INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY: APPLIED BUSINESS AND EDUCATION RESEARCH
2025, Vol. 6, No. 3, 1010 – 1021
http://dx.doi.org/10.11594/ijmaber.06.03.03

Research Article

Utilization and Types of Laboratory Approaches Employed in Public Secondary Schools in Ilocos Norte

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Article history:
Submission 01 February 2025
Revised 28 February 2025
Accepted 23 March 2025

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ABSTRACT

This study investigates the laboratory practices of science teachers in public secondary schools within the Schools Division of Ilocos Norte, focusing on the types of laboratory teaching approaches employed and their frequency of use. Utilizing a quantitative research design, data were collected through surveys to assess the extent of implementation of various methodologies, including Demonstration, Guided Inquiry, Open Inquiry, Structured Inquiry, and Confirmation Inquiry. The analysis revealed a significant correlation between the types of approaches used and their frequency of implementation, with Demonstration and Guided Inquiry being the most frequently employed methods. In contrast, Open Inquiry and Confirmation Inquiry were utilized less often, indicating potential barriers to their implementation. The findings highlight the need for targeted professional development to enhance teachers' confidence and skills in employing a wider range of inquiry-based approaches. This research contributes valuable insights into the current state of laboratory practices in science education, emphasizing the importance of understanding these practices to inform future training and support initiatives aimed at improving science instruction and fostering a more effective learning environment for students. Further research is recommended to explore the impact of these teaching approaches on student learning outcomes and to identify challenges faced by teachers in implementing diverse laboratory methodologies.

Keywords: *Laboratory approaches, Science, Science teachers, Science laboratories, Science education*

Introduction

Science laboratories play a pivotal role in enhancing students' understanding of scientific concepts across various disciplines. These facilities, equipped with scientific apparatus and materials, provide students with opportunities to engage in hands-on manipulation and observation, individually or collaboratively.

How to cite:
Dalere, J. J. & Calzada, M. P. T. (2025). Utilization and Types of Laboratory Approaches Employed in Public Secondary Schools in Ilocos Norte. *International Journal of Multidisciplinary: Applied Business and Education Research*. *6*(3), 1010 – 1021. doi: 10.11594/ijmaber.06.03.03

This practical engagement enables students to translate theoretical scientific concepts into practice. De Borja and Marasigan (2020) assert that laboratories are the cornerstone of science education, underscoring the necessity for adequate teaching kits and facilities to ensure that learning remains engaging and encourages students to appreciate the beauty of the scientific world. Furthermore, it was emphasized by Ibragimova (2023) that science laboratories can stimulate students' enthusiasm for learning and foster the development of critical and higher-order thinking skills. They also promote collaboration and effective communication, as many laboratory activities require teamwork to accomplish specific tasks (Omar & Plumb, 2023). These insights underscore the importance of integrating laboratory experiences into the science curriculum. By fostering an environment that encourages collaboration and critical thinking, science teachers can enhance student engagement and deepen their understanding of scientific concepts.

In recent years, the importance of laboratory instruction in science education has

garnered significant attention from educators and researchers. The laboratory acts as a vital setting where theoretical concepts are transformed into practical comprehension, facilitating hands-on learning experiences that enhance students' scientific literacy and critical thinking skills (Grancharova, 2024). However, the effectiveness of laboratory instruction is influenced by several factors, including resource availability, teacher competence, and the types of laboratory approaches used (Agustian, 2024).

Shahzadi (2023) stresses that the current educational landscape highlights the urgent need to assess laboratory practices in public secondary schools, especially in the field of science education. Many schools face challenges related to inadequate laboratory facilities, insufficient staff training, and outdated teaching methods that hinder effective laboratory-based teaching (Elechi, 2015 & (Nsanzimana et al., 2021). Thus, the assessment of school laboratory facilities and personnel is crucial for identifying gaps and areas for improvement in science instruction.

Moreover, Patero (2024) emphasized that the types of laboratory approaches adopted by teachers significantly influence students' learning experiences. Inquiry-based and problem-solving laboratory approaches have proven to enhance students' understanding of scientific principles and their ability to apply knowledge in real-world situations (Eymur & Cetin, 2024). However, the successful implementation of these approaches necessitates well-equipped laboratories and teachers who are both trained and confident in employing these methods.

