Print ISSN: 3116-3807; Electronic ISSN: 3116-3815

International Journal of Engineering, Industrial, Maritime, and Technological Innovation

Volume 1, Issue 1
January-March 2026

INJENI

Published by ETCOR Educational Research Center
Research Consultancy Services

A Quarterly Peer-Reviewed International Research Journal

International Journal of Engineering, Industrial, Maritime, and Technological Innovation (INJENI) P - ISSN: 3116-3807 E - ISSN: 3116-3815

PRC-CPD Accredited Provider: PTR-2025-749

NBDB Registration Book Publisher (Print & Digital): 8372

International Journal of Engineering, Industrial, Maritime, and Technological Innovation (INJENI)

Frequency: *A Quarterly Peer-Reviewed International Research Journal*
Publisher: *ETCOR Educational Research Center Research Consultancy Services*

Print ISSN: 3116-3807
Electronic ISSN: 3116-3815

About the Journal

The **International Journal of Engineering, Industrial, Maritime, and Technological Innovation (INJENI)** is a ***scholarly, open-access, quarterly, peer-reviewed, international print and online research journal*** dedicated to the advancement of knowledge in engineering systems, industrial research, maritime engineering, smart technologies, and technological innovation. INJENI serves as a global platform for engineers, industrial researchers, maritime professionals, technologists, systems designers, port and offshore engineers, and interdisciplinary scholars to disseminate high-quality experimental, computational, design-based, and applied research that drives technological progress, industrial efficiency, and sustainable engineering solutions. The journal is committed to maintaining rigorous technical standards, ethical research practices, and global visibility through international indexing, Crossref DOI registration, and print and electronic ISSN accreditation.

Aims and Scope

Aims

INJENI aims to:

1. Promote high-quality research in engineering, industrial, maritime, and technological innovation
2. Advance engineering systems design, optimization, and industrial and maritime applications
3. Encourage interdisciplinary integration of engineering, digital technologies, marine and offshore systems, and industry practices
4. Provide a venue for global, applied, and industry-relevant engineering and maritime research
5. Support innovation in maritime, smart, and emerging technologies

Scope

The journal welcomes original research articles, systematic reviews, technical reports, design studies, and applied research papers in, but not limited to, the following areas:

- Engineering systems and systems engineering

International Journal of Engineering, Industrial, Maritime, and Technological Innovation (INJENI)
P - ISSN: 3116-3807
E - ISSN: 3116-3815
PRC-CPD Accredited Provider: PTR-2025-749
NBDB Registration Book Publisher (Print & Digital): 0372

- Industrial engineering and operations management
- Mechanical, electrical, civil, and electronics engineering
- Maritime engineering, naval architecture, offshore systems, marine propulsion, and port technologies
- Automation, robotics, and smart manufacturing
- Industry 4.0, digital transformation, and cyber-physical systems
- Artificial intelligence and data-driven engineering applications
- Sustainable engineering and green technologies
- Infrastructure systems and industrial safety
- Interdisciplinary and applied engineering research

Publication Frequency and Format

- **Frequency:** Quarterly (4 issues per year)
- **Formats:** Print and Online
- **Review Type:** Double-blind peer review
- **Identifiers:**
  - Print ISSN
  - Electronic ISSN
  - Crossref DOI assigned to all published articles

Submission Guidelines

Author Guidelines / Instructions to Authors

Manuscripts are received with the understanding that they contain **original scholarly work** that has **not been previously published** nor is under consideration for publication elsewhere.

Authors must submit manuscripts through **https://tinyurl.com/INJENIjournal**

For manuscripts with **two or more authors**, the **corresponding author** must submit the manuscript on behalf of all co-authors.

For inquiries, authors may contact:

- **ETCOR Mobile:** 0939-202-9035
- **Email:** embracingthecultureofresearch@gmail.com

Funding Disclosure

All authors must disclose **all funding sources or financial support**, if any, related to the research.

With regard to research submitted for possible publication, authors must ensure that they follow **the journal format**, including the template, header, footer, font size and font style. Author/s must download and follow the sample manuscript found via this link:

International Journal of Engineering, Industrial, Maritime, and Technological Innovation (INJENI)
P - ISSN: 3116-3807
E - ISSN: 3116-3815
PRC-CPD Accredited Provider: PTR-2025-749
NBDB Registration Book Publisher (Print & Digital): 0372

https://tinyurl.com/TemplatesINJENI Kindly reduce the manuscript to **10-12 pages only, including the References**. Kindly choose only the most salient parts of the paper

Additionally, kindly comply with the following:

1. **Academic Significance, Contribution to Discipline or Community, Technical Novelty**
   The paper should demonstrate importance to the academic community or to research in general. It must offer a material contribution to its discipline and present novel or unique ideas that may be useful to the community. Clearly show the research gap, why there was a need to investigate the present study, and how it is different from previous works.
2. **English Usage (or Filipino, as may be applicable)**
   The manuscript must adhere to the rules of grammar and language usage, whether in English or Filipino.
   - Use **past tense** consistently since the study is already completed.
   - Avoid first-person point of view ("I," "we"); instead, maintain a **third-person scientific tone**.
   - Avoid contractions; spell out complete words to retain formality.
   - Provide **English translations** for words, terms, or items not understandable to international readers.
3. **Abstract**
   The abstract should follow the journal's prescribed format and accurately reflect the study's major components. Ensure that it correctly presents the **aim, methodology, key findings or results, and conclusion** in a concise and logical manner.
4. **Introduction / Background of the Study**
   The introduction must:
   - Present a clear rationale or background from the **global to Philippine/local contexts**.
   - Show the **trends and issues** related to the study, supported with recent and relevant citations (2021–2026 preferred).
   - Identify and explain the **research gap/s**, highlighting why the present study is necessary and how it differs from prior works.
5. **Statement of the Problem, Research Objectives and Research Questions**
   The Statement of the Problem, Research Objectives and Research Questions must be clearly, explicitly, and logically stated.
   - The **statement of the problem** is a detailed explanation of the issue, gap, or challenge that the study seeks to address. It frames the context and justifies why the study is necessary, usually written in declarative form as a narrative or paragraph. Its purpose is to highlight the significance, scope, and urgency of the study, providing a broad and contextual background of the issue at hand. For example, a study may state: *"Despite government programs, many senior citizens in rural areas experience delays in receiving social pensions, raising concerns about accessibility and efficiency."*

International Journal of Engineering, Industrial, Maritime, and Technological Innovation (INJENI)
P - ISSN: 3116-3807
E - ISSN: 3116-3815
PRC-CPD Accredited Provider: PTR-2025-749
NBDB Registration Book Publisher (Print & Digital): 8372

- The **research objectives** represent the specific aims or intentions of the study, focusing on what the researcher seeks to accomplish. These are written in infinitive form such as "To determine…" or "To examine…," ensuring that the targets are clear, measurable, and achievable. Unlike the broad statement of the problem, objectives are narrower and centered on actionable outcomes. For instance, a general objective could be *"To assess the implementation of the Social Pension Program in Balbalan, Kalinga."* This may be broken down into specific objectives, such as: (1) To determine the accessibility of the program, (2) To examine its impact on beneficiaries, and (3) To identify challenges faced in its implementation.
- The **research questions** are the interrogative form of the objectives, expressed as direct questions the study seeks to answer. They are usually written in formats such as "What is…?" or "How does…?" and serve the purpose of guiding data collection and analysis by pointing to specific inquiries. Research questions are even more specific than objectives, as they operationalize the study's goals into answerable items. Using the same example, the research questions could include: *RQ1: How accessible is the Social Pension Program to senior citizens in Balbalan? RQ2: What impact does the program have on the beneficiaries' quality of life? RQ3: What challenges hinder the effective implementation of the program?*

6. **Review of Related Literature and Studies**
   This section must include sufficient, relevant, and **up-to-date references** to support the rationale and conduct of the research.
   - Avoid outdated sources (1–2 decades old) for dynamic or evolving concepts.
   - Do not use sources with "no date (n.d.)."
   - Ensure citations are aligned with the arguments and logically linked to the study.
   - There must be a clear synthesis at the end of the RRLS that captures key insights, connects the reviewed works, and justifies the need for the present study.
7. **Theoretical and/or Conceptual Framework**
   An appropriate theoretical and/or conceptual framework must be presented to anchor the study.
8. **Research Methodology (Research Design, Population and Sampling, Instrument, Data Collection, Treatment of Data, Ethics in Research)**
   The methodology section should be well-structured, detailed, and properly organized. Each subsection should only contain content appropriate to it:
   - **Research Design:** Describe what design was used, how it was applied, and why it was the most suited.
   - **Population and Sampling and Other Source/s of Data:** Provide the exact number of participants/respondents, how and why they were selected. If you used other source/s of data (documents, policies, other contents), describe each document, how each was accessed, and why each is needed in the study.
   - **Instrument/s:** State whether the instrument was adopted or researcher-made. Describe its validation process, including the qualifications of validators.
   - **Data Collection:** Focus on *how, when, and where* the data was collected. Do not include ethics approval here.

International Journal of Engineering, Industrial, Maritime, and Technological Innovation (INJENI)
P - ISSN: 3116-3807
E - ISSN: 3116-3815
PRC-CPD Accredited Provider: PTR-2025-749
NBDB Registration Book Publisher (Print & Digital): 0372

- **Treatment of Data:** Clearly describe the methods of data analysis or statistical treatment. For qualitative analysis, avoid generic discussions (e.g., what thematic analysis is according to authors). Instead, show how the method was applied in your study.
- **Ethical Considerations:** Include ethical approval, informed consent, and permissions here, not in other subsections.

Important Reminders:

- Avoid "chop-suey" writing (mixing unrelated topics).
- If the study used a **mixed-method approach**, discuss both parts separately (quantitative and qualitative)—design, participants, instruments, data collection, treatment of data, ethical considerations—and explain how the two sets of data were integrated.
- Use plural ("researchers") consistently if the paper has co-authors.

9. **Results and Discussion**
   - Present results clearly, logically, and aligned with the research questions.
   - Support findings with **relevant and recent literature**.
   - Integrate discussion immediately after each result to enhance coherence.
10. **Conclusions and Recommendations**
    - Conclusions must be logically drawn from the study's findings.
    - Recommendations should be **specific, actionable, and relevant** to the results. Avoid generic statements.
11. **References (APA 7th Edition)**

References must strictly adhere to APA 7th edition. Authors must review their entire manuscript carefully:

- Ensure proper formatting (e.g., italicizing journal names, use of "&" vs. "and," correct application of *et al.*, punctuation, spacing, quotation marks).
- All in-text citations must appear in the References list and vice versa. **No mismatches allowed.**
- Avoid old references; prioritize recent ones.
- If a citation was included but missing in the References, update it properly (do not erase it without explanation). Similarly, remove unused entries from the References list.
- The paper will not be published if even one citation/reference entry is non-compliant.

APA 7th requires:

- All sources listed in the References Section must match 100% with the actual sources used in the entire manuscript, and all sources cited in the entire manuscript are reflected in the list of sources in the References section.
- Author/s should provide a link to every research article or literature/document, where we can find the journal or document, or best, where we can find the specific research article/document. Must provide the DOI for it, or URL if the journal is not yet DOI accredited, or link to the document.

International Journal of Engineering, Industrial, Maritime, and Technological Innovation (INJENI)
P - ISSN: 3116-3807
E - ISSN: 3116-3815
PRC-CPD Accredited Provider: PTR-2025-749
NBDB Registration Book Publisher (Print & Digital): 0372

- Arranged alphabetically regardless of classifications (Do not categorize or classify if books, or journals, or other documents. Just arrange alphabetically all sources)
- Used hanging indent.
- Author(s) last name, initials.
- Year of publication in parentheses.
- Title of article in sentence case (only first word, proper nouns, and first word after a colon capitalized).
- Journal titles in italics and title case.
- Volume numbers italicized; issue numbers in parentheses (not italicized).
- Page ranges given without extra words.
- DOI formatted as URL (https://doi.org/...).
- Retrieval statements are used sparingly (only when content is likely to change).
- For secondary sources, only the work actually consulted (the secondary source) is included in the References list; the original source cited indirectly (e.g., "as cited in") must not be listed unless it was directly read by the author.

12. **Acronyms and Abbreviations**
    Always define acronyms upon first mention in the manuscript. Do not assume that readers will automatically know them.

Authors are also required to submit a **duly signed Authorship and Contribution Declaration Form**, which can be accessed via this link: **https://tinyurl.com/TemplatesINJENI**

Review Process

Upon receipt, authors receive an **acknowledgment email**.

Manuscripts not following the journal template will be returned. Compliant manuscripts undergo:

1. Initial screening by the **Associate Editor**
2. **Plagiarism check**
3. **Double-blind peer review** by two subject-expert reviewers

Review decisions may be:

- Publish unaltered
- Accept after minor revisions
- Accept after major revisions
- Reject

In cases of split reviewer decisions, a **third reviewer** will be assigned. Authors are given **two weeks** for revisions. Final decisions are made by the **Editor-in-Chief**.

International Journal of Engineering, Industrial, Maritime, and Technological Innovation (INJENI)
P - ISSN: 3116-3807
E - ISSN: 3116-3815
PRC-CPD Accredited Provider: PTR-2025-749
NBDB Registration Book Publisher (Print & Digital): 0372

Publication Policies and Ethics

Changes to Authorship
Authors retain copyright under a licensed agreement and may archive:

- Pre-print
- Post-print
- Publisher's PDF

Conflict of Interest
All authors must disclose any actual or potential conflicts of interest.

Article Retraction
Retractions may occur due to ethical violations such as plagiarism, duplicate submission, or data fabrication.
Retraction fee: PHP 6,000 (USD 120)

Article Withdrawal
Withdrawal after completion of review and editorial processing incurs a fee of: **PHP 6,000 (USD 120)**

Article Removal
Articles may be removed only under **legal or safety circumstances**.

Additional Information

- **Call for Research Articles:** Rolling basis
- **Application for Peer Reviewers and Language Editors:** Open
- **Publication Charges and Discounts:** Available for ETCOR Research Consultants and External Reviewers
- **Indexing and Archiving:** International databases and institutional repositories
- **Editorial Board:** International and multidisciplinary

International Journal of Engineering, Industrial, Maritime, and Technological Innovation (INJENI)
P - ISSN: 3116-3807
E - ISSN: 3116-3815
PRC-CPD Accredited Provider: PTR-2025-749
NBDB Registration Book Publisher (Print & Digital): 0372

Editor's Note

International Journal of Engineering, Industrial, and Technological Innovation (INJENI)

It is with great pride and enthusiasm that we present the maiden issue of the International Journal of Engineering, Industrial, Maritime, and Technological Innovation (INJENI). This inaugural publication reflects ETCOR's commitment to advancing innovative and application-driven engineering and maritime research.

Engineering and industrial research lie at the core of technological progress and economic development. As industries navigate digital transformation, automation, and sustainability challenges, engineering research must continuously evolve to provide practical and forward-looking solutions.

INJENI provides a scholarly platform for research spanning engineering systems, industrial processes, maritime and offshore technologies, port systems, and smart innovations.

As a peer-reviewed international journal, INJENI upholds the highest standards of technical rigor through a double-blind review process, strict adherence to publication ethics, and emphasis on methodological soundness and validation.

The journal seeks to bridge theory and practice. Engineering research achieves its greatest impact when theoretical models and technological innovations are translated into industrial applications and operational improvements.

This maiden issue is the result of collaborative efforts among authors, reviewers, editors, and technical specialists who share a dedication to scholarly excellence and responsible engineering practice.

INJENI is positioned as a global journal that values interdisciplinary and industry-oriented research. By welcoming contributions from researchers worldwide, the journal promotes international collaboration and knowledge exchange.

The journal is also committed to supporting early-career engineers and emerging researchers. INJENI aims to provide a supportive yet rigorous platform for developing and disseminating innovative engineering ideas.

As we launch this first issue, we reaffirm our commitment to ethical research, safety, and continuous improvement. INJENI will continue to evolve alongside advances in engineering and industrial technologies.

On behalf of the Editorial Board, we extend our sincere gratitude to all who contributed to this

International Journal of Engineering, Industrial, Maritime, and Technological Innovation (INJENI)
P - ISSN: 3116-3807
E - ISSN: 3116-3815
PRC-CPD Accredited Provider: PTR-2025-749
NBDB Registration Book Publisher (Print & Digital): 0372

maiden issue. We invite engineers, technologists, and industrial researchers worldwide to join us in shaping future issues of INJENI.

Engr. Luisito Lolong Lacatan, PhD, Editor-in-Chief
International Journal of Engineering, Industrial, and Technological Innovation (INJENI)

International Journal of Engineering, Industrial, Maritime, and Technological Innovation (INJENI)
P - ISSN: 3116-3807
E - ISSN: 3116-3815
PRC-CPD Accredited Provider: PTR-2025-749
NBDB Registration Book Publisher (Print & Digital): 0372

International Journal of Engineering, Industrial, Maritime, and Technological Innovation (INJENI)
P - ISSN: 3116-3807
E - ISSN: 3116-3815
PRC-CPD Accredited Provider: PTR-2025-749
NBDB Registration Book Publisher (Print & Digital): 0372

Table of Contents

ETCOR's Website : https://etcor.org
Facebook Page : https://www.facebook.com/EmbracingTheCultureOfResearch
Twitter Account : https://twitter.com/ETCOR_research
YouTube Channel : https://tinyurl.com/YouTubeETCOR
E-mail Address : embracingthecultureofresearch@etcor.org
Mobile Number : 0939-202-9035

International Journal of Engineering, Industrial, Maritime, and Technological Innovation (INJENI)
P - ISSN: 3116-3807
E - ISSN: 3116-3815
PRC-CPD Accredited Provider: PTR-2025-749
NBDB Registration Book Publisher (Print & Digital): 0012

Speaking and Writing Skills in English of Fourth Year BS Marine Engineering Students at PMMA

Dr. Wilma David Paras
Philippine Merchant Marine Academy, San Narciso, Zambales, Philippines

Abstract

Aim: This study assessed the speaking and writing skills of Fourth Year BS Marine Engineering students of the Philippine Merchant Marine Academy (PMMA) in San Narciso, Zambales.
Methodology: The descriptive type of research was used in the study where the respondents are the Fourth Year BS Marine Engineering students of the Philippine Merchant Marine Academy in San Narciso, Zambales. Data were gathered with questionnaire and documentary analysis of their speaking and writing activities.
Results: The result of the correlation between the speaking skills of the respondents and their performance in Speech I was interpreted as moderate positive correlation. Using the Pearson r formula, the computed r = 0.474 with a significant value of 0.000 which is significant is at 0.05. This means that there is a moderate positive correlation between the speaking skills of the respondents and their performance in Speech I. Correlation is significant. Two variables are uncorrelated when a change in one doesn't lead to a change in the other and vice versa. Using the Pearson r formula, r = 0.649 with a significant value of 0.000 and a descriptive interpretation of moderate positive correlation, the computed r value in English 1 and writing skill is 0.649 which is significant at 0.05. There was a moderate positive correlation between the writing skills of the respondents and their performance in English 1. Correlation is significant.
Conclusion: Majority of the respondents were male, used Filipino language at home, used English language in school, and preferred reading newspapers. Most of the respondents obtained a satisfactory rating in their speaking skill. A few of the respondents garnered a satisfactory rating in their writing skill. The academic performance of the respondents in their Speech 1 had a moderate positive correlation in developing their speaking skill. The correlation of both variables is significant. The academic performance of the respondents in their English 1 revealed a moderate positive correlation in their writing skill. The correlation of both variables is significant.

