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Students' Active Learning And Engagement Among First Year Industrial Engineering Students In Chemistry At Batstateu-Tneu, Alangilan Campus

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Abstract

This research investigated the active learning and engagement of first-year Industrial Engineering students in Chemistry at Batangas State University-TNEU, Alangilan Campus. Specifically, it sought to determine how active learning strategies could be integrated into laboratory courses to enhance student engagement, develop conceptual understanding, strengthen laboratory skills, and improve collaboration, motivation, and academic performance. Using a descriptive quantitative research design, the study explored students' perceptions of learning content, classroom activities, and assessment tasks, as well as their willingness to learn, interest in performing assigned tasks, and participation in class discussions and group activities. The study involved 44 first year Industrial Engineering students enrolled in Chemistry during the school year 2025-2026.

Results showed that active learning strategies significantly enhance students' understanding, laboratory skills, and engagement in Chemistry, but require stronger real-life application and problem-solving integration. The study concludes that active learning strategies are highly effective in enhancing students' engagement in Chemistry laboratory classes, with an overall composite mean of 3.73, interpreted as *very influential*. The results show that active learning significantly improves students' conceptual understanding, laboratory skills, collaboration, and motivation.

Among the domains, assessment tasks and collaboration obtained the highest ratings, indicating that group-based and performance-oriented activities are the most effective in promoting engagement. Meanwhile, conceptual understanding received the lowest mean, suggesting that although students understand the lessons, there is still a need to strengthen their ability to apply concepts in real-life situations and solve problems independently.

Overall, the findings confirm that active learning creates a more engaging, interactive, and student-centered learning environment, which leads to better learning outcomes in Chemistry.

Keywords: *Active Learning, Chemistry, Industrial Engineering Students, Laboratory Activities, Students' Engagement*

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Introduction

In today's dynamic world of higher education, active learning is recognized as an effective approach for promoting deeper student engagement and comprehension, particularly in science-related disciplines such as Chemistry. For first year Industrial Engineering students at Batangas State University-The National Engineering University (BatStateU-TNEU), Alangilan Campus, Chemistry serves a vital function by linking theoretical knowledge to practical engineering applications. Despite its importance, many students perceive Chemistry as a challenging subject due to its complex concepts and the real-time demands of conceptual understanding and practical skills. It highlights the importance of innovative and interactive teaching methods that promote meaningful, enjoyable, and effective learning experiences that motivate students to participate actively in their learning.

Laboratories serve as the venue for scientific experiments, analysis, and research activities. It has various tools and facilities needed for conducting these experiments and studies. A study shows that laboratory activities positively affect student engagement in areas like attendance, collaboration, confidence, motivation, and learning. Laboratories play a crucial role in scientific research, understanding chemistry, materials, and many other scientific fields. It also fosters creativity and discovery that will boost student engagement and active learning. Active learning involves student-centered activities such as discussions, experiments, problem-solving, and collaborative projects. It has been proven to significantly improve the engagement and academic performance of students. Integrating active learning strategies into laboratory courses gives students chances to apply theoretical ideas to real situations.

Active learning approach helps strengthen students' understanding of chemistry concepts and their laboratory skills. Definitely, creating engaging classroom activities and meaningful assessment tasks that can spark curiosity, encourage teamwork, and boost students' engagement and motivation to learn. Promoting students' active learning and engagement in laboratory courses, such as Chemistry, can be achieved through the integration of active learning strategies that enhance student engagement in terms of learning content, classroom activities, and assessment tasks. The role of laboratory subjects in developing critical thinking and practical skills is vital. Science laboratories are essential to students' learning journeys, they allow students to apply theoretical knowledge and actively engage in scientific experimentation. Science laboratories offer more than just a place for experiments, they provide interactive spaces that encourage active learning. While classrooms rely on lectures and reading, laboratories provide hands-on opportunities to apply knowledge. This active engagement fosters critical thinking as students observe, analyze, and relate their experimental results to theoretical concepts or in real-world applications.

This research explores how active learning strategies may be integrated into laboratory courses to improve student engagement, identify the extent of students' participation and motivation, examine the challenges they encounter in laboratory activities, and propose effective laboratory activities that can further enhance their learning experience and academic performance.