This study aims to assess the current state of laboratory practices in public secondary schools in the School's Division of Ilocos Norte, focusing on the types of approaches employed and the extent of their use. By evaluating existing laboratory practices, the research seeks to provide insights for educational stakeholders, including school administrators and science coordinators, regarding the necessary interventions and resources to improve laboratory instruction. Ultimately, the findings of this study will contribute to the ongoing discourse on improving science education and fostering a more effective learning environment for students.

Methods

Research Design

This study employed a quantitative approach to evaluate the utilization and types of laboratory approaches used by science teachers in public secondary schools. The quantitative component involved surveys to gather data on the frequency and types of laboratory approaches.

Locale of the Study

This study was conducted among public secondary schools in the Schools Division of Ilocos Norte, which comprises 21 municipalities and is home to 57 secondary schools. Due to its larger population, this area provided an ideal setting for soliciting and investigating the current study. Additionally, the accessibility and availability of respondents were taken into account to ensure that the study proceeded smoothly.

Population and Sampling

The study focused on all science teachers employed in public secondary schools within the Schools Division of Ilocos Norte, which included both junior and senior high school levels. Participants were selected using a purposive sampling method, specifically focusing on those teachers who had direct experience with laboratory instruction.

Research Instruments

A two-part survey questionnaire was utilized for the study. The first section gathered demographic information from the respondents, including their sex, teaching position, length of service, highest degree attained, and area of specialization.

The second section consisted of a checklist that identified commonly used laboratory teaching approaches, such as demonstration, confirmation, guided inquiry, structured inquiry, and open inquiry, along with a frequency assessment for each approach, indicating whether they were used daily, weekly, or monthly.

The tool was adopted from Gecer and Zengin (2016) and was validated by a Science teacher and an English teacher to ensure the reliability and validity of the instrument.

Data Gathering Procedure

An ethical approval was obtained from the University Research Ethics and Review Board (URERB), along with clearance from the Superintendent of the Schools Division of Ilocos Norte to access a list of science teachers. After securing permissions, data collection began. Respondents received clear instructions on how to complete the survey, which was available in an online format to ensure accessibility. The online questionnaire was also shared on the SDOIN Facebook Infoboard, allowing all science teachers in the division to participate. To minimize disruption, respondents had one week to complete the questionnaire at their convenience. The collected data were then tabulated, analyzed, and interpreted using appropriate statistical tools, culminating in conclusions and recommendations based on the findings.

Data Analysis

Quantitative data from the questionnaires was analyzed using statistical software. Descriptive statistics, such as frequency counts and percentages, were used to summarize the types of laboratory approaches utilized and their frequency of use. Inferential statistics, such as chi-square, were employed to examine the relationship between the commonly used laboratory teaching approach and its extent of utilization.

Ethical Considerations

The researcher upheld ethical standards by securing approval from the University Research Ethics and Review Board (URERB) and obtaining informed consent from voluntary participants. It was then communicated that participation was optional and that participants could withdraw at any time without repercussions.

As the study targeted Science teachers from the Schools Division of Ilocos Norte, the researchers ensured their safety by conducting the survey online, minimizing any risk of harm. Confidentiality and anonymity were guaranteed, with data accessible only to the researchers and securely disposed of after the study. Moreover, it is important to note that participants received no compensation, material benefits, or snacks during the data-gathering process.

Result and Discussion

Commonly Used Laboratory Teaching Approach

Table 1 presents the commonly used laboratory teaching approaches among science teachers in the Schools Division of Ilocos Norte. The data is summarized in terms of frequency and percentage for each approach, providing insights into the preferences and practices of educators in laboratory instruction.

Table 1. Commonly used laboratory teaching approach

Laboratory Teaching Approach	Frequency	Percentage
1. Confirmation Inquiry (CI)	0	0%
2. Demonstration (D)	31	46.970%
3. Guided Inquiry (GI)	29	43.940%
4. Open Inquiry (OI)	2	3.030%
5. Structured Inquiry (SI)	4	6.060%
Total	**66**	**100%**

The findings on the teaching methodologies employed in science education highlight a significant alignment with constructivist theories, as articulated by scholars such as Piaget and Vygotsky. The Demonstration Approach of 46.970% is the most frequently used, indicating that teachers often prefer to demonstrate experiments or concepts to students rather than having them engage in hands-on activities. According to Umara (2022), this method allows teachers to control the learning environment and ensure that students observe the correct procedures and outcomes. While Pulsay (2024) emphasizes the effectiveness of the demonstration approach in science education, Kaneza et al. (2024) found that hands-on experiments resulted in more interactive behaviors and higher verbal interactions among students and teachers. This evidence suggests that prioritizing hands-on experiments could lead to a more effective teaching of scientific concepts in the laboratory setting.