Keywords: *speaking, writing, skills, Philippine Merchant Marine Academy, Marine Engineering*

INTRODUCTION

Speaking is a productive skill in the oral mode. Like other skills, it is more complicated than it seems at first and involves more than just pronouncing words. There are three kinds of speaking situations in which we find ourselves, these are: interactive, partially interactive, and non-interactive. Interactive speaking situations include face-to-face conversations and telephone calls, in which we are alternately listening and speaking, and in which we have a chance to ask for clarification, repetition, or slower speech from our conversation partner. Some speaking situations are partially interactive, such as when giving a speech to a live audience, where the convention is that the audience does not interrupt speech. The speaker nevertheless can see the audience and judge from the expressions on their faces and body language whether he/she is being understood.

Speaking a language is especially difficult for foreign language learners because effective oral communication requires the ability to use the language appropriately in social interactions (Richards, 2002). Speaking is one of the elements of communication where communication is the output modality and learning is the input modality of language acquisition.

As human beings, we always need communication to express our idea to do everything, what's more as a student or learners they must speak with their teachers if in learning process to be able to express their idea. Renandya (2002), "Communication in the classroom embedded in focused meaning activity. This requires teachers to tailor their instruction carefully to the needs of learners and teach them how to listen to others, and how to negotiate meaning in a shared context. Out of interaction, learners will learn how to communicate verbally and non-verbally as their language store and knowledge skills develop. Consequently, the give and take exchanges of messages will enable them to create discourse that conveys their intention in real life communication."

Therefore, in a formal environment between teachers and students must always interact to make communication. In fact, most of our daily communication remains interactional. It can interact in language that is

International Journal of Engineering, Industrial, Maritime, and Technological Innovation (INJENI)
P - ISSN: 3116-3807
E - ISSN: 3116-3815
PRC-CPD Accredited Provider: PTR-2025-749
NBDB Registration Book Publisher (Print & Digital): 0312

essential. Speaking is a fundamental and instrumental act. Speakers talk to have some effect on their listeners. They assert things to change their state of knowledge. They ask them questions to get them to provide information. They request things to get them to do things for them (Clark, 1997).

On the other hand, writing is a very important skill too. Just like speaking, writing helps one express oneself. It prepares us for school and employment (both of which in most cases require a lot of it). Writing is how much of the world communicates. Writing can be a great tool to help you know more about the way you think…Writing can solidify ideas and thoughts and allow you to reflect on them better than if the ideas remained evolving in your head. It is one of the ways that we translate our thoughts for other people. Some people, even students, are better at expressing themselves in writing than any other way and get a better translation when you read what they have to say rather than hearing them speak.

Speaking can help you learn those things as well, but it is easier to self-examine and evaluate how to improve when you have something concrete in front of you, you can revise, you can go back to your writing and edit what you have written. Writing is a very important component of our life. It helps us to increase our speed, learn things faster and in an easy way. We write because we forget things very fast (Matway, 2007).

Good writing is one of those skills that may not always show importance until it is mastered, and one can personally see its effect. Most people leave off their practice of expressing themselves in writing with terrible fear. They assume that because they weren't writing perfectly, they should not write it at all. This habit often stems from public school where many students are discouraged by the words, *"If you can't write, then stop trying to write something that you cannot express."* These ideas created personal obstacles just because they feared how others would react to the errors within their writing. As a result, they also put some major obstacles into their process of learning. Therefore, these two communication skills improve the outcome of students' learning and the way they will be able to leave an impression on others through their expression.

The Philippine Merchant Marine Academy (PMMA) presently stands as a pillar among maritime institutions in the country, but its graduates still need to be globally competitive in terms of communication particularly in the use of the English language. As we all know, English is the universal language that is used all over the world. It is imperative that graduates of the PMMA be communicative and conversant in the English language as they unravel and sail the seven seas.

CMO No.14, Series of 2013, Article III under its Educational Objectives Program, states that the BS Mar-E program aims to (a) provide and equip students with knowledge, understanding, proficiencies, skills, competencies, attitudes and values to qualify them for professional licensure examination and assessment and certification as officer in charge of an engineering watch in a manned engine-room or designated duty engineer officer in a periodically unmanned engine room on seagoing ships powered by main propulsion machinery of 750kw propulsion power or more; (b) produce graduates that are competent to carry out safely the watchkeeping duties of an officer in charge of an engineering watch in a manned engine room or designated duty engineer officer in a periodically unmanned engine room, both at sea and in port; fully conversant with the basic principles to be observed in keeping an engineering watch as per STCW Regulation VIII/2, Chapter VIII of the STCW Code; and qualified to pursue a professional career or advanced studies in any maritime field of specialization.

Relevant to this CHED Memorandum Order, under the STCW/Conf.2/34, Table A-III/5 on Specification of Minimum Standard of Competence for Ratings as Able Seafarer Engine**,** the ability to understand orders and to communicate with the officer of the watch in matters relevant to watchkeeping duties, procedures for the relief, maintenance and handover of a watch is clearly emphasized. Information is required to maintain a safe watch assessment of evidence obtained from in -service experience or practical test. Communications should be clear and concise. It is with these reasons that the researcher saw the need and essential of this study to help solved the pressing problems/difficulties of some marine engineering graduates who are already onboard but were still incompetent in terms of speaking and writing. Sensible to say that the English language is a very important tool in our lives, as we use it to express ourselves, to defend ourselves, and even to attack when the need arises, the language that most of us are dependent on.

In the advent of technology and students' exposure to different electronic gadgets and recreations all over, it is observed that students nowadays are far beyond compared to students of before. Many students nowadays cannot speak and write well in English. Many of them cannot express themselves properly and have difficulty in speaking and writing. Many factors need to be considered in this rampant problem since our students come from different places and from all walks of life all over the Philippines. Take a giant leap into the future by whatever means available to us. We just want to check out what changes the English language would have undergone over this period. Our growing concern for the future of the English Language is indeed justifiable, as we are fully aware that at present, certain changes to the English language are taking place and these changes are inevitable as they are

International Journal of Engineering, Industrial, Maritime, and Technological Innovation (INJENI)
P - ISSN: 3116-3807
E - ISSN: 3116-3815
PRC-CPD Accredited Provider: PTR-2025-749
NBDB Registration Book Publisher (Print & Digital): 0312

part of modernization. To integrate with the technology of the day and to facilitate the proper use of modern communication methods such as text messaging on mobile phones, i-pads, and other modern gadgets everyone is inclined to, the changes that are being applied to grammar and punctuation are inevitable.

The Internet, a great source of information serves well all those who are well versed in the English language. Technology is the culprit. The very same technology that had us reeling asking for more after the computer became a trend in offices, school and everywhere bidding a hasty farewell to typewriters. The computer, the tool with which the Internet could be accessed, made a giant leap into the lives of millions when the Internet was made accessible to the public. A parallel situation saw a thing called texting which involves sending text messages from the keypad of one mobile phone to the screen of another and vice versa. Almost immediately the trend to shorten words in a bid to save the agony of having to spell out every single word was generated.

This trend of shortening words in text messages caught on fast and soon became widely accepted. The evolution of this trend too took place so rapidly that along with simplified spellings, omitting prepositions and conjunctions, and even leaving out vowels from words caught on. From here on it would be only a matter of time for the deterioration of the English language that we have witnessed in the electronic media to seep into the other media like newspapers and magazines and wherever else the written word was needed. This new trend emerged purely for the sake of convenience, and for saving time. Speed was most vital ... they thought. This trend was carried out in chat sites online, and even noticeable was the absence of a space between words after a punctuation mark. Spell it the way you think fit and if it is understood. That's all that matters. And so, the speaking and writing skills of the students were adversely affected. Through this study, the researcher hopes to help solve the problem among students of PMMA to boost and uplift their morale and self- confidence in order to improve their communication skills particularly in speaking and writing. It is also hoped that those who will read or follow the footsteps in studying and researching such as this study will be inspired and be guided accordingly to continue to educate, improve and build upon legacy – a world famous merchant marine officers, known not only for training excellence but in academics as well particularly in speaking and writing skills to become qualified and competent merchant marine officers for shipboard and shore-based positions, in response to the global requirements of the expanding international maritime industry.

Research Questions

This study assessed the speaking and writing skills of Fourth Year BS Marine Engineering students of the Philippine Merchant Marine Academy or PMMA in San Narciso, Zambales.

Specifically, it sought answers to the following questions:

1. What is the profile of the respondents in terms of:
    - 1.1 Gender.
    - 1.2 Preferred Language Used at Home.
    - 1.3 Preferred Language Used in School; and
    - 1.4 Preferred Reading Materials
    - 1.5 Academic Performance in Speech 1
    - 1.6 Academic Performance in English 1
2. How may the speaking skills of the respondents be described?
3. How may the writing skills of respondents be described?
4. What is the correlation between the speaking skills of the respondents and their performance in Speech 1?
5. What is the correlation between the writing skills of the respondents and their performance in English1?
6. What training module may be proposed to improve the speaking and writing skills of the Marine Engineering students of PMMA?

Hypotheses

Given the stated research problem, the following are the hypotheses:

Hypothesis 1. There is no correlation between the speaking skills of the students and their performance in Speech 1.

Hypothesis 2. There is no correlation between the writing skills of the students and their performance in English1.

International Journal of Engineering, Industrial, Maritime, and Technological Innovation (INJENI) P - ISSN: 3116-3807 E - ISSN: 3116-3815

PRC-CPD Accredited Provider: PTR-2025-749

NBDB Registration Book Publisher (Print & Digital): 0812

METHODS

Research Design

The descriptive type of research was used in the study where the respondents are the Fourth Year BS Marine students of the Philippine Merchant Marine Academy, in San Narciso, Zambales. Data were gathered with questionnaire and documentary analysis of their speaking and writing activities.

Population and Sampling

This study was conducted at the Philippine Merchant Marine Academy, San Narciso, Zambales with one hundred twenty-three students in the College of Marine Engineering during the first semester of the Academic Year 2013-2014. A Survey Questionnaire form was distributed to the respondents, and they were also being tested at the PMMA Speech Laboratory and were orally graded as regards their pronunciation and diction. Similarly, the researcher gathered data/answers from the respondents as regard to their writing activities on Paragraph Writing and Subject - Verb Agreement.

Instrument

A survey questionnaire was used to collect the necessary data in this study. Said instrument was validated by experts in the field. PMMA Speech Laboratory was used as a testing area where respondents were orally graded as regard to their pronunciation and diction.

Data Collection

The data were gathered, read, and analyzed following the objective of the study and in adherence to all protocols in the conduct of this research.

Treatment of Data

The data gathered through the responses indicated in the questionnaire were organized, tabulated, and analyzed. Percentage was used to determine the proportion of the students/respondents belonging to specific categories relative to their profile. Mean was utilized to determine the final weight of each item in the respondent's awareness of themselves. Pearson r was used to discuss correlations between the speaking skill of students and their performance in Speech 1, writing skill of students and their performance in English 1.

Ethical Considerations

The researcher ensured that all research protocols involving ethics in research were complied with for the protection of all people and institutions involved in the conduct of the study.

RESULTS AND DISCUSSION

This presents the findings in tabular form, analysis and interpretation drawn from the data gathered.

1. **Profile of the Respondents**

The profile of the respondents was tabulated to give better insights on the background information of the respondents. The following Tables present the profile of the respondents in terms of gender, preferred language used at home, preferred language used in school and preferred reading materials.

1.1 Gender. Table 1 shows the profile of the respondents in terms of gender. It can be gleaned from the Table that one hundred thirteen (113) or 91.87 % among the respondents are male and ten (10) or 08.13 % among the respondents are female. There are only ten (10) female respondents out of one hundred twenty-three (123) respondents. This means that majority of the respondents are male because in PMMA male gender is dominant.

Table 1
Distribution of the Respondents According to Gender

Gender	No. of Respondents	Percentage
Male	113	91.87
Female	10	08.13

International Journal of Engineering, Industrial, Maritime, and Technological Innovation (INJENI) P - ISSN: 3116-3807 E - ISSN: 3116-3815

PRC-CPD Accredited Provider: PTR-2025-749

NBDB Registration Book Publisher (Print & Digital): 0012

Total	**123**	**100 %**

1.2 Preferred Language Used at Home. Language used at home is one of the factors that affect the students' performance in their speaking and writing skills. It can be gleaned from the table that sixty-eight (68) or 55.28% among the respondents used Filipino language at home; thirty (30) or 24.39% used the English language; eleven (11) or 08.94% used other languages; ten (10) or 08.13% used Ilokano; four (4) used Cebuano and nobody used the Zambal language. This means that majority of the respondents preferred to use the Filipino language at home.

Research in bilingual homes supports the concept that parents should communicate in their stronger language.

Table 2
Distribution of the Respondents According to Language Used at Home

Language	No. of Respondents	Percentage
English	30	24.39
Filipino	68	55.28
Ilokano	10	08.13
Zambal	0	0
Cebuano	4	03.25
Others (Kapampangan, Ilonggo, Bikolano, Tuwali,Chavacano, and Bisaya)	11 (2, 2, 2, 1,2,1,1)	08.94
TOTAL	**123**	**100 %**

1.3 Preferred Language Used in School. It can be seen from the Table that seventy-one (71) or 57.7% of the respondents used the English language in school; thirty-seven (37) or 30.1% used Taglish; and fifteen (15) or 12.2% used the Filipino language in school. It means that the most preferred language used in school is English.

Table 3
Distribution of the Respondents According to Preferred Language Used in School

Language	No. of Respondents	Percentage
English	71	57.7
Filipino	15	12.2

International Journal of Engineering, Industrial, Maritime, and Technological Innovation (INJENI) P - ISSN: 3116-3807 E - ISSN: 3116-3815

PRC-CPD Accredited Provider: PTR-2025-749

NBDB Registration Book Publisher (Print & Digital): 0012

Taglish	37	30.1
Others	0	0
TOTAL	**123**	**100 %**

1.4 Preferred Reading Materials. Table 4 reveals the profile of the respondents in terms of their preferred reading materials. Sixty-two (62) or 50.4% preferred to read newspapers; fifty (50) or 43.1% preferred magazines; four (4) or 03.3% preferred to read other reading materials; two (2) or 01.6% preferred both journals and cartoon comics; and none preferred to read pamphlets.

Table 4
Distribution of the Respondents According to Preferred Reading Materials

Preferred Reading Materials	No. of Respondents	Percentage
Magazines	53	43.1
Newspaper	62	50.4
Journals	2	01.6
Pamphlets	0	0
Cartoon Comics	2	01.6
Others (Books/pocketbooks)	4 (3/1)	03.3
TOTAL	**123**	**100 %**

This means that most of the respondents preferred to read newspapers as their reading materials. Magazines, newspapers, journals, pamphlets, cartoon comics, books and pocketbooks are among the reading materials which were all written in English.

1.5 Academic Performance in Speech 1. Table 5 shows the profile of the respondents in terms of their academic performance in Speech 1. Forty one (41) or thirty three point thirty three percent (33.33%) got a Final Grade of 76 to 80; twenty seven (27) or twenty one point ninety five percent (21.95%) got a Final Grade of 81 to 85; twenty six (26) or twenty one point fourteen percent (21.14%); eighteen (18) or fourteen point sixty three percent (14.63%) got a Final Grade of 71 to 75; six (6) or four point eighty eight percent (4.88%) got a Final Grade of 91 to 95; and five (5) or four point zero seven percent (4.07%) got a Final Grade of 70 and below. None of the respondents was able to get a Final Grade of 96 to 100 in Speech.

Table 5
Distribution of the Respondents According to Academic Performance in Speech 1

SPEECH 1 Performance	Frequency	Percentage
96-100	0	0
91-95	6	4.88
86-90	26	21.14
81-85	27	21.95

International Journal of Engineering, Industrial, Maritime, and Technological Innovation (INJENI) P - ISSN: 3116-3807 E - ISSN: 3116-3815

PRC-CPD Accredited Provider: PTR-2025-749

NBDB Registration Book Publisher (Print & Digital): 0812

76-80	41	33.33
71-75	18	14.63
70- Below	5	4.07
TOTAL	**123**	**100%**

1.6 Academic Performance in English 1. Table 7 reveals that the profile of the respondents in terms of their academic performance in English 1. Sixty two (62) or fifty point forty one percent (50.41%) got a Final Grade of 76 to 80; forty three (43) or thirty four point ninety five percent (34.95%) got a Final Grade of 81 to 85; nine (9) or seven point thirty two percent (7.32%) got a Final Grade of 71 to 75; seven (7) or five point sixty nine percent (5.69%) got a Final Grade of 86 to 90; two (2) or one point sixty three percent (1.63%) got a Final Grade of 91 to 95; nobody got a Final Grade of 70 and below and no one got a Final Grade of 96 and above.

Table 6
Distribution of the Respondents According to Academic Performance in English 1

ENGLISH 1 Performance	Frequency	Percentage
96-100	0	0
91-95	2	1.63
86-90	7	5.69
81-85	43	34.95
76-80	62	50.41
71-75	9	7.32
70- Below	0	0
TOTAL	**123**	**100%**

2. Speaking Skills.

Table 7 shows the distribution of respondents according to speaking skills. It can be gleaned from this Table that thirty-eight (38) or 30.9% of the respondents got "Satisfactory" rating in their speaking activities; twenty-nine (29) or 23.6% got "Very Satisfactory"; twenty-five (25) or 20.3% got a "Fair" rating; sixteen (16) or 13.0% got an "Excellent" rating; fifteen (15) or 12.2% got "Poor" rating; and none got a rating of "Needs Improvement".

This means that most of the respondents garnered a "Satisfactory" rating which is equivalent to eighty-six to ninety (86-90).

Baluma (1994) surveyed the communicative competence profile of freshmen students at Divine Word College of Tagbilaran. She considered five (5) aspects of oral proficiency pronunciation, and these were: (1) auditory discrimination of sounds, (2) fluency, (3) grammar, (4) vocabulary and (5) comprehension. The study provided background regarding listening competency in relation to the speaking and writing proficiency of the respondents. Based on the curriculum 2007 the students are intended to have the English ability in listening, speaking, reading, and writing.

Table 7
Distribution of the Respondents According to Speaking Skills

	SCORING		
100-ITEM SCORE	**QUALITATIVE INTERPRETATION**	**NO. OF RESPONDENTS**	**PERCEN TAGE**
96-100	Excellent	16	13.0
91-95	Very Satisfactory	29	23.6
86-90	Satisfactory	38	30.9

International Journal of Engineering, Industrial, Maritime, and Technological Innovation (INJENI)
P - ISSN: 3116-3807
E - ISSN: 3116-3815
PRC-CPD Accredited Provider: PTR-2025-749
NBDB Registration Book Publisher (Print & Digital): 0012

81-85	Fair	25	20.3
76-80	Poor	15	12.2
71-75	Needs Improvement	0	0
	Total	**123**	**100**

3. Writing Skills.

Table 8 reflects the distribution of the respondents according to writing skills. Thirty-seven (37) or 30% got a rating of" Satisfactory"; twenty-eight (28) or 22.8% got a rating of "Fair"; twenty-five (25) or 20.3% got a rating of "Very Satisfactory"; twenty (20) or 16.3% got an "Excellent" rating; twelve (12) or 09.8% got "Poor" rating; and one (1) got a "Needs Improvement" rating.