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Specifically, it aimed to answer the following questions:

1. How may active learning strategies be integrated into laboratory courses to improve student engagement in terms of;
    1.1 learning content,
    1.2 classroom activities,
    1.3 assessment task?
2. How influential are student engagement and active learning in laboratory subject relative to;
    2.1 developing conceptual understanding in Chemistry
    2.2 enhancing laboratory skills and practical application, and
    2.3 improving collaboration, motivation, and academic performance?
3. To what extent are the students active learning and engagement manifested thru;
    3.1 level of willingness to learn
    3.2 level of interest to perform assigned tasks given
    3.3 participation in class discussions and group activities?
4. What challenges do first-year college students face in laboratory subject?
5. Based on the result of the study, what enhanced laboratory activities may be designed to effectively promote student active learning and engagement in laboratory subject?

Methodology

Research Design

This study employed a **descriptive quantitative research design** to determine and describe the level of active learning and engagement among first-year Industrial Engineering students in Chemistry. The descriptive approach was chosen to collect measurable information on students' engagement, willingness to learn, interest, and participation in laboratory activities. Through this approach, patterns and relationships between active learning strategies and student engagement can be analyzed, as well as the challenges faced in laboratory courses.

Participants

The study involved **44 first year Industrial Engineering students enrolled in Chemistry at Batangas State University-TNEU, Alangilan Campus during the school year 2025-206.** The participants were selected through **purposive sampling,** where first-year Industrial Engineering students enrolled in Chemistry were deliberately chosen because they meet the specific criteria relevant to the study and can provide appropriate data for the research objectives.

Research Instrument

This study utilized a **structured survey questionnaire** as the primary data gathering instrument to collect quantitative data on the students' level of active learning and engagement in Chemistry laboratory classes. It was designed to align with the research objectives and questions

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of the study, ensuring that all aspects such as learning content, classroom activities, assessment tasks, and student participation are sufficiently covered.

The questionnaire included several sections covering:

- **Integration of Active Learning Strategies in Laboratory Courses** (Learning Content, Classroom Activities, and Assessment Tasks)
- **Influence of Student Engagement and Active Learning in Laboratory Subjects** (Developing Conceptual Understanding in Chemistry, Enhancing Laboratory Skills and Practical Application, and Improving Collaboration, Motivation, and Academic Performance)
- **Students' Active Learning and Engagement** (Level of Willingness to Learn, Level of Interest to Perform Assigned Task, and Participation in Class Discussions and Group Activities)
- **Challenges encountered by first year college students in laboratory subjects**

A **four-point Likert scale** was used to quantify students' active learning and engagement.

Data Gathering Procedure

The data gathering process began with seeking permission from the Dean of the College of Engineering and to the Department Head of Industrial Engineering at Batangas State University–The National Engineering University, Alangilan Campus to conduct the study among first-year Industrial Engineering students. Upon approval, validated survey questionnaires were distributed to the identified respondents in a controlled and organized manner.

Throughout the data collection process, strict adherence to ethical research standards and data privacy was observed. The respondents were properly informed about the purpose of the study, the voluntary nature of their participation, and the confidentiality of their responses. Clear procedures for data collection, storage, and usage were implemented to ensure the integrity and protection of all gathered information.

After the retrieval of the questionnaires, the responses were checked for completeness, then systematically tallied, classified, and tabulated. The data were encoded and analyzed using a four-point Likert scale, where 1 represented the lowest rating and 4 represented the highest, to appropriately interpret the respondents' assessments.

Data Analysis

The study utilized descriptive statistical tools, including **weighted mean, ranking, and composite mean**, to analyze students' responses.

- **Weighted Mean**- to calculate the average student response to gamified learning tools, considering their opinions on content, activities, and assessments.
- **Ranking**- will be used to determine the rank of the respondent responses in the test given.