Similarly, the Guided Inquiry Approach is also highly utilized, suggesting that 43.94% of teachers encourage students to explore and discover concepts with some level of guidance. It was confirmed by Putri et al. (2024) and Karlina et al. (2024) that this method promotes critical thinking and problem-solving skills as students are actively involved in the learning process. Furthermore, evidence from a quasi-experimental study revealed that guided inquiry positively impacts students' science process skills and concept mastery, indicating a moderate improvement in critical thinking abilities (Karlina et al., 2024).

Demonstration and Guided Inquiry not only exemplify the integration of constructivist principles in laboratory practices but also emphasize the importance of hands-on experiences that enable students to construct knowledge through interaction with their environment and collaboration with peers. These experiential learning approaches are likely to foster a more effective and engaging science education experience. Supporting this notion, Nguyen et al. (2024) found that both demonstration and guided inquiry-based learning (IBL) significantly improved student performance and confidence. Particularly, higher gains were observed following IBL activities, underscoring the effectiveness of active learning methodologies in enhancing educational outcomes. This connection highlights how both teaching methods contribute to a rich learning environment where students are actively involved in their education, leading to improved results and a deeper understanding of scientific concepts.

In contrast, the Structured Inquiry Approach, which involves providing students with a structured framework to conduct experiments, is used less frequently with 6.06%. Although Wang et al. (2022) found that this approach enhances students' mathematical and scientific literacy, as evidenced by a study that linked structured inquiry to improved performance outcomes, it has been found that teachers in the Schools Division of Ilocos Norte underutilized this laboratory approach due to a preference for teacher-directed methods. This highlights the need for flexible scaffolding tailored to students' varying needs and contexts.

The underutilization of Structured Inquiry indicates a missed opportunity to foster student autonomy and critical thinking. Evidence suggests that incorporating this approach could significantly enhance literacy skills by encouraging independent exploration of concepts.

To bridge this gap, targeted professional development for teachers could showcase the

advantages of structured inquiry. Creating a collaborative environment where educators can exchange successful strategies would also support a more balanced science education methodology. By integrating diverse teaching methods, educators can cater to various learning styles, ultimately enriching the educational experience. As the landscape of education evolves, it is crucial to reassess what is taught and how it is delivered, ensuring all students benefit from engaging and meaningful learning opportunities.

The Open Inquiry is the least utilized, with only 3.03% of teachers employing it. This approach allows students to formulate questions and design experiments. A study by Baur and Emden (2020) suggests that teachers often lack confidence in students' ability to independently formulate questions and design experiments, leading to a preference for more structured approaches. This preference indicates a need for professional development and training to build teachers' confidence in guiding students through the Open Inquiry process. Workshops that demonstrate how to facilitate independent inquiry while providing appropriate support could be beneficial. Additionally, fostering a classroom culture that encourages curiosity and risk-taking could empower students to engage more deeply in their learning. By gradually integrating more Open Inquiry experiences, teachers can help students develop vital skills in question formulation and experimental design, ultimately enhancing their overall science literacy (Dah et al., 2024).

The Confirmation Inquiry (0%) approach, which involves students confirming a known scientific principle through experimentation, was not used at all. This absence suggests that teachers may prioritize more exploratory or demonstrative methods over confirming existing knowledge. A study by Shivolo and Mokiwa (2024) found that many Namibian secondary school teachers held traditional views, emphasizing cookbook-style experiments. This preference for exploratory methods over Confirmation Inquiry may stem from challenges in implementing inquiry-based instruction and a lack of training and resources. Additionally, Silva-Núñez and Cáceres-Mesa (2024) emphasize the importance of promoting experimentation in teaching science, suggesting that teachers may focus on methods that encourage discovery and understanding rather than merely confirming known principles.

The study's findings aligned with other researchers' data, indicating that teachers prefer exploratory methods rather than providing students with the necessary opportunities to confirm and apply their knowledge actively. Moreover, the predominance of demonstration and guided inquiry approaches highlights a potential gap in fostering independent inquiry skills among students. While these methods are effective for teaching specific science concepts, they may not fully prepare students for real-world scientific inquiry, which often requires critical thinking and problem-solving abilities.