This means that most of the respondents garnered a "Satisfactory" rating which is equivalent to eighty-six to ninety (86-90). Choosing the right words requires a wide vocabulary. At present, we are using English as our medium of communication; therefore, there is a need for us to be familiar with the English vocabulary.

The study of Enriquez and Nolasco (2007) also showed that a person who has a wide range of vocabulary might not have difficulties in thinking and communication. The two also added that vocabulary, spelling, and grammar skills are the basic components of language which are very useful to man's life. The term of ability is defined as skill or power. Concisely, writing ability is the skill to express ideas, thoughts, and feelings to other people in written symbols to make other people or readers understand the ideas conveyed.

Table 8
Distribution of the Respondents According to Writing Skills

SCORING			
100-ITEM SCORE	**QUALITATIVE INTERPRETATION**	**NO. OF RESPONDENTS**	**PERCEN TAGE**
96-100	Excellent	20	16.3
91-95	Very Satisfactory	25	20.3
86-90	Satisfactory	37	30.0
81-85	Fair	28	22.8
76-80	Poor	12	09.8
71-75	Needs Improvement	1	00.8
	Total	**123**	**100**

4. Correlation between the Speaking Skills of the Respondents and Their Performance in Speech 1.

The result of the correlation between the speaking skills of the respondents and their performance in Speech I was interpreted as moderate positive correlation. As shown in Table 9 using the Pearson r formula that the computed r = 0.474 with a significant value of 0.000 which is significant at 0.05. This means that there is a moderate positive correlation between the speaking skills of the respondents and their performance in Speech I. Correlation is significant. Two variables are uncorrelated when a change in one doesn't lead to a change in the other and vice versa.

Correlational studies on professional preparation and other variables were conducted by Paloma, (1993) and Librano, (1992). Paloma's study focused on the relationship of teacher professional preparations and English

International Journal of Engineering, Industrial, Maritime, and Technological Innovation (INJENI)
P - ISSN: 3116-3807
E - ISSN: 3116-3815
PRC-CPD Accredited Provider: PTR-2025-749
NBDB Registration Book Publisher (Print & Digital): 0012

achievement and skills among freshmen college students. Their studies proved that there is a positive correlation in a teacher's professional preparation with students' achievement. On the other hand, Librano's study dealt with the relationship of the professional preparations of the senior secondary teachers' oral communication achievement.

Table 9
r - Value for the Correlations of Variables

Variables Correlated	r - value	Significance	Interpretation (L = 0.05)
Speaking Skill and Speech 1	0.474	0.000	Moderate positive Correlation and Correlation is significant
Writing Skill and English 1	0.649	0.000	Moderate positive Correlation and Correlation is significant

5. Correlation between the Writing Skills of the Respondents and Their Performance in English 1.

As shown in table 10 using the Pearson r formula, r = 0.649 with a significant value of 0.000 and a descriptive interpretation of moderate positive correlation.

Table 9 shows that the computed r value in English 1 and writing skill is 0.649 which is significant at 0.05. There was a moderate positive correlation between the writing skills of the respondents and their performance in English 1. Correlation is significant. Jutare (1990) also claimed in his article that our graduates in both high school and college can hardly speak and write. With the distressing criticism on English proficiency, it is a must to pinpoint area of difficulty in English communication, because effective communication in English naturally requires proficiency in the language.

Summary, Conclusions, and Recommendations

Profile of the Respondents

The profile of the respondents is based on their gender, preferred language used at home, preferred language used in school, preferred reading materials, academic performance in Speech 1 and academic performance in English 1.

Among the 123 respondents, 113- or ninety-one-point eighty seven percent (91.87%) of the respondents are male. Sixty-eight (68) or fifty-five-point twenty eight percent (55.28%) of the respondents used the Filipino language at home, seventy-one (71) or fifty-seven-point seven percent (57.7%) used the English language in school and sixty-two (62) or fifty-point four percent (50.4%) of the respondents preferred reading the newspaper.

In terms of their academic performance in school particularly in Speech 1 and English 1, forty-one (41) or thirty-three-point thirty three percent (33.33%) of the respondents got a Final Grade of 76 to 80, sixty-two (62) or fifty-point forty one percent (50.41%) got a Final Grade of 76 to 80.

The speaking skills of the respondents

Thirty-point nine percent (30.9%) of the respondents obtained a "Satisfactory" rating in their speaking skill which is equivalent to 86 to 90 in a 100-item score.

The writing skills of the respondents

Thirty percent (30%) of the respondents got a "Satisfactory" rating in their writing skill which is equivalent to 86 to 90 in a 100-item score.

Conclusions

Based on the salient findings presented, the following are the conclusions made:

1. Majority of the respondents were male, used Filipino language at home, used English language in school, and

International Journal of Engineering, Industrial, Maritime, and Technological Innovation (INJENI) P - ISSN: 3116-3807 E - ISSN: 3116-3815

PRC-CPD Accredited Provider: PTR-2025-749

NBDB Registration Book Publisher (Print & Digital): 0012

preferred reading newspapers.

2. Most of the respondents obtained a satisfactory rating in their speaking skill.
3. Several of the respondents garnered a satisfactory rating in their writing skill.
4. The academic performance of the respondents in their Speech 1 had a moderate positive correlation in developing their speaking skill. Correlation of both variables is significant.
5. The academic performance of the respondents in their English 1 revealed a moderate positive correlation in their writing skill. Correlation of both variables is significant.

Recommendations

After careful analysis of the data, the following recommendations are hereby presented:

1. The respondents should be encouraged to speak English at home and continue using the English language in communicating in school. They should likewise be required to explore other reading materials aside from the newspapers.
2. The respondents should be provided with more speaking activities to motivate them to earn higher grade in Speech 1.
3. The school should provide the latest equipment and facilities that can be utilized by the students to empower their capabilities and improve their speaking skills.
4. PMMA English Instructors should update their syllabi and modules to answer the needs and the difficulties encountered by the students in the four skills especially speaking and writing. They should use the recommended Maritime English Training Module to improve their teaching methods and strategies to help upgrade the students in their speaking and writing activities. A writing program could be developed to improve the writing skill of the students as well.
5. The respondents should just be encouraged to give time and importance to their General Education subjects particularly in English. More effective drills, exercises, and activities in speaking and writing are strongly recommended to overcome errors especially in their pronunciation and diction, grammar, and composition writing.
6. A parallel study should be conducted to explore other areas of speaking and writing.

REFERENCES

Agreements covering tertiary qualifications in engineering. http://www. Washington accord. Or/colleges. Retrieved January 11, 2013.

Aloc, E.S. (2012). Electro Automation. Quezon City, Philippines: MARTA

Aquino, Gaudencio V. (1992) Fundamentals of Research. Manila: National Book Store, Inc.

Biber, D. (1988) Variation Across Speech and Writing, Cambridge, England: Cambridge University Press

Calder, N. (2007). Marine Diesel Engines: Maintenance, Troubleshooting and Repair. New York: Mc Graw Hill

Cambourne, B. 1981. Oral and Written Relationship: A Reading Perspective. // B.M. Kroll & R.J. Vann, Eds.

Charan, A. (2010). Electrical Technology. New Delhi, India: Anmol Publications Pvt. Ltd.

Commission on Higher Education (CHED) Republic Act No. 7722 known as the Higher Education Act of 1994

Cruz, I. (2009). The new curriculum. http://www.philstar.com/education-and-home/480455/ new-curriculum. Retrieved January 11, 2013.

Exploring Speaking. Writing Relationships Connections and Contrasts. Illinois: National Council of Teachers of English, 82.98

Hedge (2000) Speaking Skills or Oral Communication Fluency http://www.scribd.com_ Retrieved January 9, 2000

International Journal of Engineering, Industrial, Maritime, and Technological Innovation (INJENI) P - ISSN: 3116-3807 E - ISSN: 3116-3815

PRC-CPD Accredited Provider: PTR-2025-749

NBDB Registration Book Publisher (Print & Digital): 0012

How to Improve Speaking and Writing. http:// www. ehow_5891397_improve. writing – speaking.html, (2003)

International Maritime Organization (IMO) Standard Marine Communication Phrases (SMCP) Handout, 25 January 2002 Resolution A.918 (22).

Janecek, E.T. (2012). Machinery's Handbook: Made Easy. New York, New York: Industrial Press Inc.

Killen R. (1998). Effective Teaching Startegies: Lessons from research and practice. 2nd edition, Wentworth Falls, Australia: Social Science Press

Laurilla, M.P. (2008). Marine Engineering for Deck Officers. Quezon City, Philippines: MARTA.

Leigh, Anthony (2001) How to Improve English Communication Skills http:// www. ehow_5891397_improve writing – speaking.html.

Manila Amendments (2010) to the 1978 International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (1978 STCW Convention)

PMMA Corps of Midshipmen Regimental Rules and Regulations or the Blue Book. DMA Manual Triple "R" Revised September 11,2006

PMMA Quality Procedure Manual (April 1, 2013) Issue No. 07, Controlled Document PMMA- Quality Assurance Office (QAO)

Spady, W.G. (1988) Organizing for results: The basis of authentic. restructuring and reform. Educational Leadership, 49 (2), 67-72.

Shipping Agencies: What is it? http://www.phoenix.edu/colleges_divisions/education/articles/2001 Retrieved November 25, 2012

UNirow-Stitma.net Sources of Educative Journals. SKRIPSI and Thesis http:// www.unirow-stitma.net/2012/06example of Chapter 2 - Review of Related Literature about Speaking and Communication in Skipsi or Thesis

International Journal of Engineering, Industrial, Maritime, and Technological Innovation (INJENI)
P - ISSN: 3116-3807
E - ISSN: 3116-3815
PRC-CPD Accredited Provider: PTR-2025-749
NBDB Registration Book Publisher (Print & Digital): 0312

Project Oriented Approach in Teaching Mathematics: Effects on Engineering Technology Students' Interest and Performance

Engr. Maulana M. Dadayan, MSciEd[1]*, Sitieainah S. Dadayan, LPT, CAR[2]
[1, 2] Mindanao State University – Marawi, Philippines

Abstract
Aim: This study primarily aimed to investigate effects of project-oriented approach in teaching mathematics towards the students' performance and interest in math among college students in the engineering technology courses at MSU-Lanao National College of Arts and Trade in Marawi City.
Methodology: Using a quasi-experimental research design, the respondents were grouped into two, the Experimental Group and the Control Group. Data were gathered using achievement test in math which was administered as pretest and posttest; interest test in mathematics; POA lesson plan; field notes, and journal logs. After the data was gathered, it was analyzed using SPSS for windows.
Results: Findings of the study revealed that the POA positively influenced the students' mathematics performance and interest for the reason that the experimental group has gained higher mean difference compare to that of the control group for based on the mean significant difference results of Pretest (t-test value of -75.091, p< 0.05) and Posttest (t-test value of -64.934, p< 0.05)Experimental Group gained 10.14 which is greater than the 3.773 result of Control Group, and as for the interest test, the mean difference of Pre-interest test of the Experimental Group were 14.136 which is greater than the 4.863 result of Control Group; therefore, there is a significant difference in the mathematics performance of the two (2) groups namely the Experimental Group and the Control Group after the intervention.
Conclusion: The students' Mathematics performance improved significantly, especially the students under the experimental group that exposed to POA method of teaching it had gained of 10.140. Thus, putting the knowledge based on the improvement of the students' achievements at their work in classroom must be recognized. Also, the quality of the implementation of a teaching practice greatly influences its impact on students' learning. Using manipulative materials to investigate a concept, like project-oriented approach for example, depends not only on *whether* manipulative materials are used, but also on how they are used with the students.

Keywords: *Project-Oriented Approach, Students' Interest, Students' Performance, Interactive Approach, and Learning Skills*

INTRODUCTION

Mathematics is a difficult and boring course/subject to many students in all levels of education (elementary, secondary and college). In fact, only few felt comfortable in taking mathematics subject. But people who believe and love mathematics know that there is no failure, only challenges in mathematics. And these challenges can be hurdled by proper way of learning. The problem as observed is students who do not have the full spirit to learn Mathematics, Science and Technology is now in anxiety and find difficulty in moving on.

The consistent poor performance of our students in mathematics as evidenced by the results of National Achievement Test (NAT, 2005) and international assessments (e.g. TIMSS, 2005) confirms the public perception that the quality of basic education is deteriorating (Brawner & Andrada, 2005). Based on data recorded within the ARMM Region, in the 2006-2007 NAT result, ARMM was still one of the poorest performing regions. Grade 6 pupils who participated in the National Achievement Test (NAT) in SY 2006-2007 that achieved a 75 % "mastery level", Basilan has (0.8 %), Lanao del Sur 1 has (0.9 %) and Marawi City has (3.6 %) which gives a total of (5.3 %) of the grade 6 pupils who achieved the 75 % "mastery level" yet hardly any of these provinces had sufficient competence in Science when compared to the rest of the Philippines which has a total of (8.3 %) of the Grade 6 students that achieved the 75 % "mastery level" and 37% of the grade 6 pupils achieving the 60% "near-mastery level".

In high school level, the Mindanao State University–System-Wide Admission and Scholarship Examination (MSU-SASE) results are also evidences of students' low performance in mathematics which fail to satisfy the expectations of concerned parents and teachers. The weighted average scores in percent obtained by the Mindanao State University –Lanao National College of Arts and Trade (MSU-LNCAT) feeder high school was only 11.67% in SASE 2013; 10.67% in SASE 2012; 10.44% in SASE 2011; 9.56% in SASE 2010; and 9.78% in SASE 2009, compared to the MSU-IIT students who had weighted average score of 16.67% in SASE 2013. Because of this it becomes necessary for

International Journal of Engineering, Industrial, Maritime, and Technological Innovation (INJENI) P - ISSN: 3116-3807 E - ISSN: 3116-3815

PRC-CPD Accredited Provider: PTR-2025-749

NBDB Registration Book Publisher (Print & Digital): 0312

mathematics teachers to look into different approaches that would entice the student's interest towards learning mathematics. Teachers will have to think like chefs who experiment with food presentations such that the materials they present to their students would look not only palatable but delicious.

However, the problem is that many students perceive mathematics as a very difficult area of study. Many students gained no interest towards learning the field with all the numerical figures. Students from the ARMM, Marawi City and MSU-LNCAT are not exempted from this predicament. According to Gumal (2016), Maguindanao and Lanao Del Sur including Marawi City were found to be poor in mathematics due to the mathematics teachers that are not major in mathematics, the teaching strategies were not appropriate and updated, and the student's attitudes and interest in mathematics did not directly lead to better and productive learning and teaching outcomes**.**

There are different approaches to teaching mathematics. Some of those are integrated approach (interdisciplinary), problem-based approach, cooperative learning, problem posing, project-oriented approach and so on. Project-oriented approach is the teaching approach used in this study. This approach is expected to promote better interest and performance of the students in learning Mathematics, Science and Technology. This study on Project Oriented Approach in Teaching Mathematics (POATM) will help solve the students clamor for a simplified approach in teaching Mathematics. This approach is becoming popular for providing enriching; cognitively demanding experiences for Limited-English-proficient (LEP) students. The project approach involves any type of group learning activity that brings about a sustained period of self-reliant effort by learners to achieve a clearly defined goal, Vigil (1996). Because of this reason, the researcher is hoping that this study POATM would also be an effective approach in teaching mathematics subjects that could enhance student's interest and performance in mathematics in Lanao Del Sur and Marawi City, particularly for the MSU-LNCAT students.

Objectives

This study focused on the strategy in teaching Mathematics of First Year College of Engineering Technology students of MSU-LNCAT, Marawi City. Specifically, it sought to answer the following questions:

1. What is the mathematics performance of students exposed to Project-oriented Approach in Teaching Mathematics (Experimental Group, EG) and those students exposed to the Traditional Mathematics Teaching Approach (Control Group, CG) before and after intervention?
2. What is the mathematics interest of students in the experimental and control groups before and after intervention?
3. Is there a significant difference in the mean scores of students in the experimental and control groups in the mathematics performance test before and after intervention?
4. Is there a significant difference in the mathematics interest of students in the experiment and control groups before and after intervention?
5. Is there a significant relationship of students' interest in mathematics with their performance before and after intervention?
6. Is there a significant change in the students' interest and performance in mathematics in both experimental and control groups before and after intervention?
7. How do the students' interest and performance in mathematics change in both students' participants of the experimental and control groups?
8. What are the traces of students' change of interest and performance in mathematics in the experimental group?

Hypothesis

Given the stated research problem, the following hypotheses were tested on 0.05 level of significance:

Hypothesis 1: There is a significant change in the students; interest and performance in mathematics in both experimental and control groups before and after intervention.

Hypothesis 2: There is a significant relationship between the students' interest in mathematics with their performance before and after intervention.

METHODS

Research Design

This study used quasi-experimental research design to determine whether the Project Oriented Approach method of Teaching Mathematics is more effective than the traditional method of teaching. In this design, control and

International Journal of Engineering, Industrial, Maritime, and Technological Innovation (INJENI) P - ISSN: 3116-3807 E - ISSN: 3116-3815

PRC-CPD Accredited Provider: PTR-2025-749

NBDB Registration Book Publisher (Print & Digital): 0312

experimental groups were used in the study. The control group was exposed to traditional method of teaching while the experimental group was exposed to the treatment where the project oriented approach in teaching mathematics was used. Using a two group pretest-posttest design, pretest was given prior to the grouping of the respondents while posttest was given later after the treatment. Pre-test scores of the respondents serve as baseline for their mathematics performance. The assigning of the respondents group was done through matched pair using their grades in their previous subject Workshop Mathematics – 1 in order to be sure that the two (2) groups belong statistically the same level of thinking and capability. Moreover, interest test was used before and after the treatment to find out if there are improvements in the interest of the students towards Mathematics. Though this experiment consumed a short period of time, it is purely experiment in nature. Following is the diagram of the research design used in this study.

Groups	Matched	Pretest	Treatment	Posttest
Experimental Group	M_1	Q_1	X	Q_3
Control Group	M_2	Q_2	O	Q_4

M_1 represent the Matched students for the Experimental Group, while M_2 are the Matched students for the Control Group. They were matched through their average grade in their previous math subject, Workshop Mathematics – 1. Q_1 represents the Pretest result of Experimental Group and at the same time it serves as baseline score whereas Q_2 represent the Pretest result of Control Group and it will also serves as baseline score.

X represents the intervention or treatment for Experimental Group whereas O represents no intervention or treatment for Control Group.

Q_3 represent the posttest result of Experimental Group whereas Q_4 represent the posttest result of Control Group.

Based on these data results, the evaluation for performance of these two groups can be made.