- **Composite Mean**- This will be used to combine multiple means into a single, representative value. This is particularly useful in research when you have multiple measures or indicators for a specific construct

Results

1. Integration of Active Learning Strategies in Laboratory Courses

1.1 Learning Content

Table 1

RQ 1.1 Learning Content	Weighted Mean	Verbal Interpretation	Rank
1. The laboratory activities help me connect chemistry concepts to real-life engineering applications.	3.61	Strongly Agree	4
2 The laboratory activities help me connect chemistry concepts to real-life engineering applications.	3.82	Strongly Agree	3
3. The lessons and lab content promote critical thinking and problem-solving skills.	3.45	Strongly Agree	5
4. Learning content is presented in ways that stimulate curiosity and inquiry.	3.89	Strongly Agree	1
5. The instructor provides opportunities for me to relate chemistry topics to industrial engineering concepts.	3.86	Strongly Agree	2
Composite Mean	**3.73**	**Strongly Agree**	

Interpretation: 3.25-4.00=Strongly Agree, 2.50-3.24=Agree, 1.75-2.49=Disagree, 1.00-1.74=Strongly Disagree

The data show that students strongly agree that laboratory learning content effectively supports their understanding and engagement, with a composite mean of 3.73. The highest-rated indicator (M=3.89) shows that lessons stimulate curiosity and inquiry, aligning with Caswell and LaBrie (2017), who emphasized inquiry-based learning as student-centered and driven by curiosity, where teachers act as facilitators.

The second highest mean (M=3.86) indicates that instructors help students connect Chemistry to Industrial Engineering concepts, improving relevance and contextual learning. Meanwhile, the lowest mean (M=3.45) relates to the development of critical thinking and problem-solving skills, suggesting an area for improvement, although still rated highly. This supports Jasnani (2022), who stressed that critical thinking promotes careful and rational decision-making. The findings suggest that the learning content is engaging, relevant, and supportive of student learning outcomes.

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1.2 Classroom Activities

Table 2

RQ 1.2 Classroom Activities	Weighted Mean	Verbal Interpretation	Rank
1. Laboratory instructor uses short conceptual questions during experiments.	3.61	Strongly Agree	4
2. Laboratory sessions often include group problem solving based on experimental results.	3.82	Strongly Agree	3
3. I am encouraged to design or modify parts of experiments.	3.45	Strongly Agree	5
4. The use of interactive teaching methods helps maintain my interest.	3.89	Strongly Agree	1
5. The laboratory promotes collaboration and teamwork among students.	3.86	Strongly Agree	2
Composite Mean	**3.73**	**Strongly Agree**	

Interpretation: 3.25-4.00=Strongly Agree, 2.50-3.24=Agree, 1.75-2.49=Disagree, 1.00-1.74=Strongly Disagree

Table 1.2 shows that students strongly agree classroom laboratory activities effectively promote engagement and learning, with a composite mean of 3.73, indicating that instructors successfully support active learning.

The highest-rated indicator (M=3.89) shows that interactive teaching methods maintain student interest through discussions, demonstrations, and hands-on activities. This aligns with Mbuti (2022), who emphasized that interactive teaching enhances creativity and motivation, and Huang et al. (2020), who found that collaborative and authentic learning activities significantly improve student engagement.

The second highest mean (M= 3.86) highlights that laboratory work promotes collaboration and teamwork, supporting Jordan (2018), who noted that cooperative learning strengthens social and interpersonal skills. Group problem-solving (M=3.82) also reinforces analytical learning, while conceptual questioning (M=3.61) supports understanding.

The lowest mean (M=3.45) indicates fewer opportunities for student-designed experiments, though it remains positively rated. Cariaga et al. (2024) emphasized that hands-on experimentation enhances creativity and problem-solving. The findings show that laboratory activities are engaging, collaborative, and supportive of student learning, though more student-led experimentation could further improve outcomes.

1.3 Assessment Tasks

Table 3

RQ 1.3 Assessment Task	**Weighted Mean**	**Verbal Interpretation**	**Rank**
1. Group projects and presentations encourage me to think critically about the experiment results.	3.91	Strongly Agree	1
2. Laboratory assessments measure my understanding through application and analysis, not just recall.	3.82	Strongly Agree	3
3. I find laboratory sessions enjoyable and intellectually stimulating.	3.84	Strongly Agree	2
4. The assessment tasks (lab reports, quizzes, outputs) motivate me to learn more actively.	3.66	Strongly Agree	5
5. The evaluation system recognizes creativity and problem-solving skills in performing experiments.	3.73	Strongly Agree	4
Composite Mean	**3.79**	**Strongly Agree**	

Interpretation: 3.25-4.00=Strongly Agree, 2.50-3.24=Agree, 1.75-2.49=Disagree, 1.00-1.74=Strongly Disagree

The composite mean of 3.79 indicates that students strongly agree the assessment system is effective in promoting higher-order thinking skills such as critical analysis, application, and problem-solving rather than memorization. The highest-rated indicator (M=3.91) shows that group projects and presentations are most effective in encouraging critical thinking and engagement. This supports Phillips (2020), who noted that project-based learning fosters exploration, collaboration, and the connection between theory and practice.