The low usage of open and structured inquiry approaches corresponds to challenges of teachers as to time constraints, unavailability of materials, safety concerns for both teachers and students, lack of laboratory classrooms, and insufficient training for teachers.

Following the acknowledgment of the challenges leading to the low usage of Open and Structured Inquiry approaches, it is crucial to propose targeted solutions. Addressing these obstacles requires comprehensive professional development programs aimed at equipping teachers with the necessary skills to effectively implement inquiry-based methods. Additionally, providing schools with adequate resources, such as laboratory materials and dedicated laboratory spaces, can facilitate hands-on learning experiences.

Moreover, promoting a culture of safety and support within schools will help alleviate concerns associated with conducting experiments. By focusing on these areas, educational institutions can create an environment that encourages exploration and innovation, empowering teachers to incorporate a wider range of laboratory methodologies.

Extent of Using Laboratory Teaching Approach

Table 2 presents a detailed overview of the frequency with which various laboratory teaching approaches are employed by science

teachers within the Schools Division of Ilocos Norte. The data categorizes the extent of use into specific intervals, providing valuable insights into the pedagogical practices of educators in the region.

Table 2. Extent of Using Laboratory Teaching Approach

Extent of Using Laboratory Approach	Frequency	Percentage
Everyday	2	3.03%
Once a week	17	25.76%
Twice a week	4	0.06%
Thrice a week	3	4.55%
Once every two weeks	17	25.76%
Once every three weeks	5	7.58%
Once a month	9	13.64%
Once a quarter	8	12.12%
When students want	0	0%
Never	1	1.52%
Total	66	100%

The data indicates that only a small fraction of teachers (3.03%) engage in laboratory activities on a daily basis. This low percentage suggests that the integration of laboratory work into everyday instruction may be constrained by factors such as curriculum demands, resource availability, and time management challenges. The limited frequency of daily laboratory use may hinder the development of student's practical skills (Efendi & Jayanti, 2024) and their ability to apply theoretical knowledge in real-world contexts, thereby hindering the development of essential experimental and research skills necessary for effective learning and real-world application in scientific disciplines (Mosiienko et al., 2023).

A more substantial proportion of teachers (25.76%) reported utilizing laboratory approaches once a week. This frequency reflects a moderate commitment to incorporating hands-on learning experiences into the curriculum. Weekly laboratory sessions can facilitate the reinforcement of concepts taught in lectures, thereby enhancing students' understanding and retention of scientific principles. However, Efendi and Jayanti (2024) emphasize that inadequate management of weekly laboratory activities can lead to underutilization of resources, resulting in incomplete documentation and minimal follow-up. This negatively impacts student engagement and learning experiences, ultimately hindering the development of practical skills in natural sciences.

Similar to the weekly usage, the bi-weekly frequency with a percentage of 25.75% indicates that a significant number of educators opt for laboratory instruction every two weeks. This approach may strike a balance between theoretical instruction and practical application, allowing students to engage in scientific inquiry without overwhelming the curriculum. Nonetheless, the infrequency of these sessions may still limit the development of students' inquiry skills and their familiarity with laboratory procedures.

The data reveals that 13.64% of teachers utilize laboratory approaches once a month. This infrequent engagement may restrict students' opportunities for hands-on learning, potentially impacting their ability to grasp complex scientific concepts. The reliance on monthly laboratory sessions may not provide sufficient exposure to practical applications of science, which is critical for fostering a comprehensive understanding of the subject matter.

A notable percentage of teachers (12.12%) reported using laboratory approaches once a quarter. This infrequent engagement raises concerns regarding the adequacy of practical experiences provided to students. Such limited exposure may hinder the development of essential skills necessary for scientific inquiry and experimentation.

Alarmingly, a small percentage of teachers (1.52%) indicated that they never employ laboratory approaches in their instruction. This finding underscores a significant gap in the educational experience for students in these classrooms, as Garcia et al. (2022) highlighted that the absence of laboratory activities makes it difficult for students to understand complex concepts, leading to challenges in formulating scientific explanations and critical thinking. Students described their learning experiences as "finding light in the dark" due to these limitations. Moreover, Nimreskosu et al. (2024) emphasizes that the limited use of laboratories in high schools restricts practical learning, negatively impacting students' scientific attitudes and creative thinking.