Population and Sampling

There were forty-four (44) students from the Engineering Technology Students of MSU- Lanao National College of Arts and Trades that participated in the study. This intact number of students serves as the respondents and was divided into two (2) groups through matched pairing based on the grade results of their previous grade in Workshop Mathematics-1. Group 1 serves as the Experimental Group and group 2 serves as the Control Group. Each group consists of twenty-two (22) students. The 1st group, the Experimental Group, was exposed to the Project-Oriented Approach while the 2nd group, the Control Group, was just exposed to Traditional Approach in teaching.

Instruments

There were five (5) types of research instruments used by the researcher to gather data on this study. These instruments are: (1) Achievement Test in Mathematics, (2) Interest Test in Mathematics, (3) POA Lesson Plan, (4) Field notes, and (5) interview. Each instruments were described below:

1. Achievement Test

   This instrument was administered as the Pretest and Posttest. This test contains questions involving Fractions, Ratio and Proportions, and basic Geometry in a multiple choice and matching type (see Appendix 1 and table 3.1 in Appendix 3). The Test-questioner (see Appendix 1) consists of fifty (50) questions. Moreover, the Achievement Test content was validated by Dr. Acsara A. Gumal, a mathematics education expert from the dean's office of MSU-Lanao National College of Arts and Trades.
2. Interest Test in Mathematics

   The second instrument was the interest test in Math (See Appendix 2). This test was used to evaluate the students interest in mathematics using Likert –scale adapted from LISD Student Interest Survey - Math Motivation (9-12), Retrieved September 22, 2014 (https://www.surveymonkey.com/r/339S5JK).
3. POA lesson plan

   The third instrument was the POA lesson plan (See Appendix 4). This instrument was designed as the treatment employed in the experimental group with the following topics covered during the duration of the experiment; 1) in the first week from April 5 & 7, 2016, which was equivalent to six (6) hours topics given includes: *Familiarization of fractions, Addition of fractions, Subtraction of fractions, Multiplication of fractions* and *Division of fractions.* The learning procedures were supported with visual aids and designing project model activities, 2) from April 12, 14, & 19, 2016, which was equivalent to nine (9) hours, the students were exposed to learn Ratio

International Journal of Engineering, Industrial, Maritime, and Technological Innovation (INJENI) P - ISSN: 3116-3807 E - ISSN: 3116-3815

PRC-CPD Accredited Provider: PTR-2025-749

NBDB Registration Book Publisher (Print & Digital): 0312

and Proportions. Under these topics were the comparisons of *Ratio to another Ratio, Projection of sells, Projection of measurement* and *Mixture problems,* 3) from April 21, 26, 28 and May 3 and 5, 2016, which was equivalent to fifteen (15) hours the students were exposed the following topics namely: *Matching type, Familiarization of some formulas, Computation of some areas, Perimeters* and *Volumes of some geometrical figures.*

4. Field notes

   Field notes were made by the researcher during class observation recording all activities, behavior and attitudes of the respondents during the entire period of the experiment. This instrument is designed to capture the teacher-student's interaction and how the topics maintain the student's active participation in the classroom discussion.

5. Interview guide with the used of Journal log

   The questions made for this interview were basically designed to get the perceptions of the students in POA during the sessions. Follow up questions were also asked to gain exhaustive answer from the respondents. Interviews were then documented and written by hired Research Assistance with camera to ensure the reliability of the information's gathered.

Data Collection

Five (5) types of research instruments were utilized by the researchers to gather the primary data for this study namely: (1) Achievement Test in Mathematics, (2) Interest Test in Mathematics, (3) POA Lesson Plan, (4) Field notes, and (5) interview schedule.

Data were collected by observing the protocol. The first step employed was the letter of permit from the head of the MSU-LNCAT institution allowing the researcher to conduct the study. After obtaining necessary permission, the researcher oriented the possible respondents of the study giving them a brief background on the purpose of the study. As such, all 44 students engineering technology students served as the respondents of the study and they were given a pre-test on achievement test and interest test in mathematics. After the pretest, the forty-four (44) students were divided into the experimental group or control group through matched pairing based on their previous grades in the Workshop Mathematics – 1. This technique was used to ensure that each group is comparable enough in terms of their mathematics performance as measured by their previous grades in their subject WM-1.

As results of grouping, treatment for the experimental group which is the POA lesson plan and POA teaching method was employed and delivered to the respondents in the said group. On the other hand, respondents assigned in the control group were taught with the same topics in the POA lesson plan but in the TA method of teaching. During the experiment the researcher observed the class and took down notes for the field note. The respondents were asked to explain of what they had experienced and felt in the journal log and asked some interview questions posted while the researcher took note in from time to time in every class session. After the entire period of experiment, all gathered data were then tabulated and analyzed using Statistical Packages for Social Science (SPSS) for Windows.

Treatment of Data

The data gathered were analyzed using SPSS for Windows and the hypothesis were tested at $\propto = 0.05$ level of significance. Specifically using the following mathematical tools:

1. ***Arithmetic mean*** – the average of a set of numbers, calculated by adding them together and then dividing their sum by the number of terms (Microsoft Encarta, 2009).
2. ***Standard deviation (SD)*** - a number representing how closely bunched a set of numbers is around its mean, or average value. The standard deviation is an important concept in statistics because it is a precise indicator of the degree of variability within a set of numbers. A set with a smaller standard deviation consists of more closely bunched numbers than a set with a larger standard deviation (Microsoft Encarta, 2009).
3. ***Mean*** – also known as the arithmetic mean, a value that helps summarize an entire set of numbers. It is used in examining large collections of numbers to be able to present a number that provides a summary of the data. Such numbers are often called descriptive statistics (Microsoft Encarta, 2009).
4. ***Levene's test*** - is an inferential statistic used to assess the equality of variances for a variable calculated for two or more groups (Levene, 1960).
5. ***T-test*** – is a statistical examination of two population means. A two-sample t-test examines whether two samples are different and is commonly used when the variances of two normal distributions are unknown and when an experiment uses a small sample size (Levene, 1960).

Ethical Considerations

International Journal of Engineering, Industrial, Maritime, and Technological Innovation (INJENI) P - ISSN: 3116-3807 E - ISSN: 3116-3815

PRC-CPD Accredited Provider: PTR-2025-749

NBDB Registration Book Publisher (Print & Digital): 0312

The researcher ensured that all research protocols involving ethics in research were complied for the protection of all people and institutions involved in the conduct of the study.

RESULTS and DISCUSSION

Mathematics Performance of the Respondents

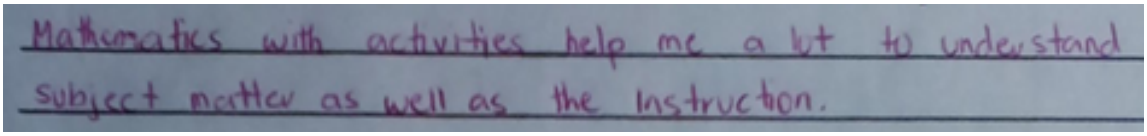
Performance of the respondents in Mathematics was measured through the use of Achievement test in Mathematics designed by the researcher involving the concepts of fractions, ratio and proportion, and basic geometrical skills. Table 1 below presents the results of the respondents' mathematics performance before and after treatment.

Table 1
Mathematics Performance of Students Exposed and not Exposed to make Project Oriented Approach in teaching Mathematics before and after the Intervention

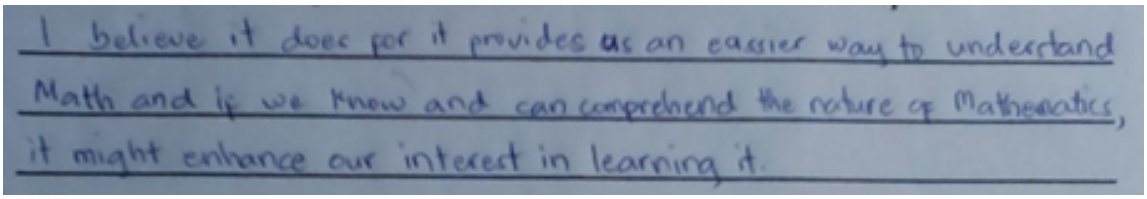
Mathematics performance of students	**Before Intervention**		**After Intervention**	
	Experimental *n*=22	Control *n*=22	Experimental *n*=22	Control *n* =22
Mean	17.636	17.227	28.046	21.00
SD	5.687	4.810	3.748	3.8669

As shown in Table 1, respondent's performance in Mathematics before intervention was comparable considering that the mean of both groups experimental and control is almost the same. As shown, the mean scores of the control group were 17.227 before intervention and 21.000 after the intervention, while the experimental group has mean scores of 17.636 before intervention and 28.046 after the intervention. The results of the computation on Table 1 implies that the performance of the control group slowly improved whereas the performance of experimental group improves better than the control group as it has been computed in table 1. The better improvement on the performance of respondents in the experimental group might be due to the POA teaching methods. Based on the researchers' observations it was noted on his field notes, *it has been noticed that some of them listen with full attention in the first session, and later on, it has been observed that all of them were curious everybody works with full of interest to find and get the right answers on their activity problems.*

Based on the interview of the researcher to the respondents in the experimental group, answering the question "*does the project oriented approach enhances learning strength and increases your interest in math"?* Excerpt below are some of their opinion.



("Mathematics with activities helps me a lot to understand subject matter as well as the instruction", Nurs, Interview Written Response, 4/12/16)

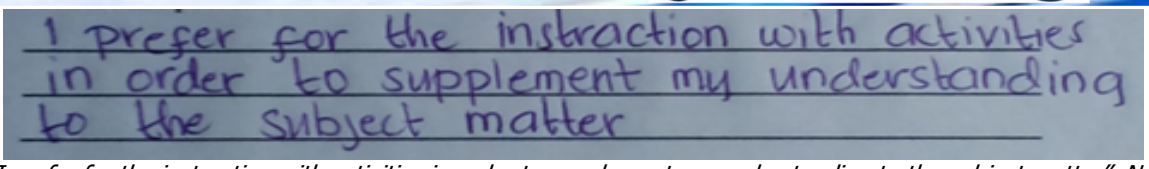


("I believe it does for it provides us as easier way to understand Math and if we know and can comprehend the nature of Mathematics, it might enhance our interest in learning it", Ainah, Interview Written Response, 4/12/16)

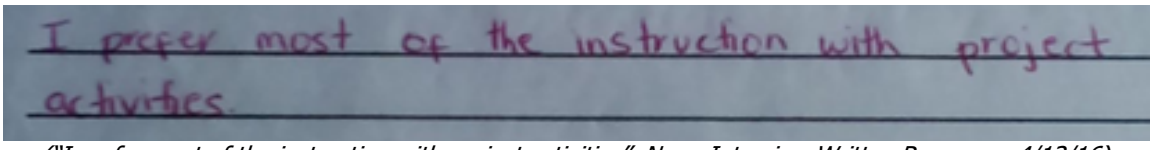
International Journal of Engineering, Industrial, Maritime, and Technological Innovation (INJENI) P - ISSN: 3116-3807 E - ISSN: 3116-3815

PRC-CPD Accredited Provider: PTR-2025-749

NBDB Registration Book Publisher (Print & Digital): 0312



("I prefer for the instruction with activities in order to supplement my understanding to the subject matter", Nur, Interview Written Response, 4/12/16)



("I prefer most of the instruction with project activities", Nurs, Interview Written Response, 4/12/16)

Respondents' Interest in Mathematics

Respondents' interest in math was measured using Mathematics Interest Survey 2010/2011 Adapted from LISD Student Interest Survey - Math Motivation (9-12). Table 2 below shows the tabulated results of the respondents' interest in mathematics.

Table 2

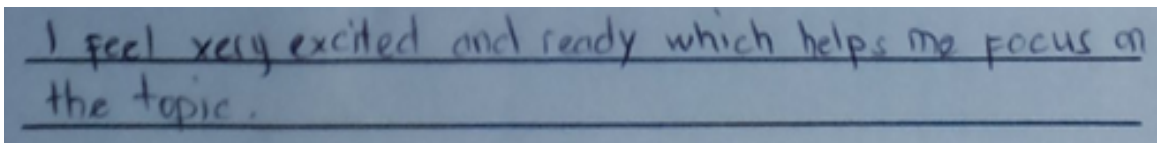
Mathematics Interests of Students Exposed and not exposed to Project Oriented Approach in teaching Mathematics before and after the Intervention

Mathematics Interests of students	**Before Intervention**		**After Intervention**	
	Experimental *n*=22	Control *n*=22	Experimental *n*=22	Control *n* =22
Mean	148.682	138.864	162.818	143.727
SD	9.959	8.610	14.670	8.525

As depicted in the table above, the mean score of pre-interest test of control group was 138.864 before and 143.727 after distribution of the lesson plan. The difference of mean of control group before and after was 4.864. the mean score of experimental group before intervention was 148.682 and 162.818 after intervention. The difference of mean score of experimental group before and after intervention was 14.136; therefore, it implies that the interest of control group increased a little while the interest of experimental group increased a lot. This also was proven on the field note as the researcher observed during the second meeting of the experiment on April 7, 2016 in the morning which was quoted below;

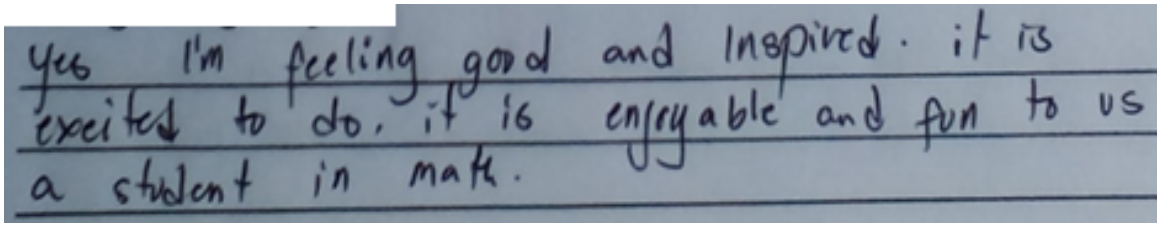
> *They finished the two activities and answered the question on it faster than what the researcher expected.*
>
> *The researcher observed that most of the students worked hard and has increased their interest and curiosity to find the right answers of the given problems on their activities they performed.*
>
> *Most of the students ask questions on how they could properly follow the procedure as stated in the lesson plan for Experimental group. till such time they understand well and then they finished their work activities.*

In the same manner, this proof can be seen in the respondents' journal below. In addition, this can also be proven in the traces based on the student's responses on question number 4 stating "*How do you feel when you are doing activities, feeling good and inspired or feeling boring?*



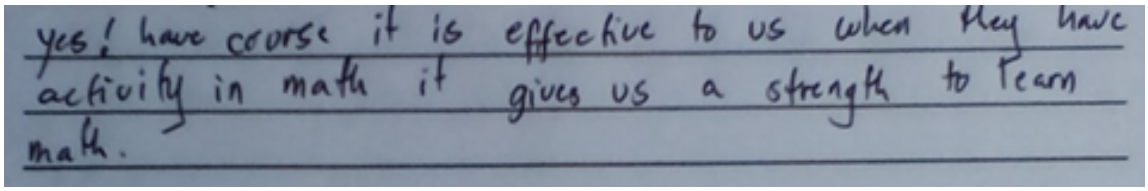
International Journal of Engineering, Industrial, Maritime, and Technological Innovation (INJENI) P - ISSN: 3116-3807 E - ISSN: 3116-3815
PRC-CPD Accredited Provider: PTR-2025-749
NBDB Registration Book Publisher (Print & Digital): 0312

("I feel very excited and ready which helps me focus on the topic", Taslima, Interview Written Response, 4/12/16)



("Yes. I feel good and inspired. It is exciting to do. It is enjoyable and fun for us students", Cam, Interview Written Response, 4/12/16)

On question number 1, many students said that mathematics course is effective when activities in math are provided. Excerpt below is some of their common answers.



("Yes! Of course it is effective to us when the instructors give activities in Math. It gives us strength to learn Math", Cam, Interview Written Response, 4/12/16)

Comparison of Experimental and Control Group of students' Mathematics Performance Before and After Intervention

To further validate the results presented in Table 1, t-test for equality of means was done comparing the pretest and posttest mean scores of the respondent's in the control and experimental group and the results were presented in Table 3.

Table 3
T-test and Significance (p) Values on the Comparison between the Control Group and Experimental Group of Student's Pretest Mean and Posttest Mean

Test	Group	N	Mean Score	t-test	p-value
Pretest	Control group	22	17.227		
	Experimental group	22	17.636	-0.258	0.798 (ns)
Posttest	Control group	22	21.000		
	Experimental group	22	28.046	-6.137	0.000 (s)

s – significant at 0.05 level of significant

It can be seen from Table 3 that during pretest, the t-value is -0.258 with a p-value of 0.798 which is greater than 0.05 level of significance. This implies that there is no significant difference between the pretest mean scores of the control and experimental groups prior to treatment in the experimental group. After the intervention, results revealed that the posttest mean scores between the groups significantly differ considering that the t-value is -6.137 with a p-value of 0.000 which is smaller than 0.05 level of significance. This implies that the respondents exposed to POA performed better than the students exposed only to TA.

On the other hand, for the Experimental Group, the mean score was 17.6364 before the intervention and 28.0455 after the intervention. The significant difference of mean score before and after intervention was 10.4091 (See Appendix 7 for the details of computation). The results clearly implied that each group, Control and Experimental group, mathematics performance differ significantly after the intervention in favor of the experimental group. This significant difference maybe the positive effects of the POA on students learning skills in mathematics. Valdez (2009) research findings support the findings of this study wherein, she pointed out that when students were exposed to

International Journal of Engineering, Industrial, Maritime, and Technological Innovation (INJENI) P - ISSN: 3116-3807 E - ISSN: 3116-3815

PRC-CPD Accredited Provider: PTR-2025-749

NBDB Registration Book Publisher (Print & Digital): 0312

modular instruction with varied activities learned more and performed better than when exposed to traditional method of teaching which is less structured and less activities provided. Moreover, Valdez (2015) also contends that the critical thinking skills of the students improved significantly if they were exposed to activity-based and cooperative learning approach. This is also consistent with the propositions as mentioned in various literature (Dizon & Sanchez, 2020; Muńoz & Sanchez, 2023; Salendab & Sanchez, 2023; Sanchez, 2023a; Sanchez & Sarmiento, 2020)

Comparison of Experimental and Control Group of Students' Mathematics Interest Before and After Intervention

To test whether there is a significant difference on the respondents' interest, t-test for equality of means were computed comparing their mean score during pretest and posttest. The results were presented in Table 4.