In contrast, the lowest-rated item (M=3.66) shows that traditional assessments like lab reports, quizzes, and written outputs are less motivating, although still positively rated. Overall, the findings suggest that students respond more positively to collaborative and performance-based assessments, which better enhance engagement and critical thinking.

2. Influence of Student Engagement and Active Learning in Laboratory Subjects

2.1. Developing Conceptual Understanding in Chemistry

Table 4

RQ 2.1 Developing Conceptual Understanding in Chemistry	Weighted Mean	Verbal Interpretation	Rank
1. Helping you understand fundamental Chemistry concepts through hands-on laboratory activities.	3.68	Very Influential	2.5
2. Encouraging you to connect theoretical knowledge to real-life chemical applications.	3.57	Very Influential	5
3. Allowing you to analyze and interpret experimental results to strengthen your understanding.	3.73	Very Influential	1
4. Promoting critical thinking in solving Chemistry-related problems.	3.68	Very Influential	2.5
5. Clarifying abstract Chemistry concepts through active participation and discussion.	3.68	Very Influential	2.5
Composite Mean	**3.67**	**Very Influential**	

Interpretation: 3.25-4.00=Very Influential, 2.50-3.24=Influential, 1.75-2.49=Slightly Influential, 1.00-1.74=Not Influential

The table shows that students perceive active learning in laboratory activities as "Very Influential" in developing their conceptual understanding of Chemistry, with a composite mean of 3.67. This indicates that hands-on, analytical, and discussion-based activities enhance understanding of key Chemistry concepts.

The highest-rated indicator (M=3.73) shows that analyzing and interpreting experimental results most strongly supports conceptual learning. This highlights that students gain deeper understanding when they interpret their own data and outcomes.

Three indicators tied at M=3.68, showing that hands-on activities, critical thinking, and discussions equally support learning. This aligns with Brown (2022), who emphasized that active learning promotes inquiry, critical thinking, and lifelong learning skills.

The lowest-rated item (M=3.57) shows that connecting Chemistry to real-life applications is less emphasized, suggesting a need for stronger contextualization. Okam and Zakari (2017) noted that practical work improves motivation and understanding by linking theory to real-world experiences. The findings show that laboratory activities strongly enhance conceptual understanding, especially through analysis and hands-on learning, but could benefit from stronger real-life applications.

2.2 Enhancing Laboratory Skills and Practical Application

Table 5

RQ 2.2 Enhancing Laboratory Skills and Practical Application	Weighted Mean	Verbal Interpretation	Rank
1. Improving your accuracy and precision when performing laboratory experiments.	3.77	Very Influential	3
2. Enhancing your ability to follow proper laboratory procedures and safety protocols.	3.82	Very Influential	1.5
3. Applying Chemistry concepts effectively during laboratory tasks.	3.82	Very Influential	1.5
4. Strengthening your problem-solving skills in experimental situations.	3.52	Very Influential	4.5
5. Increasing your confidence in conducting and interpreting laboratory experiments.	3.52	Very Influential	4.5
Composite Mean	**3.69**	**Very Influential**	

Interpretation: 3.25-4.00=Very Influential, 2.50-3.24=Influential, 1.75-2.49=Slightly Influential, 1.00-1.74=Not Influential

The results show that students agree active learning in laboratory activities is “Very Influential” in enhancing their laboratory skills and application of Chemistry concepts, with a composite mean of 3.69. This indicates that laboratory work effectively builds technical competence, procedural understanding, and confidence in experiments.

The highest-rated indicators (M=3.82) show that following laboratory procedures and applying Chemistry concepts are the most developed skills. This aligns with studies emphasizing that practical work strengthens critical thinking and problem-solving while promoting experiential learning (University of the Philippines Diliman, 2023; Fagihi, 2018).

The second highest mean (M=3.77) indicates improvement in accuracy and precision, showing that repeated laboratory practice enhances scientific skills. However, the lowest-rated indicators (M=3.52) show that problem-solving and confidence still need further development, suggesting a need for more inquiry-based activities. Gill (2020) and Caglak (2017) highlight that hands-on, real-life science experiences are essential for developing practical and meaningful learning. The findings suggest that laboratory activities strongly improve skills, but more emphasis on inquiry and real-world application is needed.