The findings from Table 2 suggest that while there is a recognition of the importance of laboratory instruction among science teachers, the overall frequency of its implementation remains relatively low. The predominance of weekly and bi-weekly usage indicates a commitment to hands-on learning; however, the limited frequency of more frequent laboratory activities may impede the development of students' inquiry skills and practical knowledge (Chang et al., 2022).

The low percentage of daily laboratory use underscores the need for targeted professional development, resource allocation, and institutional support. By focusing on these areas, it is possible to enhance both the frequency and quality of laboratory instruction, ultimately improving the educational experience for students and fostering their engagement and understanding of scientific concepts.

Correlation between Commonly Used Laboratory Teaching Approach and Extent of Use

This study examines the relationship between frequently employed laboratory teaching methods, specifically Demonstration, Guided Inquiry, Open Inquiry, Structured Inquiry, and Confirmation Inquiry, and the frequency of their implementation in public secondary schools.

Table 3. Correlation between commonly used laboratory teaching approach and extent of use

LTA	CI	D	GI	OI	SI	**Total**
Everyday	0	1	1	0	0	**2**
Once a week	0	11	5	0	1	**17**
Twice a week	0	2	1	0	1	**4**
Thrice a week	0	0	3	0	0	**3**
Once every two weeks	0	7	8	0	2	**17**
Once every three weeks	0	2	3	0	0	**5**
Once a month	0	3	4	2	0	**9**
Once a quarter	0	4	4	0	0	**8**
When students want	0	0	0	0	0	**0**
Never	0	1	0	0	0	**1**
Total	**0**	**31**	**29**	**2**	**4**	**66**

The data indicates that the Confirmation Inquiry approach was not utilized at all (0%). This absence suggests a significant gap in the pedagogical practices of science teachers, as Confirmation Inquiry typically involves students confirming known scientific principles through experimentation. The lack of this approach may reflect a preference for more exploratory or demonstrative methods, potentially limiting students' opportunities to engage in validating scientific concepts through hands-on experiences.

The Demonstration approach emerged as the most frequently used method, with 1 instance of daily use and 11 instances of weekly use. This indicates that teachers often prefer to demonstrate experiments or concepts rather than allow students to engage in hands-on activities. While this method can effectively convey specific scientific principles, Martín-Alguacil and Avedillo (2024) emphasize that this

method may not foster the development of independent inquiry skills among students, as they are primarily passive observers rather than active participants in the learning process.

The Guided Inquiry approach was also utilized frequently, with 1 instance of daily use, 8 instances once every two weeks, and 5 instances of weekly use. This method encourages students to explore and discover concepts with some level of guidance from the teacher. The higher frequency of this approach compared to others suggests that educators recognize the value of promoting critical thinking and problem-solving skills. However, the reliance on guided inquiry may still limit the extent to which students can engage in fully independent scientific inquiry.

The Open Inquiry approach was the least utilized among other approaches, which allows students to formulate their own questions and design their own experiments and was utilized once every two weeks. This suggests a hesitance among teachers to allow students complete autonomy in the laboratory setting.

The Structured Inquiry approach on the other hand, with only a few instances of use. This method provides a structured framework for students to conduct experiments, but its low frequency suggests that teachers may prefer more open-ended or teacher-directed methods. The limited use of this approach may hinder students' opportunities to engage in inquiry-based learning.

Chi-Square Points

LTA	CI	D	GI	OI	SI
Everyday	0	0.004	0.017	0.061	0.121
Once a week	0	1.139	0.817	0.515	0.001
Twice a week	0	0.008	0.327	0.121	2.367
Thrice a week	0	1.409	2.146	0.091	0.182
Once every two weeks	0	0.121	0.038	0.515	0.913
Once every three weeks	0	0.052	0.294	0.152	0.303
Once a month	0	0.356	0.001	10.939	0.545
Once a quarter	0	0.016	0.067	0.242	0.485
When students want	0	0	0	0	0
Never	0	0.599	0.439	0.03	0.061

Chi square = 25.494
The p-value is 0.0000 significant at p<0.01
H1: There is a significant correlation between the commonly used laboratory teaching approaches and the extent of their use among science teachers in public secondary schools in the Schools Division of Ilocos Norte.
H0: There is no significant correlation between the commonly used laboratory teaching approaches and the extent of their use among science teachers in public secondary schools in the Schools Division of Ilocos Norte.