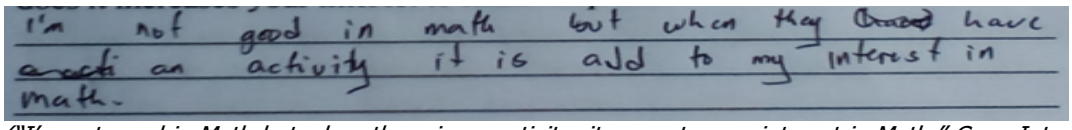
Table 4

T-test and Significance (p) Values on the Comparison between the Control Group and Experimental Group of Student's Interest in Math before and after the Intervention

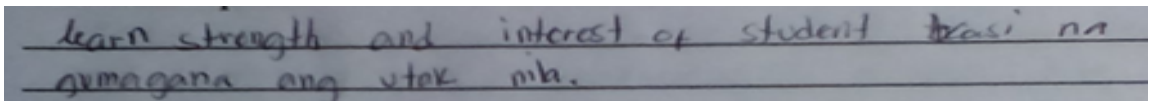
Test	Group	N	Mean Score	t-test	p-value
Pretest	Control group	22	138.864		
	Experimental group	22	148.682	-3.498	.001 (s)
Posttest	Control group	22	143.727	-5.278	.000 (s)
	Experimental group	22	162.818		

s – significant at 0.05 level of significant

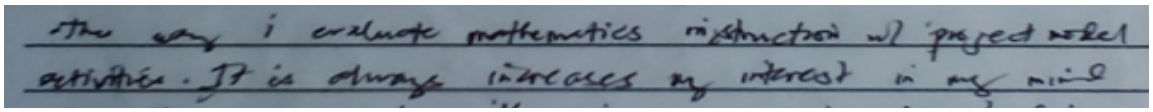
As depicted in Table 4 respondent's interest in math significantly differ before and after the intervention. The significant different in the mathematics interest of the control group before was 138.8636 and after distribution of lesson plan was 143.7273 and the difference was 4.86 while, the significant different in the mathematics interest of the experimental group before was 148.6818 and after intervention became 162.8182 the difference was 14.1364. Now, with these results it implied that the two (2) groups Control group and Experimental group's interest in math were differ significantly. To support this implication excerpt below are some of the respondents' opinion when they were asked how they evaluate mathematics instruction with project model activities, whether it does increases their interest to learn (See Appendix 6 of this paper for more information).



("I'm not good in Math but when there is an activity; it promotes my interest in Math." Cam, Interview Written Response, 4/12/16)



("It enhances my learning strength and Interest because it activates my brain." Fats, Interview Written Response, 4/12/16)



("The way I Evaluate Mathematics instruction with Project model activities.it is always increases my interest in my mind." Ham, Interview Written Response, 4/12/16)

In the researchers' field notes (See Appendix 5), June 07, 2015, it was also observed that most of the students work hard and have increased their interest and curiosity. This claim is also supported with the findings of Tan (2016) stating that materials can be design for a purpose of changing students' interest. Hence, better performance is possible

International Journal of Engineering, Industrial, Maritime, and Technological Innovation (INJENI) P - ISSN: 3116-3807 E - ISSN: 3116-3815

PRC-CPD Accredited Provider: PTR-2025-749

NBDB Registration Book Publisher (Print & Digital): 0312

if lessons and activities address the needs of the students and could elicit their interest as well. This can also be proven and seen in photos attached in appendix 8.

Relationship of Respondents' Performance in Mathematics and their Interest in Mathematics

Relationship on respondent's math performance and interest in math before and after intervention were computed and the results are presented in Table 5.

Table 5

Paired Samples Statistics on Respondents Math Performance and Interest in Math before and after the Intervention

Correlated	Mean	N	Pearson -value	Sig. value
Math Performance & Interest in Math(Before)	17.432 143.773	44	.109	0.481 (ns)
Math Performance & Interest in Math(After)	24.523 153.273	44	0.553**	0.000 (s)

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

As depicted in Table 5 above the mean obtained by the respondents during pre-test on math performance and interest in math are 17.432 and 143.773 respectively. After intervention the mean obtained by the respondents increases to 24.523 for math performance and 153.273 for interest in math.

Correlation analysis reveals that for both group, the respondents' mathematics performance and interest in math before intervention or during pretest showed no significant relationship considering that the computed significant value of r = 0.481 is greater than 0.05 level of significance. However, mathematics performance and mathematics interest of the respondents after the intervention showed significant correlation since the computed significant value of r = .000 is less than 0.05, level of significance. This result implies that the respondents' mathematics performance significantly correlated or influence to the respondents' interest in math after the intervention was implemented. This claim is supported with the research findings of Valdez (2013) pointing out that the students became more motivated and eager to learn and shifted their motivation style and learning style after exposure to hands-on activities in the teaching - learning process. Based on the research findings of various studies, context-based and activities teaching and learning approach improved students' motivation to learn shifted their attitudes towards loving the subject and increases their achievement level in the subject (Magwilang, 2016; Amihan & Sanchez, 2023; Carvajal & Sanchez, 2023; Carvajal, et al., 2024; Sanchez, et al., 2024a; Sanchez, Sanchez & Sanchez, 2023; Sanchez, et al., 2022)

Aside from the correlation test to determine the degree of the relationship among variables, paired sample test using t-test was also employed. Table 6 below presents the results of the computations.

Table 6

T-test and Significance (p) Values on the Comparison between the Control Group and Experimental Group of Students Mathematics Performance and Interest in Mathematics

Test	Pair	N	Mean Difference	t-test	p-value
Pre-test	Math Performance & Interest in Math	44	-126.341	-75.091	0.000 (s)
Post-test	Math Performance & Interest in Math	44	-128.750	-64.934	0.000 (s)

ns – not significant at 0.05 level of significant
s – significant at 0.05 level of significant

Table 6 paired sample test shows that the respondents' mathematics performance and interest in math during pre-test significantly differ since the p-value =0.000 is lesser than 0.05 level of significance. Moreover, mathematics performance and mathematics interest of the respondents in the control and experimental group still significantly differ

International Journal of Engineering, Industrial, Maritime, and Technological Innovation (INJENI) P - ISSN: 3116-3807 E - ISSN: 3116-3815

PRC-CPD Accredited Provider: PTR-2025-749

NBDB Registration Book Publisher (Print & Digital): 0312

with each other since p value = 0.000 is less than the 0.05 level of significance. Generally, the respondents' performance and interest in math between groups differ significantly before and after the intervention. This claim is supported with the research findings of Valdez (2013) indicating that the performance level of the students significantly increases and improve after they had been exposed to modular instructions that has varied activities that calls for higher order thinking skills. Research findings also indicated that students learn faster and retain most of the lesson longer when they actually see what they are expected to learn (Laurente, 2016; Amihan, Sanchez & Carvajal, 2023; Carvajal & Sanchez, 2024; Carvajal, Sanchez & Amihan, 2023; Salendab, Ocariza-Salendab & Sanchez, 2023; Sanchez, 2022; Sanchez, et al., 2024b). The significant difference of the respondents in the control and experimental group mathematics performance and interest in math probably attributed by the treatment employed in the experimental group which is the project-based approach. Considering that one of the vital subjects in education is the teacher, teaching methods must be more on learner centered, interactive and manipulative just like the project-oriented approach (Sanchez, 2020; Sanchez, 2023b; Sanchez, et al., 2024c; Sanchez, et al., 2024d).

Respondents Interests after Exposure to POA Teaching Method

It is more advantageous in teaching Mathematics, Science and Technology to inspire the students to read their lesson in advance. Providing some reading material inspires the students to study in advance. The researcher selected topics in Mathematics and formed questions to answer in order for the students to think deeply with enthusiast.

At the start of the class, the Lesson Plan that contains the special topics which are discussed in the classroom was distributed at both the Experimental and Control group. It was observed that most of the students in the Experimental group were surprised; their faces were full of curiosity for the new environmental strategy in the teaching of Mathematics inside the classroom.

The intervention used in the experimental group was POA (Project-oriented Approach in Teaching Mathematics) that changed and triggered the attention of the Engineering Technology students of MSU- Lanao National College of Arts and Trades. This approach is unique, challenging and interactive unlike the traditional or normal Approach in teaching Mathematics which is classified as an individualistic system of learning; wherein the students get inside the classroom and seat to their chairs, listen to the instructions and sometime taking-note, seating on their chairs without any reaction about the discussion and not participating.

In this study, the Lesson Plan used contains activities which bring questions and answers to students and instructions that are strictly to be followed; otherwise, it will result into error-answers. This statement of changes can be seen and proven by the student's interview responses, field note of observations, interview response of the observer and the photos taken during the session (See Appendices 5, 6, & 8 for the notes and documentation).

The changes in the Student's Interest and Performance

In the observation regarding the changes of Mathematics performance and Mathematics interest of both Experimental and Control groups before and after intervention revealed that there was a significant change of Mathematics performance and Mathematics interest of both the Experimental and Control groups after intervention. It had been appeared that the changes of Mathematics performance and Mathematics interest of the students in the Experimental group was more rapid and significant compared to the students in the Control group, though Mathematics performance and Mathematics interest of the students in Control Group had a gradual change because the only new for them was the Lesson plan handout that the researcher provided.

On the other hand, the mean difference between the pre-test and post-test of the two (2) groups were all positive. The mean pretest of Experimental group was 17.636 while the mean posttest was 28.046 which give a positive mean of 10.410. This implies that the student's performance and interest have improved. Also, the mean result of pre-interest test was 148.682 while the mean result of Post-interest test was 162.818, hence the changes is 14.136 which is positive. Therefore, the changes of the performance and interest test of Experimental group were both positive and significant.

In the case of the Control group, the mean pretest was 17.227 and the mean posttest was 21.000 the change was 3.773 which is positive, for the interest test, the mean pre-interest test was 138.864 and the mean post-interest test was 143.727, the changes was 4.863 which was positive. The changes of mean performance test and the mean interest test were both positive, thus, in the since that the changes were all positive in result, therefore, the researcher concluded that there were improvement in the performance and interest of the students in the control group regardless of how smaller the changes was compare to Experimental group, but it has been shown that the result of performance and interest tests of Control Group were both positive and then considered as slightly improved.

International Journal of Engineering, Industrial, Maritime, and Technological Innovation (INJENI) P - ISSN: 3116-3807 E - ISSN: 3116-3815

PRC-CPD Accredited Provider: PTR-2025-749

NBDB Registration Book Publisher (Print & Digital): 0312

Mathematics had been accepted to many students that it is not easy but a hard to understand. This could be a challenge for Mathematics teachers to change and disproof of what the students' belief. During the intervention period, most of the students in Experimental group like to adopt the new instruction of POA. This approach is a group-working and is fitted to the interest of the students, each group has a group leader to compile the idea of the group members and finalize their agreed ideas and answers. Each of them had a copy of the instruction to analyze; this can also be considered as sharing of works and ideas. At that time of activity, everybody is busy in analyzing and performing the work activities, all of them were participating in the class working-activities, as it had been observed and seen in the captured photos (see in appendix 8) and besides, at the start of intervention in experimental group, the students never had an absent in the class as it had been mentioned by the observer in the later part.

The students of both experimental and control groups had improved in terms of performance and interest in Mathematics as it had been reflected in the statement above. The changes of performance and interest test of Experimental group were both positive, 10.41 for performance changes and 14.136 for interest test changes. It had been proven that the performance and interest tests had significantly changed. The Control group had also a slightly changes which is 3.773 for performance changes and 4.863 for interest-test changes, both were also positive. Although the changes of Control group in terms of student's performance and interest test were smaller compare to Experimental Group but still the changes of performance and interest tests were both positive.

In addition to the above mentioned which proves that the performance and interest of both groups (Experimental and Control groups) had been improved, the researcher picked-up six (6) students, three (3) students from the experimental group and three (3) students from the Control group, and then observed their performance and interest. The researcher start observing before intervention from prelim examination, the three (3) consecutive quizzes up to the midterm examination and after intervention, the three (3) consecutive quizzes and the final examination. One of the students in experimental group got a score of 30% in the prelim, 38%, 35%, 36% in the three (3) quizzes and 36% in the midterm examination before intervention but after the intervention, he got a score of 82%, 78%, 85% in the three (3) quizzes and 88% in the final examination.

The second student got a score of 26% in the prelim, 36%, 34%, 35% in the three (3) consecutive quizzes and 38% in the midterm examination before the intervention but after the intervention, he got a score of 75%, 78%, 84% in the three (3) consecutive quizzes and 85% in the final examination.

The third student chosen in the experimental group had got a score of 28% in the prelim, 30%, 29%, 32% in the three (3) consecutive quizzes and 40% in the midterm examination before intervention but after the intervention, he got a score of 50%, 56%, 64% in the three (3) consecutive quizzes and 78% in the final examination.

The scores achieved by the three (3) students from the experimental group implied that before intervention, all of them had got low scores but after the intervention, their scores had improved. The researcher noticed that the three (3) students failed in their prelim exam, the three quizzes, as well as their midterm exam but after intervention their scores had improved a lot. Based on the observation of the researcher, it can therefore be concluded that POA is effective method in teaching Mathematics. Interest can be seen in the student's activeness in the classroom discussion. Most of the students in the experimental group were active and fully participating in the classroom work-activities. They were always present in the work activities and come earlier unlike before when there is no intervention yet, they always came late as it has been mentioned by the observer on her reaction statements.

The researcher also observed three (3) students from the Control group before and after releasing of lesson plan. Before the releasing of lesson plan, the researcher let them attend their prelim examination, three quizzes and midterm examination. One of the students in Control group got a score of 32% in the prelim examination, 28%, 30%, 36% in the three (3) consecutive quizzes and 32% in the midterm exam. But after providing the lesson plan for them to study in advance, he got a score of 60%, 68%, 78% in the three (3) consecutive quizzes and 78% in the final examination.

The second student got a score of 28% in the prelim examination, 32%, 30%, 38% in the three (3) consecutive quizzes and 43 % in the midterm examination. But after releasing the lesson plan, he got a score of 60%, 64%, 64% in the three (3) consecutive quizzes and 66% in the final examination. The third student got a score of 32% in the prelim examination, 34%, 35%, 38% in the three (3) consecutive quizzes and 40% in the midterm examination. But after the releasing of lesson plan for them to read in advance, she got a score of 64%, 60%, 67% in the three (3) consecutive quizzes and 68%in the final examination. Therefore, the researcher concluded that giving lesson plan to the students for them to study in advance can help a lot to the students to cope-up in the subject matters.

In this observation, it shows the mental configuration of the six (6) students taken from the experimental and control group based on their scores achieved in every quizzes and examinations had attended before and after

International Journal of Engineering, Industrial, Maritime, and Technological Innovation (INJENI) P - ISSN: 3116-3807 E - ISSN: 3116-3815

PRC-CPD Accredited Provider: PTR-2025-749

NBDB Registration Book Publisher (Print & Digital): 0312

intervention as indicated. The first three (3) are the students taken from experimental group while the other three (3) were the students taken from control group. All of them had their respective scores achieved from the two (2) examinations (First Prelim and Mid Term Examinations) and the three (3) consecutive quizzes before intervention, their four scores were based on the three (3) consecutive quizzes and the Final Examination which was given after the intervention. It appears that the performance and interest of the students were poor before the intervention and turned better after the intervention.

The traces of influence on students' performance and interest

The traces of influence on student's performance in MSU-Lanao National College of Arts and Trades, Engineering Technology students. There were 6 students taken from experimental group and control group whom the researcher asked and interviewed regarding the traces of influence of Project-Oriented Approach towards the performance and interest in Mathematics of the Engineering Technology students of MSU-LNCAT.

The following are the responses of the students regarding the students' feeling during intervention period.

Researcher: Does the POA enhance learning strength and increase the interest of the students? Why?

Student 1: Sa tutuo lang sir, hindi ako gaano ka talino sa Math. Mahirap mag analys pero kung may kasama ako na nagpeperform sa activities, hindi ako nababahala dahil pwede ako maka pagtanong sa kagropo ko. *("Actually sir, I am not that good in Mathematics. It is difficult to analyze the problem but if I have a companion while doing the activity, I feel at ease for I can easily ask my co-members", Pre, Interview Response, 9/05/16)*

Her scores are 30% in the prelim, 38%, 35%, 36% in the three (3) quizzes and 36% in the midterm examination before intervention but after the intervention, she got a score of 82%, 78%, 85% in the three (3) quizzes and 88% in the final examination.

Student 2: So instruction a adun a actibity-on na malubod a kapuka sabota-on ago ditambokl'n ka puka-kaog permi so lawas ago kapakay tapun a phagisa ko mga pud ta. *("An instruction with activity are not difficult to understand and it is not also boring because our body and brain acting on different working-styles, we can also refer our works to group co-member", Tam, Interview Response, 9/05/16)*

His scores are 26% in the prelim, 36%, 34%, 35% in the three (3) consecutive quizzes and 38% in the midterm examination before the intervention but after the intervention, he got a score of 75%, 78%, 84% in the three (3) consecutive quizzes and 85% in the final examination.

Student 3: Sa bagay, nakakatulong din ang instruction na may activities lalo na sa Mathematics. Ang hirap kasi ang Math. Pero kung may matanongan ka kasabay yong instruction, lalawak ang kaalaman natin at mawawala ang tamad at hirap sa ating isipan. *("In fact, instruction with activity help a lot more over in mathematics, it is not easy to understand and analyze but if ever there is instruction in which to be followed plus you can ask to other classmates, surely it will strengthen our performance, laziness and anxiety be minimized", Fats, Interview Response, 9/05/16)*

Her score of 28% in the prelim, 30%, 29%, 32% in the three (3) consecutive quizzes and 40% in the midterm examination before intervention but after the intervention, she got a score of 50%, 56%, 64% in the three (3) consecutive quizzes and 78% in the final examination.

Student 4: ana sakn sir na aya kiagudama koron igira ana activity na maka e-enjoy ako. Dita maaluk, puki-iza ta so dita katawan ko mataoron. *("For me sir, I feel better and enjoyed in every activity, I don't feel worry about to answer the questions and perform the activity, I can ask and refer my works to my classmates who are knowledgeable on the activity", Saf, Interview Response, 9/05/16)*

His score of 29% in the prelim, 32%, 33%, 37% in the three (3) consecutive quizzes and 39% in the midterm examination before the intervention but after the intervention, he got a score of 73%, 76%, 82% in the three (3) consecutive quizzes and 84% in the final examination.

Student 5: Yes, sir, phakala so sabot ta ko kang group-working ka phuka-izaan ta so group leader ko dataon sabota ago igira kang groupo a activity na ditawn thoratod'n. interesado tawn p'n ka and magaan mapasad. *("Yes sir, group working will strengthen our knowledge because we can ask question to the group-leader, we are interested to finish the activities as early as possible and not to be sleepy", Nuri, Interview Response, 9/05/16)*

His score of 22% in the prelim, 31%, 30%, 34% in the three (3) consecutive quizzes and 34% in the midterm examination before the intervention but after the intervention, he got a score of 74%, 76%, 83% in the three (3) consecutive quizzes and 86% in the final examination.

International Journal of Engineering, Industrial, Maritime, and Technological Innovation (INJENI) P - ISSN: 3116-3807 E - ISSN: 3116-3815

PRC-CPD Accredited Provider: PTR-2025-749

NBDB Registration Book Publisher (Print & Digital): 0312

Student 6: Oway sir, igira ana activity na phagisug so sowata. Balabaw igira ana activity kang-groupo. Puka correctionan o isa so p'dian na puka-l'bodan ta ko kaanswer ago kambaal sa project-model. *("Yes sir, if ever there is activities it will widen our knowledge moreover if it is in the form of group-working we can refer our work to others, so it is not hard for us to find answer and perform work activities", Ham Interview Response, 9/05/16)*

His score of 24% in the prelim, 34%, 33%, 35% in the three (3) consecutive quizzes and 37% in the midterm examination before the intervention but after the intervention, he got a score of 76%, 78%, 82% in the three (3) consecutive quizzes and 84% in the final examination.