2.3 Improving Collaboration, Motivation, and Academic Performance

Table 6

RQ 2.3 Improving Collaboration, Motivation, and Academic Performance	Weighted Mean	Verbal Interpretation	Rank
1.Encouraging teamwork and cooperation among classmates during laboratory activities.	3.86	Very Influential	1
2. Motivating you to actively participate and contribute during experiments.	3.82	Very Influential	2.5
3. Boosting your interest and enthusiasm in learning Chemistry.	3.80	Very Influential	4
4. Developing a positive attitude toward completing laboratory requirements.	3.82	Very Influential	2.5
5. Improving your overall academic performance and learning outcomes in Chemistry.	3.59	Very Influential	5
Composite Mean	**3.78**	**Very Influential**	

Interpretation: 3.25-4.00=Very Influential, 2.50-3.24=Influential, 1.75-2.49=Slightly Influential, 1.00-1.74=Not Influential

The findings show that students perceive laboratory activities as "Very Influential" in improving collaboration, motivation, and academic performance, with a composite mean of 3.78. The highest-rated indicator (M=3.86) shows that teamwork and cooperation are the most enhanced aspect of laboratory learning, supporting Cresswell and Loughlin (2017), who emphasized that inquiry-based learning strengthens communication, collaboration, and shared problem-solving.

The next indicators (M=3.82) show that laboratory work also improves student motivation and positive attitudes through active participation and hands-on tasks, reinforcing engagement and responsibility. The lowest-rated indicator (M=3.59) suggests that while laboratory activities support learning, their direct impact on academic performance is less immediate, as grades are influenced by multiple factors. Overall, the results indicate that laboratory activities strongly enhance collaboration and motivation, which indirectly support long-term academic success.

3. Students' Active Learning and Engagement

3.1 Level of Willingness to Learn

Table 7

RQ 3.1 Level of Willingness to Learn	Weighted Mean	Verbal Interpretation	Rank
1. Showing eagerness to understand Chemistry concepts during discussions.	3.55	Very Evident	3
2. Seeking clarification or assistance when lessons are unclear.	3.43	Very Evident	4
3. Taking initiative to study Chemistry topics beyond classroom instruction.	3.36	Very Evident	5
4. Demonstrating a positive attitude toward new and challenging lessons.	3.66	Very Evident	1.5
5. Showing persistence in completing laboratory activities even when difficult.	3.66	Very Evident	1.5
Composite Mean	**3.53**	**Very Evident**	

Interpretation: 3.25-4.00=Very Evident, 2.50-3.24=Evident, 1.75-2.49=Slightly Evident, 1.00-1.74=Not Evident

The table shows that students demonstrate a "Very Evident" willingness to learn in Chemistry, with a composite mean of 3.53. This indicates positive attitudes, persistence, and engagement in both lessons and laboratory activities. Studies by Astawan et al. (2023) and Huang (2022) support that laboratory-based instruction enhances motivation, critical thinking, and scientific skills.

The highest-rated indicators (M=3.66) show that students are highly positive toward challenging lessons and persistent in completing laboratory tasks. The next indicator (M=3.55) reflects strong interest in understanding Chemistry during discussions.

However, lower-rated items include seeking help (M=3.43) and studying beyond class (M=3.36), suggesting a need to strengthen independent learning habits. Cho et al. (2017) emphasized that self-regulated learning helps students manage their motivation and achieve academic goals. Overall, students are willing to learn, but further support is needed to develop independence and initiative.

3.2 Level of Interest to Perform Assigned Task

Table 8

RQ 3.2 Level of Interest to Perform Assigned Task	Weighted Mean	Verbal Interpretation	Rank
1. Completing Chemistry assignments and laboratory tasks on time.	3.82	Very Evident	3
2. Displaying enthusiasm in carrying out experiments and exercises.	3.57	Very Evident	5
3. Taking responsibility for your role during group laboratory work.	3.77	Very Evident	4
4. Paying attention to detail and following instructions carefully in experiments.	3.86	Very Evident	1
5. Showing motivation to improve the quality of your laboratory work.	3.80	Very Evident	2
Composite Mean	**3.76**	**Very Evident**	

Interpretation: 3.25-4.00=Very Evident, 2.50-3.24=Evident, 1.75-2.49=Slightly Evident, 1.00-1.74=Not Evident

The results show that students demonstrate strong interest in engaging with Chemistry tasks, with a composite mean of 3.76, indicating high motivation and active involvement in laboratory and academic responsibilities. This aligns with engagement frameworks identifying affective, behavioral, and cognitive engagement (Fredricks et al., 2004; Bowden et al., 2021).