The chi-square test was conducted to examine the relationship between the commonly used laboratory teaching approaches (Demonstration, Guided Inquiry, Open Inquiry, Structured Inquiry, and Confirmation Inquiry) and the extent of their use (frequency of implementation) among science teachers in public secondary schools within the Schools Division of Ilocos Norte. The results yielded a chi-square value of 25.494, with a corresponding p-value of 0.0000, indicating statistical significance at the $p < 0.01$ level.

Given the chi-square value of 25.494 and the p-value of 0.0000, we reject the null hypothesis (H0) in favor of the alternative hypothesis (H1). This finding suggests that there is a statistically significant correlation between the types of laboratory teaching approaches employed by science teachers and the frequency with which these approaches are implemented in their classrooms.

The significant chi-square result indicates that the distribution of responses regarding the frequency of use of each teaching approach is not uniform. Specifically, the data reveals that certain approaches, such as Demonstration and

Guided Inquiry, are utilized more frequently than others, such as Open Inquiry and Confirmation Inquiry. This disparity in usage suggests that teachers may have preferences for specific methodologies, which could be influenced by factors such as pedagogical effectiveness, teacher training, and resource availability.

Conclusion

This study aimed to assess the current state of laboratory practices among science teachers in public secondary schools within the Schools Division of Ilocos Norte. The findings reveal a clear preference for specific laboratory teaching approaches, notably the Demonstration and Guided Inquiry methods, which are utilized more frequently than Open Inquiry and Confirmation Inquiry. This trend indicates a tendency among educators to favor structured methodologies that allow for greater control over the learning environment, potentially at the expense of fostering independent inquiry skills among students.

The data analysis, including a chi-square test, demonstrates a significant correlation between the types of laboratory approaches used and their frequency of implementation, suggesting that teachers' choices are influenced by various contextual factors. The low engagement with Open Inquiry and Confirmation Inquiry highlights critical barriers that may hinder the development of essential scientific skills in students, such as critical thinking and problem-solving.

These findings underscore the urgent need for targeted professional development initiatives aimed at equipping teachers with the necessary skills and resources to diversify their instructional approaches. Enhancing teachers' confidence and capabilities in implementing a broader range of inquiry-based methodologies, can improve the quality of science education and better prepare students for real-world scientific inquiry.

In conclusion, this research provides critical insights into the laboratory practices of science teachers in the region, emphasizing the importance of understanding these practices to inform future training and support initiatives aimed at enhancing science education. Further research is recommended to explore the impact of these teaching approaches on student learning outcomes and to identify the specific challenges teachers face in implementing diverse laboratory methodologies.

Acknowledgment

The completion of this paper reflects months of challenges and perseverance through long days and nights. The researcher received generous support from family and friends, who selflessly provided motivation and inspiration. Therefore, the researcher would like to express heartfelt gratitude to all those who contributed to the successful completion of this work.

To Dr. Marc Paul T. Calzada, the research adviser, for his steadfast guidance, wisdom, and support throughout this research process. His insightful feedback and constructive criticism have been crucial in steering the study in a productive direction. His commitment to fostering his students' potential has encouraged the researcher to pursue excellence.

To Mariano Marcos State University (MMSU) for its commitment to fostering academic excellence and research and for supporting students in achieving their academic goals.

Additionally, heartfelt appreciation goes to the supportive public secondary school teachers in the Schools Division of Ilocos Norte for their time, kindness, and patience in completing the research questionnaire. Your willingness to share your experiences and insights has greatly enriched this study and underscored the significance of collaboration in education.

The researcher wishes to acknowledge her primary source of strength and motivation: her parents, Mr. Hector A. Tabulog and Mrs. Glenda D. Tabulog; her siblings, Dane Andy D. Tabulog and Sean Dylan Jaimes D. Tabulog; and her loved one, Franz Bryan V. Balon. Their moral support, unwavering encouragement, genuine love, and constant prayers have been instrumental in her journey. Your faith in me has fueled my quest for knowledge and personal development.

Most importantly, gratitude is extended to the Almighty God for the knowledge, guidance, wisdom, strength, and unconditional love that

inspired her to pursue and appreciate the significance of earning a master's degree. Your blessings have illuminated my path and equipped me with the resilience to face challenges.

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