In consolidation of the six (6) students' interview response for the question number 1, all of them were convinced that instruction with activities improved their learning strength and increased their interest in learning Mathematics, as reflected on their respective scores achieved from the different types of examinations and quizzes. This can be supported by the claims of the study of Vigil (1996) which says that hand-on project can motivate students to communicate using Math and Science language in order to produce a final product.

Researcher: Which do you prefer in learning Math, with or without activities? Why?

Student 1: Ana oway sir, mas-tomo so adun a activity ron ka dita toratodun, ma-iinspired ta para mapiya i paras so pasad ta. *("yes sir, it's better to have activity in instruction because we do not feel sleepy, we are also inspired to work hard to make our project better", Didan, Interview Response, 9/05/16)*

Student 2: Ana masgusto ko sir yong may activity kay kung hindi mo maintindihan pwede ka maka pagtanong sa kagropo mo. *("Sir, I like the instruction with activity,because if ever you did not understand the instruction, you can ask from your co-member in your group", Salic, Interview Response, 9/05/16)*

Student 3: Tomo sir so ana activity ron ka dita mbokl'n. ana manga pud ta a dinggalb'k. ana dita di mipagshare-a sa idea paano magawa at masolve yong problem. *("Sir, it's better to have instruction with activity, we don't feel boring, we have companion to work together, we can share ideas on how to make the projects better and solve the problems", anifah, Interview Response, 9/05/16)*

Student 4: Tomoon akun sir so adun a activity ron ka khapakay a aya kasabota ko dataon sabota na igira pangbaal ta sa project-model ago phukamosawiran ta o leader ko gropo o antonaa i ikhidia-on. *("Sir, for me, I preferred to the instruction with activity, probably we can understand instruction through doing of project and seek advice from our group-leader on how to make our project", Sam, Interview Response, 9/05/16)*

Student 5: Mas mapiya rakun sir so adun a activity ron adi so da. Ago mapiya pun so kapag-activity a by group ka phuka sowata so dita katawan. Puki-iza ta ko pud ta a matao ron. *("For me, I'd rather prefer to have instruction with activity because doing work by group is enjoyable, we can learn a lot from others classmates", Magarang, Interview Response, 9/05/16)*

Student 6: Sakun sir na aya pukababayaang ko na so kanggroupo a kapag-activity. Pukhailay ta so pusuwaan ta ko pud ta ago siipun ko pud a groupo. *("For me sir, I like to work by group because we can see and observe in our co-member on how to do the project and solve the problems", Naser, Interview Response, 9/05/16)*

The six interviewed students have unanimously agreed that instruction with activities is better than the instruction without activities, it increased the interest and modified the comfort ability of the students inside the classroom. This can be supported by the statements made in the International Congress on Mathematics Education Program (ICMEP, 2012) that project-modeling in a cyclical process of process of creating and modifying models of empirical situations to understand then better and improve decision-making. The role of project-modeling in school mathematics has received increasing attention as generating authentic learning and reading the ways of thinking that produced it.

Researcher: How do you evaluate Math instructions with Project-model activities? Does it increase your interest to learn? Why?

Student 1: Igira ana activity tapus na kanggroupo pun a diron di kanggalub'ka na dita mbokul'n. phuka enjoy ta ko diron di kapamagoyawai ko kagaan ago kapiya o project. *("When there is activities then we work by group, we should not be bored but to enjoy working together then take consider the majority decision to make the work fast and better", Naser, Interview Response, 9/05/16)*

Student 2: Mas gusto ko sir so ana activity ron adi so da. Dikambokl'n ka madakul a pud-ta.odata sabota na maputaro o pud-ta. *("For me it's better to have activity rather than nothing, we will not be bored because we*

International Journal of Engineering, Industrial, Maritime, and Technological Innovation (INJENI) P - ISSN: 3116-3807 E - ISSN: 3116-3815

PRC-CPD Accredited Provider: PTR-2025-749

NBDB Registration Book Publisher (Print & Digital): 0312

have co-member, if ever something which we do not understand in the instruction some member can tell and correct the words" Pre, Interview Response, 9/05/16)

Student 3: Para sa akin sir na mas maganda yong may activity ka phuka panamaran ta i kagaan a kapasad o galb'k sa dipun maoma so oras. Ditaon bokl' ka mafofocus a otuk ta ko dita dimbaalan. *("For me sir, I prefer to have instruction with activity, we will be forced to finish the work before to finish on time without boring felt", Magarang, Interview Response, 9/05/16)*

Student 4: oway sir, phag-increase so interest ta igira madakul a dita di mipagogopa ko galb'k. *("Yes sir it increases our interest if group working together to finish the work", Didaagun, Interview Response, 9/05/16)*

Student 5: Syempre sir, phakala so interest ta ka ph'ka pwersa ta ko galb'k-on oda a miyapasad ta na damambo a grades tawn. *("Of course sir our interest increases because we will be forced to work on the activity, without work activity finished there will be no grade also" Tam, Interview Response, 9/05/16)*

Student 6: Ang na observe ko sir na igira adun a experiment na da-a bok'l ta. Mapipiya a ginawa ta. Kombaga na phukababayata ko dita dinggalbk'n.mapopokos so pamikiran ta kung paano mo magagawa yong project niyo. Phaka answer tap'n gagaan ka khaipos so oras. *("I have observed when there is an experiment. We will not be boring, our body is condition our body act comfortable position to work, our brain always be focused on to have correct answer and follow the instruction properly on or before time allotted", Salic, Interview Response, 9/05/16)*

Based on the common responses of the six (6) students, it is shown that they all agreed that activities molded the instruction and increases the interest of the students. This is supported by the claim of the Mathematics teacher MT (2008) that teachers who hold model of teaching and learning certainly exercise professional care for their pupils and help them achieved an important measure of Science in public examination.

Researcher: How do you feel when doing your activities? Feeling good and inspired or feeling boring? Why?

Student 1: Ana sak'n sir na basta kanggalb'k na diyakombokl'n. feeling-well ako kagia mintin tawn phkakaog. Kapakay a montod ta kapakay a gomanat ko dita kanggalubuk na dita mambo bokulun ago mapaparota. *("For me sir, in every work, I don't feel boring but feeling well because sometimes I am standing then seating again, my body feel well and comfortable", Fats, Interview Response, 9/05/16)*

Student 2: so sak'n-on sir na diya ko bobokl'n mag-activity. Nakaka enjoy panga ie, so kasi so kawntod ago kapamakinug bo na kakaboring, torotorogun tawn. *("For me sir, I don't feel boring during activities actually I enjoy performing some project rather than seating and listening only without acting", Tam, Interview Response, 9/05/16)*

Student 3: mapiya sir so ana activity ron adi so da. Ditambokl'n ka ditap'n khitanod so oras. Matutumbang ta ko galb'k ta. *("It is better sir if there is activity rather than no activity, we will not be bored and felt time is to short, we were entertaining on working", Saf, Interview Response, 9/05/16)*

Student 4: Nakaka enjoy sir pag may activities. Puki-iza ta so dita katawan ko manga kagroupo ta. Puki-compare tap'n so pasad ta ago answer ta ko p'd ta. *("We are enjoying sir, if there is activity we can ask and compare our work to our co-member", Pre, Interview Response, 9/05/16)*

Student 5: Sakun sir na para rakn na mapiya so ana activity on ka dika khazero. Apiya kasi dinga sabot'n na khapakay a khi-iza aka ko matao ron. *("For me sir, I am feeling good because I am sure if I work well a good grade will receive, but if I do not work, no grade will receive, if I don't understand the instruction I can ask to the knowledgeable one", Nurs, Interview Response, 9/05/16)*

Student 6: Mapiya sir so ana activity ron ka phukabint'ng a otuk ta ko diron di kaphlanowi ko kakhasowa a tawn. Kakokonsentretan ta oba maribat. *("It is better sir if there is activity our brain will be forced to think and plan to follow the instruction properly and recognize error", Anifah, Interview Response, 9/05/16)*

These six students commonly response that all of them felt good during classroom activities and no one (1) feels boring and sleepy during performing activity inside the classroom. This can be supported by the statement in the study of cheng (2001) that model or project can be considered a simplification of a complex real model problem into a Mathematical form, models or project in Mathematics help interpreting and translating problems into real and simplified terms.

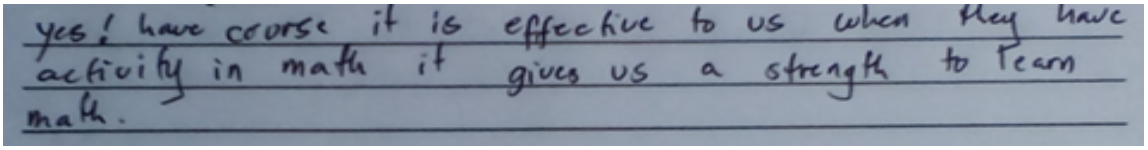
In addition, the following were the various reactions statements of some students as well as the observers' findings during intervention inside the classroom

International Journal of Engineering, Industrial, Maritime, and Technological Innovation (INJENI) P - ISSN: 3116-3807 E - ISSN: 3116-3815

PRC-CPD Accredited Provider: PTR-2025-749

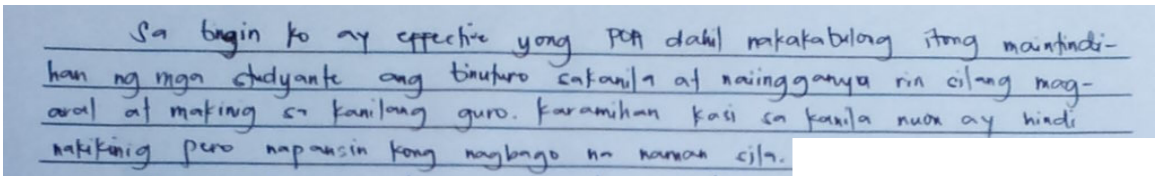
NBDB Registration Book Publisher (Print & Digital): 0312

Question 1*: Does the POA enhances learning strength and increases the interest of the students? Explain.*
Student's Reaction Statement:



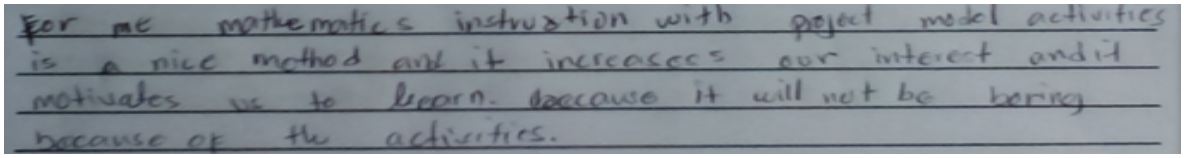
("Yes! Of course it is effective. To us, when they have activity in Math, it gives us a strength to learn Math", Sam, Interview Written Response, 4/12/16)

Observer's Reaction Statement:



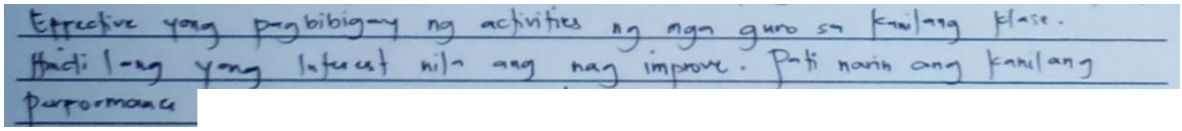
("I think it is effective because it helps the students understand their lessons and it encourage them to study and listen to their instructor because at first, they don't listen to their instructor but that attitude of them changed after the intervention "ipah, Interview Written Response, 7/21/16.)

Question 2: *Which do you prefer most in learning Mathematics, learning with or without project activities?Explain*
Student's Reaction Statement:



("for me, Mathematics instruction with project model activities is a nice method and it increases our interest and it motivates us to learn. Because it will not be boring because of the activities", Fats, Interview Written Response, 4/12/15)

Observer's Reaction Statement:



("The approach wherein the instructor gives activities is much more effective. Not only does it increase their Interest but it also improves their Performance ", ipah, Interview Written Response, 7/21/16)

Reaction statement of the three (3) students from control group as well as their respective scores achieved from different types of examinations and quizzes.

Researcher: How does the lesson plan help the student to learn mathematics? Explain

Student 1: So lesson plan na pakaogop igira pamatiya so studeante sa walay, pero igira da Pamatiya na dimagisug so learning strength iyan. (*Lesson plan can help the students if the student read the lesson plan at home but if the student did not read at Home, his learning strength never increase.*)

His score of 32% in the prelim examination, 28%, 30%, 36% in the three (3) consecutive quizzes and 32% in the midterm exam. But after providing the lesson plan for them to study in advance, he got a score of 60%, 68%, 78% in the three (3) consecutive quizzes and 78% in the final examination.

Student 2: So lesson plan na pupakaogop sa mala ko mapasang I kapagistadi sa walay, Puki dobli ko text book. *(Lesson plan can help a lot for the student whose Studious at home).*

Her score of 28% in the prelim examination, 32%, 30%, 38% in the three (3) consecutive quizzes and 43 % in the midterm examination. But after releasing the lesson plan, he got a score of 60%, 64%, 64% in the three (3) consecutive quizzes and 66% in the final examination.

Student 3: Mapiya so lesson plan ka anapukabatiya ta sa walay a reference. *(Its' better to Have lesson plan. We can have extra reference to read at home).*

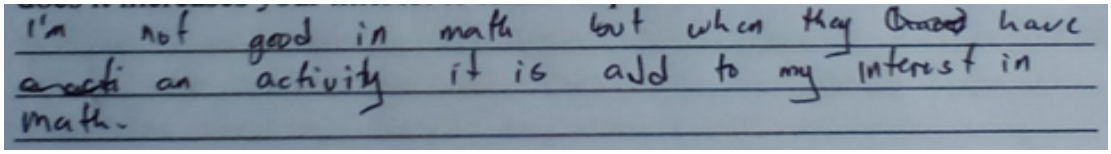
International Journal of Engineering, Industrial, Maritime, and Technological Innovation (INJENI)
P - ISSN: 3116-3807
E - ISSN: 3116-3815
PRC-CPD Accredited Provider: PTR-2025-749
NBDB Registration Book Publisher (Print & Digital): 0312

His score of 32% in the prelim examination, 34%, 35%, 38% in the three (3) consecutive quizzes and 40% in the midterm examination. But after the releasing of lesson plan for them to read in advance, she got a score of 64%, 60%, 67% in the three (3) consecutive quizzes and 68%in the final examination.

For the Project Oriented Approach (POA), there was a new approach that changes the environmental teaching style. In every class lecture, the researcher gives Lesson Plan for the students to analyze and solve problems written below the instruction. Everyone was given a chance to find way to understand instruction and solve related problems. They were also given a time to consult each other's works. What happened during the session was enjoyable. Everybody looks busy during activities and were full of excitement. Changes in the teaching environment made the students active and increased their interest; this can be proven and seen on the photos taken during the session. When it comes to the performance of both groups, the Experimental and the Control group became better because of the treatment done, providing Lesson Plan to each group to study and analyze the topics, plus each of the students were free to ask and clarify instructions and problems to their Co-group member and to their teacher, consequently the result of the Experimental group in their Exam and quizzes were all passed and some have gained higher scores compared to the Control group. This implies that the Experimental group have improved prominently as compared to that of the Control group. This traces or illustration can be seen and proven in the interview response of the students, the field-note of the researcher, the narrative report of the observer as well as the Photos taken during intervention, (See Appendix 5, 6, and 7). This learning is more related to the claim of constructivist learning environments in which requires the students to use their prior knowledge and experiences to formulate new, related, and or adaptive concepts in learning, (Termos, 2012). Under this framework the role of the teacher becomes that of a facilitator, providing guidance so that learners can construct their own knowledge, this framework is very much related and similar with the framework of K-12 and this research POA.

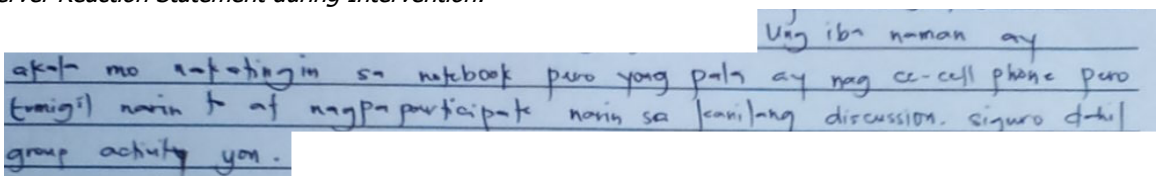
To prove these statements, the researcher took three students in the Experimental group as a sample. First of them is Lam. Before the intervention, he is a very world-weary guy. He is always using his Cellphone inside the classroom despite the teacher presence, but when the POA was applied, he become lively and asks questions always. Maybe because this approach and his friends/companions were motivated and their interest in learning Math had been promoted.

Student Reaction Statement after Intervention:



("I'm not good in Math but when there is an activity, it adds to my interest in Math", Fam, Interview Written Response, 4/12/16)

Observer Reaction Statement during Intervention:



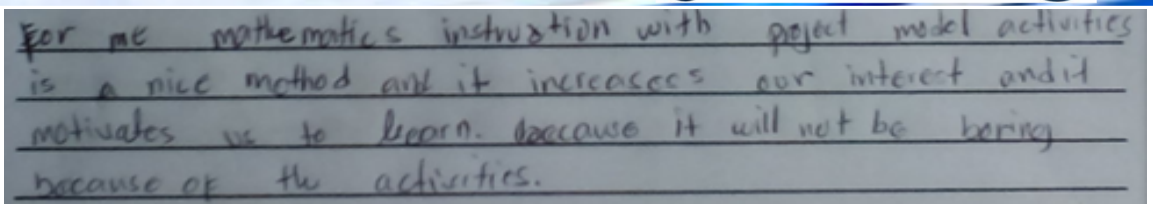
("You'll think that Fam is taking down notes but when you look at him clearly, you'll see that he just playing on his phone which is hidden in his notebooks. But after the intervention, I can say that Cam has changed his attitude. he participating in the class discussion, probably because he attracted with the activity ", ipah, 7/21/16)

Student Reaction Statement After Intervention:

International Journal of Engineering, Industrial, Maritime, and Technological Innovation (INJENI) P - ISSN: 3116-3807 E - ISSN: 3116-3815

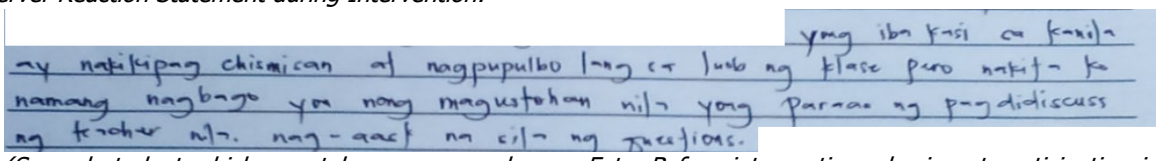
PRC-CPD Accredited Provider: PTR-2025-749

NBDB Registration Book Publisher (Print & Digital)- 0312



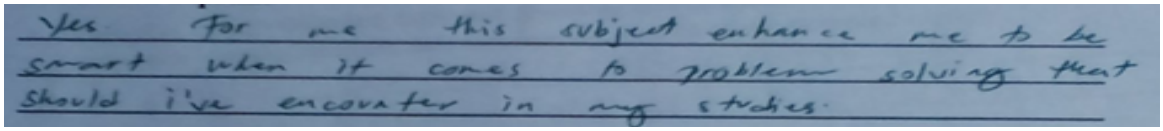
("for me, Mathematics instruction with Project model activities is very interested, it increases our interest and motivates us to learn Mathematics", Fats, Interview Written Response, 4/12/16)

Observer Reaction Statement during Intervention:



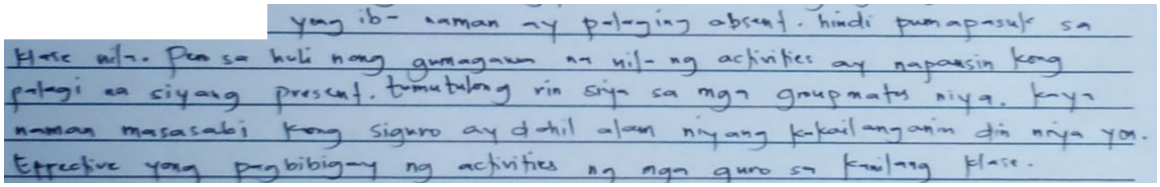
(Second student which was taken as a sample was Fats. Before intervention, she is not participating in the discussion and always applies face powder and make-up even if we are in the middle of the discussion and she keeps on talking to her classmates about the latest k-pop video, but after the intervention, she become enthusiastic and always asks the next steps when they're performing an activity. doing activities doesn't make the students feel bored but to makes the participate in the class discussion", ipah, 7/21/16)

Student Reaction Statement:



("Yes. For me this approach POA enhances my attitude to be smart when it comes to problem solving that I've encounter in my studies" Sam, Written Response, 4/12/16)

Observer's Reaction Statement:



(The third student is Sam. Before intervention, he always comes to class late and sometimes absent and come to class whenever he feels almost time to go home but after intervention, he become reliable and comes to class at the scheduled time because he realized that mathematics is useful in our day-to-day lives, ipah, 7/21/16).