The highest indicator (M=3.86) shows that students carefully follow instructions and pay attention to detail, reflecting strong discipline and commitment to laboratory accuracy and safety. The second highest (M=3.80) indicates motivation to improve laboratory performance.

Other high ratings include completing tasks on time (M=3.82) and taking responsibility in group work (M=3.77), showing accountability and teamwork. However, the lowest-rated item (M=3.57) suggests that student enthusiasm could still be improved. The findings suggest that students are engaged, responsible, and motivated, though more interactive and stimulating laboratory experiences could further enhance enthusiasm and interest.

3.3 Participation in Class Discussions and Group Activities.

Table 9

RQ 3.3 Participation in Class Discussions and Group Activities	**Weighted Mean**	**Verbal Interpretation**	**Rank**
1. Actively contributing ideas during class discussions.	3.32	Very Evident	3.5
2. Asking questions or sharing insights related to Chemistry topics.	3.30	Very Evident	5
3. Cooperating effectively with group members during laboratory sessions.	3.75	Very Evident	2
4. Participating in planning and decision-making during group experiments.	3.80	Very Evident	1
5. Demonstrating leadership or initiative when working in a team.	3.30	Very Evident	3.5
Composite Mean	**3.49**	**Very Evident**	

Interpretation: 3.25-4.00=Very Evident, 2.50-3.24=Evident, 1.75-2.49=Slightly Evident, 1.00-1.74=Not Evident

The data show that students have a "Very Evident" level of participation in class discussions and group activities, with a composite mean of 3.49. This indicates that learners are generally active, cooperative, and engaged in Chemistry-related collaborative tasks.

The highest indicator (M=3.80) shows that students are most involved in planning and decision-making during group experiments, reflecting ownership and responsibility. The second highest (M=3.75) highlights strong cooperation among group members, supporting findings on interactive engagement pedagogies (Apugliese & Lewis, 2017; Rahman & Lewis, 2019; Theobald et al., 2020), which emphasize that collaboration improves learning in STEM.

Lower-rated indicators include contributing ideas (M=3.32), leadership (M=3.30), and asking questions (M=3.30), suggesting students are more reserved in expressing ideas and taking initiative. Pedersen et al. (2018) and Datu & Bernardo (2020) note that cultural and value influences may affect student confidence and leadership. Overall, results show strong collaboration but a need to further develop communication, confidence, and leadership in group activities.

4. Challenges encountered by first year college students in laboratory subjects

Table 10

I have encountered…	Weighted Mean	Verbal Interpretation	Rank
1. difficulty understanding Chemistry concepts applied in laboratory work.	2.39	Sometimes Experienced	1
2. poor time management in preparing for and completing laboratory tasks.	1.91	Sometimes Experienced	3
3. struggles in analyzing and interpreting experimental data	2.02	Sometimes Experienced	2
4. inadequate laboratory materials or equipment during experiments.	1.84	Sometimes Experienced	4
5. overcrowded laboratory rooms that limit participation.	1.27	Never Experienced	5
Composite Mean	**1.89**	**Sometimes Experienced**	

Interpretation: 3.25-4.00=Always Experienced, 2.50-3.24=Often Experiencedt, 1.75-2.49=Sometimes Experienced, 1.00-1.74=Never Experienced

The findings show that students sometimes experience challenges in Chemistry laboratory activities, with a composite mean of 1.89, indicating that these difficulties are present but not severe or constant. The most common challenge (M=2.39) is difficulty connecting Chemistry concepts to laboratory applications, showing gaps between theory and practice. This highlights the need for stronger conceptual integration in instruction (Adarlo, De Leon, & Favis, 2022).

Other challenges include difficulty analyzing data (M=2.02) and poor time management (M=1.91), suggesting issues in organization and analytical skills. Studies by Sadera, Torres, & Rogayan Jr. (2020) and King, McQuarrie, & Brigham (2021) note that such difficulties are linked to limited understanding, motivation, and time management skills.

