Retrieved from https://www.ukdr.uplb.edu.ph/etd-undergrad/10761/
14. Gregorio, C., Yu, K., Singson, F., Alas, C., & Balbuena, J. (2020). Towards the establishment of baseline scientific information based on the volatile organic compounds (VOCs) of Philippine traditional alcoholic beverages. The Philippine Journal of Science. Retrieved from https://doi.org/10.56899/149.3A.14
15. Hadji Said, M. G., Oledan, A., Buan, A. T., Luga, M. F., & Saromines, C. C. (2024). Development of contextualized learning packet in inequalities in triangle for Grade 8 learners. International Journal of Scientific Engineering and Science. Retrieved from http://ijses.com/wp-content/uploads/2024/06/146-IJSES-V8N5.pdf
16. Ho, K., Luong, Y., Sherwood, C., & Clark, D. B. (2024). Widening university participation in learning using students' contextualised storytelling in general chemistry. Royal Society of Chemistry. Retrieved from https://pubs.rsc.org/en/content/articlelanding/2024/rp/d4rp00084f/unauth
17. Jariun, A. S., Nabua, E. B., Salic-Hairulla, M. A., Alcopra, A. R., & Fernandez, M. F. (2025). Learners' mastery of competencies in chemical reaction. International Journal of Research and Innovation in Social Science. Retrieved from https://dx.doi.org/10.47772/IJRISS.2025.905000138
18. Kausar, F. N., Ghazala, N., & Haroon, A. (2022). Causes of students' learning difficulties in secondary school chemistry: A study in context of content and assessment strategies. Journal of Positive School Psychology. Retrieved from https://www.researchgate.net/publication/378359674 Causes Of_Students'_Learning_Difficulties In_Secondary School Chemistry_A_Study In Context Of_Content_And_Assessment_Strategies
19. Khadka, N., Acharya, D., Dangal, A., Rai, K., Gurung, G., Sherma, G., … Gautam, N. (2024). Study on the changes during the fermentation of the wine prepared from palm (Phoenix sylvestris) sap. Heliyon. Retrieved from https://doi.org/10.1016/j.heliyon.2024.e35799
20. Li, M., Wang, Y., Stone, H. N., & Turki, N. (2021). Teaching introductory chemistry online: The application of socio-cognitive theories to improve students' learning outcomes. Multidisciplinary Digital Publishing Institute. Retrieved from https://doi.org/10.3390/educsci11030095
21. Madrid, L. M., Balawag, L. R. A., & Franca, G. C. (2025). Perceived reading comprehension difficulties and academic performance of intermediate learners. Asian Journal of Education and Social Studies, 51(6), 1373–1381. Retrieved from https://doi.org/10.9734/ajess/2025/v51i62082
22. Majid, A. N., & Rahaeti, E. (2018). The effect of context-based chemistry learning on student achievement and attitude. American Journal of Educational Research. Retrieved from https://pubs.sciepub.com/education/6/6/37/index.html
23. Malagday, J. A., Bacolod, D. B., & Gara, M. E. (2024). Modular chemistry instruction enhanced by contextualized teaching videos: A new approach to science education. Journal of Southwest Jiaotong University. Retrieved from https://doi.org/10.35741/issn.0258-2724.59.5.18
24. Mandal, M. (2023). A brief about chemistry: An importance and scope. Journal of Emerging Technologies and Innovative Research. Retrieved from https://www.jetir.org/papers/JETIR2302213.pdf
25. Mangarin, R. A., & Macayana, L. B. (2025). Why schools lack laboratory and equipment in science? Through the lense of research studies. International Journal of Research and Innovation in Social Science. Retrieved from https://dx.doi.org/10.47772/IJRISS.2024.8100238
26. Manseguiao, A. S., Salic-Hairulla, M. A., Salazar, D. A., Dinoro, A. P., & Adamat, L. A. (2025). Development of contextualized learning packets in ecosystem for Grade 7 learners. International Journal of Research and Innovation in Social Science (IJRISS). Retrieved from https://dx.doi.org/10.47772/IJRISS.2024.8120223