Observer's Reaction Statement:

("Some of them are always absent but at the time they are doing their project-activities, I saw him personally, he had changed his attitude. He always present in the class and helps his group mates doing of their project-activities.", ipah, Observer, Interview Response, 7/21/16)

The noted change on student's interest and performance in mathematics in the experimental group was the result of the intervention, considering the fact that the Post- interest test and performance test were better than the result of Pre-interest and performance test. Experimental group had a significant change on interest and performance in mathematics as compared to the control group without intervention, maybe because of the POA method of teaching. These two sets of results can be an evidence that the interest of the students of Engineering Technology had increased. In addition, this was also seen and proven in the field note of the observer, the interview responses of the students and the photos taken during the sessions (see the student's responses: Appendices 5, 6, & 8 in the documentation).

Another sign or evidence that the student's performance and interest in math had dramatically changed to both experimental and control groups was due to the intervention of the experimental group and only lesson plan for the control group. However, again the experimental group had better result in Posttest as compared to the Posttest result of the control group, but these two groups had better performances and interest compare to other groups with no intervention and lesson plan used. This statement can be seen and proven in the field notes of the observers, the

International Journal of Engineering, Industrial, Maritime, and Technological Innovation (INJENI) P - ISSN: 3116-3807 E - ISSN: 3116-3815

PRC-CPD Accredited Provider: PTR-2025-749

NBDB Registration Book Publisher (Print & Digital): 0312

interview responses of the students and the photos taken during the sessions (See Appendices 5, 6, & 8 for the notes and documentation). Excerpt below are some of respondents' response that is quoted relevance to support the claims that using POA really improve students' performance in math and interest in math in a written interview. The statements below were verbatim transcript as how the respondents wrote it in their journal logs (See Appendix 6 for the details of the written interview of student's journal log). This claim is the same with the claim of Mathematics Teacher (MT 141, Dec. 1992) that teacher who hold model of teaching and learning certainly exercise professional care for their pupils and help them achieve an important measure of success in public examination.

Based on the excerpts presented, it can be manifested that the POA mathematics teaching helped students to learn much. They can manage the demands of the instructions through manipulations according to their pace of learning. Moreover, POA motivated the students to learn and love learning, inspiring them, making fun in learning, taking challenges, enough space for initiative and creativity and learn to be independent. More of this conversation that can be considered as evidence effects of POA can be seen in Appendix 6 of this paper, and some observations of the researcher written in the field notes place in Appendix 5 of this paper. Moreover, photos as documentation are also attached in this paper as Appendix 8.

According to Novak (2011), creative teacher and true learning method, can stimulate student to grow up leadership skill. So, teaching approaches that with all of its creative learning can make student into future leader. Teaching and learning mathematics are complex tasks. The effect on student learning of changing a single teaching practice may be difficult to discern because of the simultaneous effects of both the other teaching activities that surround it and the context in which the teaching takes place. Thus, as teachers seek to improve their teaching effectiveness by changing their instructional practices, they should carefully consider the teaching context, giving special consideration to the types of students they teach.

Conclusion

Based on the results and findings of the study, the following conclusions were forwarded:

The mathematics performance and interest in math of the students who were exposed to Project-oriented approach of Teaching Mathematics (Experimental Group, EG) and those students exposed to traditional Mathematics Teaching Approach (Control Group, CG) differ significantly. There is a significant relationship between mathematics interest and mathematics performance of the students before and after intervention. The student's interest and performance in mathematics improved when students are exposed to Project-oriented Approach in Teaching Mathematics.

Recommendations

In view of the aforementioned conclusions drawn from the study, the following recommendations were presented:

As seen by the findings of the study that using an interactive/ participative approach through activity based learning's will affect the interest and performance of students in such a difficult subject such as mathematics. Thus, in teaching it is strongly suggested that it would be more effective if the teachers can employ more and better pedagogy to better designed lesson plan which consists of lectures, activities, and project-based orientation with higher order questions as the post assessment. Teachers should let their students be exposed to the actual application of the topics into activities (making of Project-models) especially on real-life scenarios in order to improve the student's learning skills in Mathematics, and other subject areas like Science and Technology.

Another recommendation is a parallel study could be conducted using different sample and subject matter as well as with more variables for triangulation and comparisons of results to validate the findings of this study.

REFERENCES

Amihan, S. R., & Sanchez, R. D. (2023). Connecting Workplace Literacy Gaps through Innovative Academe-Industry Collaboration. *International Journal of Open-access, Interdisciplinary and New Educational Discoveries of ETCOR Educational Research Center (iJOINED ETCOR),* 2(2), 515-528.

Amihan, S. R., Sanchez, R. D., & Carvajal, A. L. P. (2023). Sustained quality assurance: Future-proofing the teachers for an ASEAN higher education common space. International Journal of Open-access, Interdisciplinary and New Educational Discoveries of ETCOR Educational Research Center (iJOINED ETCOR), 2(4), 276-286. https://etcor.org/storage/iJOINED/Vol.%20II(4),%20276-286.pdf

International Journal of Engineering, Industrial, Maritime, and Technological Innovation (INJENI)
P - ISSN: 3116-3807
E - ISSN: 3116-3815
PRC-CPD Accredited Provider: PTR-2025-749
NBDB Registration Book Publisher (Print & Digital): 0312

Brawner, F. G., & Andrada, L. M. (2005). *Market Study and Monitoring System on Teacher Education in Mathematics and Science*. Science Education Institute. www.spheres.dost.gov.ph

Carvajal, A. L. P., & Sanchez, R. D. (2023). Strategic Considerations, Challenges, and Opportunities in Establishing the International Journal of Open-access, Interdisciplinary, and New Educational Discoveries (iJOINED). *International Journal of Open-access, Interdisciplinary and New Educational Discoveries of ETCOR Educational Research Center (iJOINED ETCOR),* 2(2), 539-546.

Carvajal, A. L. P., & Sanchez, R. D. (2024). Probing the Leadership Qualities of Local Chief Executives (LCEs) in Creating Competitive Creative Communities: Basis for Leadership Framework and Development Plan. International Journal of Open-access, Interdisciplinary and New Educational Discoveries of ETCOR Educational Research Center (iJOINED ETCOR), 3(1), 380-400. https://etcor.org/storage/iJOINED/Vol.%20III(1),%20380-400.pdf

Carvajal, A. L. P., Sanchez, R. D., Bacay, R. B. R., Sanchez, A. M. P., Sia, J. B., Moldez, R. G., Llego, J. H., Bation, N. D., & Pangilinan, A. M. (2024). The reflective leader's handbook: Mapping the path to effective leadership. ETCOR Educational Research Center Research Consultancy Services. https://etcor.org/book-publications/the-reflective-leaders-handbook-mapping-the-path-to-effective-leadership

Carvajal, A. L. P., Sanchez, R. D., & Amihan, S. R. (2023). Probing the Seven Qualities of True Leadership: A Qualitative Investigation of Selected Experienced and Successful Leaders in Various Industries. *International Journal of Open-access, Interdisciplinary and New Educational Discoveries of ETCOR Educational Research Center (iJOINED ETCOR),* 2(3), 898-912. https://etcor.org/storage/iJOINED/Vol.%20II(3),%20898-912.pdf

Cheng, A. K. Teaching Mathematical Modelling in Singapore Schools. *The Mathematics Educator, 6*(1). https://math.nie.edu.sg/kcang/TME_paper/teachmod.html

Dizon, E. C., & Sanchez, R. D. (2020). Improving select grade 7 Filipino students' reading performance using the eclectic model. *Journal of World Englishes and Educational Practices*, 2(2), 216-221.

Gumal A.(2016). Factor Affecting the Teaching of Public High School Mathematics in the Province of Lanao del Sur and Maguindanao. *International Journal of Learning, Teaching, and Educational Research, 15*(4).

Laurente, M. (2016). Effects of Instructional Objectives on Mathematics Learning among Selected College Students in LSU-Ozamis. *International Journal of Learning, Teaching, and Educational Research, 15*(4).

Levene, Howard (1960). Robust tests for equality of variances. Stanford University Press, 278–292. https://en.wikipedia.org/wiki/Levene%27s_test.

Magwilang, E. (2016). The Teaching Chemistry in Context: Its Effects on Students' Motivation, Attitudes and Achievement in Chemistry. *International Journal of Learning, Teaching, and Educational Research, 15*(4).

Muńoz, M. C., & Sanchez, R. D. (2023). Exploring Fernandino Teens TV as a supplementary learning delivery modality: Opportunities and challenges from the lens of select learners. *International Journal of Open-access, Interdisciplinary and New Educational Discoveries of ETCOR Educational Research Center (iJOINED ETCOR)*, 2(1), 358-374.

Novak, J.D. (2011). A theory of education: meaningful learning underlies the constructive integration of thinking, feeling, and acting leading to empowerment for commitment and responsibility. *Aprendizagem Significativa em Revista/Meaningful Learning Review, 1*(2), 1-14.

Olkin, I., Hotelling, H., & et al. (n.d.). Contributions to Probability and Statistics: Essays in Honor of Harold Hotelling. *Stanford University Press, 278–292*.

Salendab, F. A., & Sanchez, R. D. (2023). Graduates Tracer Study: The Employability Status of Bachelor of Elementary Education (BEED) of Sultan Kudarat State University – Kalamansig Campus. *International Journal of Open-access, Interdisciplinary and New Educational Discoveries of ETCOR Educational Research Center (iJOINED ETCOR)*, 2(2), 642-655

Salendab, F. A., Ocariza-Salendab, R. L. A., & Sanchez, R. D. (2023). Employers' Feedback on the Performance of Bachelor of Elementary Education (BEED) Graduates in the Workplace: A Pre-Deployment Training Remediation Implications. *International Journal of Open-access, Interdisciplinary and New Educational Discoveries of ETCOR Educational Research Center (iJOINED ETCOR)*, 2(3), 882-897. https://etcor.org/storage/iJOINED/Vol.%20II(3),%20882-897.pdf

Sanchez, A. M. P. (2022). HR practitioners' perceptions on boosting employees' loyalty and commitment: Inputs for a 21st century-responsive human resource system. *International Journal of Open-access, Interdisciplinary and New Educational Discoveries of ETCOR Educational Research Center (iJOINED ETCOR)*, 1(4), 89-102.

International Journal of Engineering, Industrial, Maritime, and Technological Innovation (INJENI) P - ISSN: 3116-3807 E - ISSN: 3116-3815

PRC-CPD Accredited Provider: PTR-2025-749

NBDB Registration Book Publisher (Print & Digital): 0312

Sanchez, R. D. (2020, December 27). "Preserving the Honor of the 'Honoris Causa': Revisiting the Guidelines on the Conferment of Honorary Degrees". SunStar Pampanga. Retrieved from https://www.pressreader.com/philippines/sunstar-pampanga/20201227/281608128045257

Sanchez, R. (2023). Utilization of the daily lesson logs: An evaluation employing the CIPP model. *International Journal of Open-access, Interdisciplinary and New Educational Discoveries of ETCOR Educational Research Center (iJOINED ETCOR),* 2(1), 199-215.

Sanchez, R. D. (2023). Unveiling the moral-theological foundations of the nullity of marriage due to psychological incapacity. *International Journal of Open-access, Interdisciplinary and New Educational Discoveries of ETCOR Educational Research Center (iJOINED ETCOR),* 2(1), 397-404.

Sanchez, R. D., Belz, J. A., Sia, J. B., Sanchez, A. M. P., Pangilinan, A. M., & Sanchez, J. J. D. (2024). Run, researchers! Run! Research, health and fitness in one running community. ETCOR Educational Research Center Research Consultancy Services. https://etcor.org/book-publications/run-researchers-run-research-health-and-fitness-in-one-running-community

Sanchez, R. D., Carvajal, A. L. P., Molano, R. R., Amihan, S. R., Valdez, J. V., Sanchez, R. V., Santos, M. J. D., Eler, G. M., & Gonzales, R. D. (2024). Leading from within: Nurturing leadership skills and service mindset of educators. ETCOR Educational Research Center Research Consultancy Services. https://etcor.org/book-publications/leading-from-within-nurturing-leadership-skills-and-service-mindset-of-educators

Sanchez, R. D., Carvajal, A. L. P., Cabrejas, M. M., Barcelona, K. E. P., de Rama, I. V., Convocar, A. D., Panimbang, G. M., Sia, J. B., & Tiquis, M. V. V. (2024). Living the passionate journey: Creating a life and career fueled by lasting excitement. ETCOR Educational Research Center Research Consultancy Services. https://etcor.org/book-publications/living-the-passionate-journey-creating-a-life-and-career-fueled-by-lasting-excitement

Sanchez, R. D., Carvajal, A. L. P., Francisco, C. DC, Pagtalunan, E. C., Alon-Rabbon, K., Llego, J. H., Sanchez, A. M. P., Pangilinan, A. M., & Sanchez, J. J. D. (2024). The power of influence: Leading by example for greater role and productivity. ETCOR Educational Research Center Research Consultancy Services. https://etcor.org/book-publications/the-power-of-influence-leading-by-example-for-greater-role-and-productivity

Sanchez, R., & Sarmiento, P. J. (2020). Learning together hand-in-hand: An assessment of students' immersion program in a schools division. *International Journal of Research Studies in Education,* 9(1), 85-97.

Sanchez, R. D., Sanchez, A. M. P., & Sanchez, J. J. D. (2023). Delving into the Integration of Research Subjects in the Junior High School Curriculum from the Learners' Point of View. *International Journal of Open-access, Interdisciplinary and New Educational Discoveries of ETCOR Educational Research Center (iJOINED ETCOR),* 2(1), 432-442.

Sanchez, R., Sarmiento, P. J., Pangilinan, A., Guinto, N., Sanchez, A. M., & Sanchez, J. J. (2022). In the name of authentic public service: A descriptive phenomenological study on the lives of Filipino teachers in select coastal villages. *International Journal of Open-access, Interdisciplinary and New Educational Discoveries of ETCOR Educational Research Center (iJOINED ETCOR),* 1(1), 35-44.

Tan, J.G. (2016). English Instructional Materials: Imperative Learning Aid for the High School Bound Summer Program of the MSU-Science High School. *International Journal of Learning, Teaching, and Educational Research, 15*(4).

Valdez, A. (2009). Cross Validation on the Effect of Modular Instruction on Students Achievement in Chemistry as Measured by the TIMSS-Like Test. *Mindanao State University-Marawi, Unpublished Research*.

Valdez, A. (2013). Effects of HOTS Techniques through Modular Instructions in Teaching High School Chemistry in MSU-Balindong Community High School. *International Journal of e-Education, e-Business, e-Management, and e-Learning, 3*(4), August.

Valdez, A. (2015). Developing Critical Thinking through Activity-Based and Cooperative Learning Approach in Teaching High School Chemistry. *Internatinal Journal of Social Science and Humanity,* 5(1), January.

Vigil, J. (1996). What is Science Literacy? *IDRA Newsletter*, Intercultural Development Research Association, Dec. 1996.

International Journal of Engineering, Industrial, Maritime, and Technological Innovation (INJENI)
P - ISSN: 3116-3807
E - ISSN: 3116-3815
PRC-CPD Accredited Provider: PTR-2025-749
NBDB Registration Book Publisher (Print & Digital): 8372

Monitoring for results: An evaluation of City Engineering Project Monitoring System (CEPMS) in Quezon City

Flordeliz B. Hernandez
Polytechnic University of the Philippines, A. Mabini Campus, Anonas Street, Sta. Mesa Manila, Philippines 1016

Abstract
Aim: This study evaluated the City Engineering Project Monitoring System (CEPMS) as a digital monitoring platform used by the Quezon City Department of Engineering. Specifically, it assessed users' evaluation of CEPMS in terms of outcome achievement, efficiency, service delivery quality, and trust and legitimacy, examined its observed strengths and weaknesses across the project monitoring process, and assessed the extent of challenges encountered in its implementation and utilization.
Methodology: A descriptive–quantitative research design was employed involving 148 respondents composed of internal personnel and external contractors. Data were collected using a validated survey questionnaire grounded in public value dimensions. Descriptive statistical tools, including frequency, percentage, and weighted mean, were used to analyze respondents' profiles, evaluations of CEPMS performance indicators, observed strengths and weaknesses, and implementation challenges.
Results: Findings revealed that CEPMS was evaluated positively across all four public value dimensions by both internal and external respondents, with internal users consistently reporting stronger agreement. The system was particularly rated high in supporting timely project tracking, improving documentation workflows, enhancing information accessibility, and promoting transparency and accountability in infrastructure monitoring. The core process components—data encoding and validation, field monitoring and updating, and report generation and utilization—were identified as strengths, with minimal perceived weaknesses. Identified challenges related to system access, data updating, digital literacy, and notification features were generally rated as manageable and did not significantly hinder system implementation or utilization.
Conclusion: The study concludes that CEPMS functions as an effective and reliable digital monitoring and governance tool that contributes to improved efficiency, transparency, and accountability in local government infrastructure projects. Continued system enhancement, targeted user support, and incremental feature improvements may further strengthen its performance and sustain its contribution to results-based infrastructure monitoring in Quezon City.
Keywords: *City Engineering Project Monitoring System, digital monitoring, public value, infrastructure, Quezon City*

INTRODUCTION

Digital transformation has become a defining feature of contemporary public administration, reshaping how governments plan, implement, and monitor infrastructure projects worldwide. As urban environments grow more complex, public sector organizations increasingly rely on digital monitoring systems to enhance accountability, transparency, and efficiency in service delivery (Flyvbjerg, 2021; Li & Sun, 2025). Scholars have noted that traditional manual monitoring approaches often struggled with fragmented information, delayed reporting, and limited coordination, particularly in large-scale engineering projects requiring real-time oversight and multi-stakeholder collaboration (Jelodar, 2021; Hall & Bonanomi, 2021). Consequently, digital project monitoring platforms have emerged as critical governance tools for ensuring that public infrastructure investments deliver measurable outcomes and public value.