Lower-rated issues include inadequate lab materials (M=1.84), while overcrowding was never experienced (M=1.27), indicating generally good laboratory conditions. Abas (2020) emphasizes that sufficient resources support effective learning. The results suggest that while laboratory environments are generally supportive, students still need stronger conceptual understanding, time management, and analytical support to improve performance.

5. Proposed Enrichment Activities

Based on the findings from the active learning and engagement of first-year Industrial Engineering students in Chemistry at Batangas State University-TNEU, Alangilan Campus, the following enhanced laboratory activities are proposed to promote active learning and engagement among first-year Industrial Engineering students. These proposed activities were formulated in response to the results of assessments on students' engagement levels, active learning strategies, and the challenges encountered in laboratory courses.

To ensure consistent evaluation and address constraints observed in student participation, general rubrics were also designed for the activities. These rubrics focus on four key areas: scientific content, organization/clarity, performance/peer review, and punctuality. By integrating these enhanced laboratory activities, the study seeks to strengthen students' conceptual understanding, improve laboratory skills and practical application, foster collaboration, and increase overall motivation and academic performance, directly addressing the research questions regarding active learning, engagement, and challenges faced in laboratory courses.

ENHANCED LABORATORY ACTIVITIES:

- **Laboratory Experiment No. 1 EXPERIMENTAL VARIABLES:** This experiment demonstrates the changing one variable (independent) can affect another (dependent), while keeping other factors constant. This is important in analyzing cause-and-effect relationships in scientific investigations.
- **Laboratory Experiment No. 2 ALUMINUM FOIL & NAOH REACTIONS:** This experiment demonstrates the chemical reaction between aluminum foil (Al) and sodium hydroxide (NaOH), a strong base. It is commonly used to illustrate metal reactivity, exothermic reactions, and gas formation in Chemistry.
- **Laboratory Experiment No. 3 INVESTIGATING HEAT CHANGES IN ENDOTHERMIC AND EXOTHERMIC REACTIONS:** This experiment aims to determine whether reactions are endothermic or exothermic by observing temperature changes. It records the energy absorbed or released during different reactions to explain the relationship between heat transfer and reaction type.
- **Laboratory Experiment No. 4 THE TIN HEDGEHOG EXPERIMENT:** This experiment demonstrate the reaction between tin (II) chloride solution and zinc pellets, and understand how differences in metal reactivity influence the outcome.
- **Laboratory Experiment No. 5: ORANGE CANDLE:** This experiment shows the type of chemical reaction involved in burning, specifically combustion, and to predict the products formed during the reaction.

Discussion

The findings revealed that active learning strategies were moderately to highly implemented in terms of learning content, classroom activities, and assessment tasks. Students perceived that collaborative experiments, inquiry-based activities, and real-life applications helped them better understand Chemistry concepts, which in turn encouraged participation, improved interest, and increased engagement during laboratory sessions. This indicates that when students are actively involved in laboratory tasks, they develop a deeper understanding of concepts and become more motivated to learn, as reflected in their participation in discussions, willingness to perform tasks, and collaboration with peers. These results support the findings of

Olimpo and Esparza (2020), who emphasized that active participation enhances conceptual understanding in STEM education.

Similarly, Astawan and Huang (2022) highlighted that laboratory-based instruction strengthens critical thinking and problem-solving skills through hands-on engagement, while Holmes et al. (2021) noted that active learning strategies improve both cognitive and emotional engagement. The findings suggest that instructors should continuously integrate active learning strategies such as inquiry-based learning, cooperative learning, and problem-based experiments. Schools may also provide teacher training, encourage student-centered instruction, integrate technology like simulations and virtual labs, and develop structured assessment rubrics to improve both academic performance and laboratory skills. However, the findings are limited to first-year Industrial Engineering students from one institution and rely on self-reported data, which may be influenced by students' perceptions.

Furthermore, the study found that students generally demonstrated a moderate level of engagement in laboratory activities, particularly in terms of willingness to learn, interest in tasks, and participation in group activities. However, engagement was not consistently high, indicating that some students still experience difficulty maintaining active involvement due to factors such as lack of confidence, limited prior knowledge, and difficulty understanding concepts. This finding is consistent with Han (2021), who stated that low engagement in Chemistry is often linked to instructional methods, and with Adarlo et al. (2022), who emphasized that motivation and engagement significantly influence academic success in Science.