27. Melgar, F., Leyva, A., Utrilla, J., & Beristain, G. (2019). Bacterial diversity and population dynamics during the fermentation of palm wine from Guerrero Mexico. Frontiers in Microbiology. Retrieved from https://www.frontiersin.org/journals/microbiology/articles/10.3389/fmicb.2019.00531/full
28. Moju, M., Taylor, L., & Iweuno, B. (2025). Tackling the challenge of chemical representations through sensemaking practices in chemistry education. Discover Education. Retrieved from https://link.springer.com/article/10.1007/s44217-025-00703-3
29. Mundy, C. E., & Nokeri, B. K. (2024). Investigating the effects of a context-based laboratory exercise for meaningful learning. Journal of Chemical Education. Retrieved from https://pubs.acs.org/doi/10.1021/acs.jchemed.3c01260
30. Nahm, F. S. (2016). Nonparametric statistical tests for the continuous data: The basic concept and the practical use. PubMed. Retrieved from https://doi.org/10.4097/kjae.2016.69.1.8
31. OECD. (2023). PISA 2022 results (Volume I and II) - Country notes: Philippines. Retrieved from https://www.oecd.org/en/publications/pisa-2022-results-volume-i-and-ii-country-notes_ed6fbcc5-en/philippinesa0882a2d-en.html#:~:text=In%20the%20Philippines%2C%2036%25%20of,mathematics%20was%20344%20score%20points
32. Ongy, E. E., & Molleno, G. L. (2024). Optimizing profit from coconut sap-based products at different investment levels. Science and Humanities Journal, 20, 30–56. Retrieved from https://shj.vsu.edu.ph/wp-content/uploads/2025/01/3-Optimizing-Profit-from-SAP-Vol20_3.pdf
33. Ongy, E., & Molleno, G. L. (2025). Optimizing profit from coconut sap-based products at different investment levels. Science and Humanities Journal. Retrieved from https://www.researchgate.net/publication/388862187_Optimizing_Profit_from_Coconut_Sap-based_Products_at_Different_Investment_Levels
34. Orcan, F. (2020). Parametric or non-parametric: Skewness to test normality for mean. International Journal of Assessment Tools in Education. Retrieved from https://dergipark.org.tr/en/download/article-file/1096261
35. Ortencio, F., Golangayan, K., Fuyonan, P., Dosado, E. G., Agallas, J. P., Mecida, S. V., … Meriales, L. C. (2025). Learning challenges and coping strategies in chemistry among STEM and non-STEM students in the Bachelor of Secondary Education major in Science (BSEd-Science) program: A phenomenological study. ASEAN Journal for Science Education. Retrieved from https://ejournal.bumipublikasinusantara.id/index.php/ajsed
36. Pratomo, H., Fitriyana, N., Wiyarsi, A., & Marfuatun, M. (2025). Mapping chemistry learning difficulties of secondary school students: A cross-grade study. Journal of Education and Learning. Retrieved from https://edulearn.intelektual.org/index.php/EduLearn/article/view/21826/10755
37. Ramli, R. Z., Jamion, N., & Ahmad, T. S. (2025). A usability and motivation analysis of laboratory manuals for empowering non-science students in chemistry. International Journal of Research and Innovation in Social Science. Retrieved from https://rsisinternational.org/journals/ijriss/articles/a-usability-and-motivation-analysis-of-laboratory-manuals-for-empowering-non-science-students-in-chemistry/
38. Reid, J. W., Gunes, Z. K., Fateh, S., Fatima, A., Shuck, M., Nenning, H. T., … Talanquer, V. (2022). Investigating patterns of student engagement during collaborative activities in undergraduate chemistry courses. Royal Society of Chemistry. Retrieved from https://doi.org/10.1039/D1RP00227A
39. Salamat, R. (2024). Effect of contextualized-based e-learning modules in Chemistry 10 on student's conceptual understanding. Social Science Exploration (Psychology, Education and Multidisciplinary Perspectives). Retrieved from https://scimatic.org/show_manuscript/2920
40. Saraiva, A., Carrascosa, C., Ramos, F., Raheem, D., Lopes, M., & Raposo, A. (2023). Coconut sugar: Chemical analysis and nutritional profile; health impacts; safety and quality control; food industry applications. PubMed. Retrieved from https://pmc.ncbi.nlm.nih.gov/articles/PMC9964017/