In addition, Gara and Dela Cruz (2023) found that students exhibit higher engagement when teaching methods are interactive and supportive, reinforcing the importance of active learning environments. To improve engagement, educators should foster a supportive and inclusive classroom environment, provide step-by-step guidance during experiments, encourage peer collaboration, and use interactive tools and real-world applications. Institutions may also implement policies that promote continuous improvement of teaching strategies and monitoring of student engagement. However, engagement was measured based on students' perceptions, which may not fully reflect actual behavior, and other factors such as motivation, personal issues, and learning styles were not deeply explored.

Lastly, the results showed that students sometimes experience challenges in laboratory activities, with the most significant difficulty being the understanding of Chemistry concepts applied in experiments. Other challenges include limited resources, time constraints, and lack of confidence, which affect their engagement and performance. These findings are consistent with Abas (2020), who identified insufficient laboratory resources as a barrier to effective Science learning, and Sadera et al. (2020), who emphasized that abstract concepts and lack of interest contribute to students' difficulties in Science.

Moreover, Urbano et al. (2022) suggested that microscale experiments can help address resource limitations while maintaining effective learning outcomes. To address these challenges, it is recommended to provide adequate laboratory materials, use simplified or microscale experiments, allocate sufficient time for activities, offer additional support and scaffolding, and integrate technology-based simulations as alternatives. Educational institutions should also prioritize funding and resource allocation for laboratory facilities. However, the study did not deeply examine institutional constraints such as budget and infrastructure, nor did it include instructors' perspectives, which could provide a more comprehensive understanding of the challenges.

Conclusion

1. Active learning strategies are effectively integrated into Chemistry laboratory courses. Students strongly agreed that learning content, classroom activities, and assessment tasks promoted engagement, critical thinking, and application of concepts to real-life and Industrial Engineering contexts.

2. Laboratory activities significantly enhance students' conceptual understanding and practical skills. Hands-on experiments, data analysis, and discussion-based activities were perceived as very influential in helping students understand fundamental Chemistry concepts, apply theories in practical contexts, and strengthen problem-solving abilities.

3. Collaboration, motivation, and academic engagement are positively influenced by laboratory participation. Students rated teamwork, active contribution, and adherence to laboratory procedures highly, demonstrating that cooperative and interactive learning promotes motivation and engagement in Chemistry laboratory courses.

4. Students demonstrate a high level of willingness to learn, interest, and participation in laboratory tasks. While enthusiasm and initiative were evident, some areas such as independent study and active contribution in discussions could still be strengthened to further enhance engagement and leadership skills.

5. Challenges in laboratory subjects exist but are generally manageable. Difficulty in understanding Chemistry concepts and struggles in data interpretation were occasionally experienced, while issues such as overcrowded laboratories were minimal. This highlights the need for continuous support, guidance, and resource management to ensure optimal learning experiences.

Recommendation

Based on the conclusions drawn, the following recommendations are proposed to enhance Chemistry laboratory learning for first-year Industrial Engineering students:
1. Strengthen inquiry-based and interactive laboratory activities. *The Chemistry instructors and laboratory facilitators* may incorporate more student-led experiments, design modifications, and real-world applications to promote curiosity, critical thinking, and problem-solving skills.

2. Enhance assessment strategies to promote creativity and engagement. *The course instructors and the department's curriculum committee* may emphasize collaborative projects, presentations, and applied assessments alongside traditional laboratory reports to encourage higher-order thinking and active participation.

3. Foster student independence and leadership. *Laboratory instructors* may encourage students to take initiative in discussions, planning, and decision-making during laboratory sessions to strengthen leadership, initiative, and self-directed learning.

4. Address conceptual and analytical challenges. *The Chemistry instructors and the department may* provide targeted support for students struggling to link theoretical knowledge with laboratory applications. This may include guided analysis exercises, supplementary tutorials, and contextualized examples related to Industrial Engineering.

5. Maintain well-equipped and safe laboratory environments. *The school administration, laboratory custodians, and safety officers* may ensure the availability of necessary laboratory materials, equipment, and space, and provide proper training in safety and procedural protocols to enhance students' confidence, accuracy, and overall learning experience.

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