Globally, governments have adopted results-based monitoring frameworks supported by digital technologies such as centralized databases, Geographic Information Systems (GIS), and standardized reporting dashboards to respond to increasing demands for transparency and performance accountability (Agbaxode et al., 2024; Iandolo et al., 2024). These systems were designed not only to track physical progress but also to improve documentation accuracy, support timely decision-making, and strengthen public trust in government institutions.

In the Philippine context, the adoption of digital monitoring tools is aligned with national reforms promoting transparency, accountability, and results-based management in local governance. Frameworks advanced by the Department of the Interior and Local Government (DILG) and the National Economic and Development Authority (NEDA) encouraged local government units to modernize monitoring mechanisms and strengthen evidence-based decision-making (NEDA, 2023; DILG, 2023). Despite these policy directions, several studies reported uneven implementation of digital systems across local governments, citing challenges related to data consistency, system

International Journal of Engineering, Industrial, Maritime, and Technological Innovation (INJENI)
P - ISSN: 3116-3807
E - ISSN: 3116-3815
PRC-CPD Accredited Provider: PTR-2025-749
NBDB Registration Book Publisher (Print & Digital): 8372

utilization, digital literacy, and inter-organizational coordination (Kokogho et al., 2024). These findings suggested that the presence of a digital platform alone did not guarantee improved governance outcomes, underscoring the need for empirical evaluations at the local level.

Quezon City, as the largest and most infrastructure-intensive local government unit in Metro Manila, introduced the City Engineering Project Monitoring System (CEPMS) to modernize the monitoring of engineering projects and standardize reporting within the Quezon City Department of Engineering. While CEPMS demonstrated potential in consolidating project data and improving visibility over infrastructure activities, internal assessments and audit observations indicated persistent concerns such as delayed updates, inconsistent data entry, and gaps in user compliance. Despite the growing use of CEPMS, limited empirical research has examined its effectiveness as a governance tool using a results-based public value framework, particularly from the perspectives of both internal personnel and external contractors. Existing studies on digital monitoring systems often focused on technical features or user satisfaction in isolation, with few integrating outcome achievement, efficiency, service delivery quality, and trust and legitimacy into a unified city-level assessment.

This study addressed this gap by evaluating CEPMS as both a technological system and a governance mechanism within Quezon City. By examining user assessments of the system's performance, strengths, weaknesses, and implementation challenges, the study aimed to determine how CEPMS contributed to public value in infrastructure monitoring. Unlike prior works that emphasized system design alone, this research provided an integrated, user-centered evaluation grounded in public value dimensions. The findings offered evidence-based insights to support system enhancement, inform local policy decisions, and contribute to broader discourse on digital governance and performance-driven infrastructure monitoring in Philippine local governments.

Review of Related Literature and Studies

Engineering projects are widely recognized as complex undertakings that require the coordinated application of technical expertise, scientific principles, and structured project management to deliver infrastructure that meets societal needs (Evans et al., 2022; Alhosani & Alhashmi, 2024). Recent studies emphasize that engineering works, ranging from large-scale public infrastructure to localized community improvements, demand multidisciplinary collaboration to balance safety, functionality, cost, environmental sustainability, and regulatory compliance (Hamta et al., 2021; Iandolo et al., 2024). Because these projects typically follow a life cycle from planning and procurement to construction and commissioning, weaknesses in any stage may result in delays, cost overruns, and quality defects, especially in high-demand urban environments (Agbaxode et al., 2024; Kim, 2021). In this context, documentation integrity and transparent reporting are not only technical requirements but also governance necessities that shape public trust in infrastructure delivery (Flyvbjerg, 2021; Chen et al., 2024).

Monitoring has been identified as a critical governance function in engineering project delivery because it enables project teams to measure progress against planned schedules, budgets, and performance standards while detecting risks early (Agbaxode et al., 2024; Hamta et al., 2021). Studies highlight that monitoring increasingly relies on measurable indicators and milestone tracking, supported by regular site validation and structured reporting systems to ensure both quantity and quality of outputs (Panwar & Jha, 2021; Shah, 2023). Additionally, monitoring practices have expanded beyond physical accomplishment to include safety, environmental compliance, and stakeholder coordination, dimensions that directly influence project outcomes and institutional credibility (Chen et al., 2024; Rane, 2023). Because engineering projects involve multiple contractors and implementing units, research consistently notes that fragmented reporting and inconsistent updates remain persistent drivers of disputes, delays, and weak accountability (Purchase et al., 2021; Rudele et al., 2024).

In response to these monitoring challenges, the literature underscores the growing adoption of Engineering Project Monitoring Systems (EPMS) as integrated platforms that consolidate time, cost, quality, and resource data into a unified decision-support environment (Purchase et al., 2021; Piccardo & Hughes, 2022). Recent studies argue that modern EPMS implementations are strengthened by digital features such as cloud-based dashboards, GIS-enabled project visualization, and standardized reporting modules, which improve visibility and support evidence-based corrective action (Iandolo et al., 2024; Shah, 2023). EPMS platforms are also linked to improved contractor management, as performance tracking can strengthen enforcement of timelines, technical specifications, and compliance requirements using verifiable documentation and time-stamped monitoring evidence (Hamta et al., 2021; Kim, 2021). Overall, the literature suggests that EPMS effectiveness should be judged not only by technical capability but by how well the system improves outcomes, operational efficiency, service quality, and accountability in public infrastructure governance (Flyvbjerg, 2021; Iandolo et al., 2024).

International Journal of Engineering, Industrial, Maritime, and Technological Innovation (INJENI)
P - ISSN: 3116-3807
E - ISSN: 3116-3815
PRC-CPD Accredited Provider: PTR-2025-749
NBDB Registration Book Publisher (Print & Digital): 0372

Despite the recognized benefits, studies also identify recurring implementation constraints that can weaken EPMS performance in practice. The most frequently reported issue is the accuracy and timeliness of data input, as delayed, incomplete, or inconsistent reporting can undermine system reliability and distort decision-making (Amede et al., 2025; Hamta et al., 2021). Technology adoption barriers are also common, including resistance to shifting from manual processes, uneven digital literacy, limited technical support, and workflow noncompliance among users and stakeholders (Shah, 2023; Rudele et al., 2024). Interoperability limitations, cybersecurity risks, and communication gaps further complicate integrated monitoring, particularly when multiple contractors and offices operate with varying tools and reporting practices (Schafer et al., 2022; Rane, 2023). These findings imply that the success of EPMS depends not only on system design but also on governance alignment, capacity building, and sustained user adoption across internal and external stakeholders (Iandolo et al., 2024; Agbaxode et al., 2024).

The reviewed literature consistently affirms that engineering projects require rigorous monitoring due to their complexity, multi-stakeholder nature, and high public accountability demands. Research further supports EPMS as a promising approach for strengthening oversight through real-time reporting, integrated documentation, and improved coordination. However, the same literature also shows that monitoring systems are vulnerable to operational challenges, particularly delayed updates, inconsistent data entry, uneven digital capacity, and weak compliance, which can reduce reliability and weaken governance outcomes. While many studies discuss EPMS functions and implementation issues broadly, fewer works evaluate city-scale systems using governance-oriented dimensions that reflect public value, such as outcome achievement, efficiency, service delivery quality, and trust and legitimacy. Based on the perspectives of both internal personnel and external contractors, this gap supports the necessity of the present study, which evaluated the City Engineering Project Monitoring System (CEPMS) as both a technological platform and a governance tool, generating evidence to guide system enhancement and strengthen performance-driven infrastructure monitoring in local government settings.

Theoretical Framework

This study was anchored on Public Value Theory proposed by Moore (1995), which asserts that public sector programs and systems should be evaluated based on the value they create for society rather than solely on efficiency or outputs. Public value emphasizes the achievement of meaningful outcomes, effective use of public resources, quality of service delivery, and the maintenance of trust and legitimacy among stakeholders. In the context of this study, the City Engineering Project Monitoring System (CEPMS) was viewed as a governance tool intended to support transparent, accountable, and results-oriented infrastructure monitoring in local government.

While Moore provided the theoretical foundation of public value, the study adopted the measurement framework of Faulkner and Kaufman (2017) to operationalize the concept. Their framework translates public value into four measurable dimensions: outcome achievement, efficiency, service delivery quality, and trust and legitimacy. By integrating Moore's theory with Faulkner and Kaufman's evaluative dimensions, this study established a coherent basis for assessing CEPMS as both a technological system and a mechanism for public value creation in infrastructure governance.

Conceptual Framework

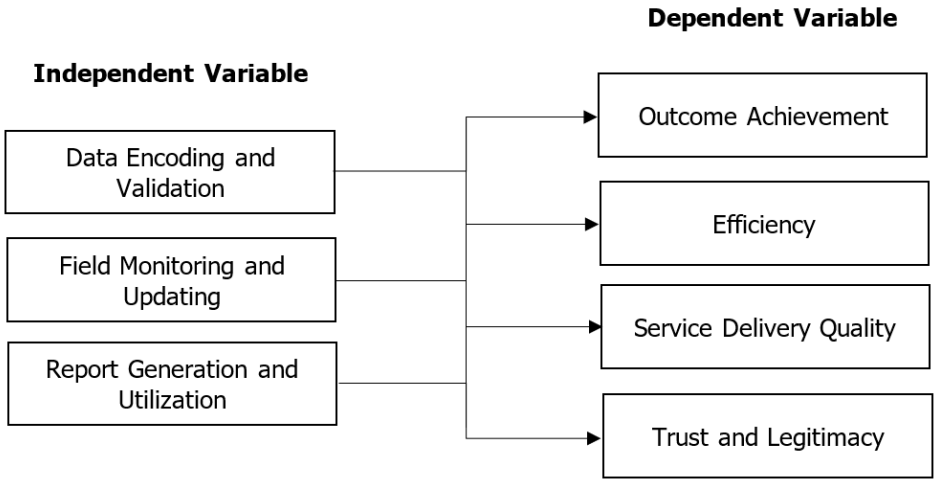
The conceptual framework illustrates the hypothesized relationship between the City Engineering Project Monitoring System (CEPMS) operational components and public value outcomes in infrastructure monitoring. The independent variable (IV) consists of the core CEPMS processes, Data Encoding and Validation, Field Monitoring and Updating, and Report Generation and Utilization, which represent how project information is captured, updated, and transformed within the system. The dependent variable (DV) comprises the public value dimensions of Outcome Achievement, Efficiency, Service Delivery Quality, and Trust and Legitimacy, reflecting users' evaluation of the system's governance performance.

The framework assumes that effective implementation of CEPMS operational components leads to improved public value outcomes by enhancing project oversight, streamlining workflows, improving information quality, and strengthening transparency and accountability. This hypothesized relationship was examined using a descriptive–quantitative approach, providing an empirical basis for assessing CEPMS performance and identifying areas for system enhancement.

International Journal of Engineering, Industrial, Maritime, and Technological Innovation (INJENI) P - ISSN: 3116-3807 E - ISSN: 3116-3815

PRC-CPD Accredited Provider: PTR-2025-749

NBDB Registration Book Publisher (Print & Digital): 0372



Statement of the Problem

The increasing use of digital monitoring systems in local government aims to improve transparency, efficiency, and accountability in infrastructure project implementation. In the Philippines, local government units are encouraged to adopt such systems to support results-based monitoring and evidence-based decision-making. However, despite the growing reliance on digital platforms, limited empirical studies have examined how these systems perform in actual governance contexts, particularly at the city level. In Quezon City, the City Engineering Project Monitoring System (CEPMS) was introduced to modernize infrastructure monitoring and standardize reporting within the Department of Engineering. While CEPMS has shown potential in improving project oversight, concerns remain regarding data consistency, system utilization, and workflow compliance. This study addressed this gap by evaluating the performance of CEPMS based on public value dimensions, including outcome achievement, efficiency, service delivery quality, and trust and legitimacy, to generate evidence that can inform system enhancement, strengthen accountability, and support results-based infrastructure governance in Quezon City.

Research Objectives

General Objective:

To evaluate the performance of the City Engineering Project Monitoring System (CEPMS) in Quezon City based on public value dimensions.

Specific Objectives:

1. To describe the demographic profile of internal personnel and external contractors using CEPMS.
2. To assess CEPMS performance in terms of outcome achievement, efficiency, service delivery quality, and trust and legitimacy.
3. To identify the observed strengths and weaknesses in the implementation and utilization of CEPMS.
4. To assess the specified challenges in the implementation and utilization of CEPMS.
5. To develop a SWOC-based strategic plan to enhance CEPMS implementation and performance.

Research Questions

1. What is the demographic profile of respondents in terms of their role and length of system use?
2. How is CEPMS evaluated in terms of outcome achievement, efficiency, service delivery quality, and trust and legitimacy?
3. What are the observed strengths and weaknesses of CEPMS in its process flow from project registration to project completion?
4. How do the respondents assess the specified challenges in the implementation and utilization of CEPMS?
5. What strategic actions may be proposed to improve the performance of CEPMS based on the study findings?

International Journal of Engineering, Industrial, Maritime, and Technological Innovation (INJENI) P - ISSN: 3116-3807 E - ISSN: 3116-3815

PRC-CPD Accredited Provider: PTR-2025-749

NBDB Registration Book Publisher (Print & Digital): 0372

METHODS

Research Design

This study employed a descriptive–quantitative research design to evaluate the performance of the City Engineering Project Monitoring System (CEPMS) in Quezon City. The design was appropriate because the study sought to describe and assess users' evaluations of CEPMS in terms of outcome achievement, efficiency, service delivery quality, and trust and legitimacy, without introducing interventions or manipulating system conditions. Because the inquiry focused on existing perceptions and experiences of system users, a non-experimental approach was deemed most suitable. The design was implemented through the administration of a structured survey questionnaire to internal personnel and external stakeholders who utilized CEPMS.

Population and Sampling

The study was conducted in Quezon City and involved users of the City Engineering Project Monitoring System (CEPMS). The respondents consisted of 148 participants, comprising internal personnel from the Quezon City Department of Engineering and external stakeholders, including accredited contractors and Quezon City residents who accessed or monitored infrastructure projects through CEPMS. A purposive sampling technique was employed, wherein respondents were selected based on the criterion that they had direct involvement in or exposure to CEPMS-related project monitoring activities. This approach ensured that both system implementers and external users with actual system interaction were represented, allowing the study to generate informed and balanced assessments of CEPMS performance from multiple stakeholder perspectives.

Instruments

A researcher-made survey questionnaire served as the primary instrument for evaluating the performance of the City Engineering Project Monitoring System (CEPMS). The instrument was developed based on Public Value Theory by Moore (1995) and the public value measurement dimensions proposed by Faulkner and Kaufman (2017). It consisted of items assessing CEPMS performance in terms of outcome achievement, efficiency, service delivery quality, and trust and legitimacy, measured using a 4-point Likert scale ranging from Strongly Disagree to Strongly Agree.

The questionnaire also included items assessing system strengths, weaknesses, and implementation challenges, focusing on system functionality, data consistency, workflow compliance, and coordination among stakeholders. To establish content validity, the instrument was reviewed by three experts: a public administration specialist, a licensed civil engineer with experience in public infrastructure projects, and a research methods expert holding a doctoral degree. Their feedback was used to refine and improve the questionnaire. Following content validation, the instrument underwent reliability testing, which yielded an overall Cronbach's Alpha coefficient of 0.839, indicating good internal consistency and confirming its suitability for the study.

Data Collection

Permission was secured from the Quezon City Department of Engineering to administer the survey instrument prior to data collection. Upon approval, the structured questionnaire was distributed to internal personnel and external stakeholders, including accredited contractors and Quezon City residents who were directly involved in or exposed to CEPMS-related project monitoring activities. Data collection was conducted within Quezon City over a designated period to allow respondents adequate time to complete the instrument. Completed questionnaires were subsequently retrieved and reviewed for completeness and consistency. All responses were then systematically encoded and organized to ensure data accuracy prior to statistical analysis.

Treatment of Data

The data gathered were analyzed quantitatively using descriptive statistical techniques aligned with the objectives of the study. Frequency counts and percentages were used to describe the demographic profile of the respondents. To address the evaluation of CEPMS performance, weighted means were computed to determine respondents' assessments of the system in terms of outcome achievement, efficiency, service delivery quality, and trust and legitimacy. Weighted means were likewise used to analyze respondents' perceptions of system strengths and implementation challenges, while ranking was applied to identify the most and least frequently observed strengths and issues. These analytical procedures enabled a systematic interpretation of user evaluations and facilitated the identification of prevailing performance patterns and areas for improvement.

International Journal of Engineering, Industrial, Maritime, and Technological Innovation (INJENI)
P - ISSN: 3116-3807
E - ISSN: 3116-3815
PRC-CPD Accredited Provider: PTR-2025-749
NBDB Registration Book Publisher (Print & Digital): 8372

Ethical Considerations

This study adhered to established ethical standards in public administration and social research. All respondents were provided with a clear explanation of the study's purpose and procedures, and informed consent was obtained prior to participation. Participation was voluntary, and respondents were assured of confidentiality and anonymity, with no personally identifiable information collected. All data were securely stored, treated with strict confidentiality, and used solely for academic and research purposes. Findings were reported in aggregate form to protect participant identities.

RESULTS and DISCUSSION

This section presents an overview of the respondents' profiles related to their use of the City Engineering Project Monitoring System (CEPMS). It also summarizes respondents' assessments of CEPMS performance based on public value dimensions, as well as the identified strengths, weaknesses, and implementation challenges encountered in using the system.

Profile of the Respondents

This section presents the profile of the respondents, categorized as internal personnel and external stakeholders involved in the use of the City Engineering Project Monitoring System (CEPMS).

Table 1. Demographic Profile of Internal and External Respondents

Variable	Category	Internal (n = 103)	External (n = 45)
Age (years)	20–29	18 (12.16%)	7 (4.73%)
	30–39	36 (24.32%)	22 (14.86%)
	40–49	26 (17.57%)	8 (5.41%)
	50–59	16 (10.81%)	6 (4.05%)
	60 and above	7 (4.73%)	2 (1.35%)
Gender	Male	74 (50.00%)	34 (22.97%)
	Female	27 (18.24%)	11 (7.43%)
	LGBTQIA+	2 (1.35%)	0 (0.00%)
Position	Project Engineer	60 (40.54%)	–
	Technical Staff	37 (25.00%)	–
	Administrative Personnel	6 (4.05%)	–
	Contractor	–	42 (28.38%)
	Quezon City Resident	–	3 (2.03%)
Length of service	< 1 year	1 (0.68%)	0 (0.00%)
	1–5 years	22 (14.86%)	9 (6.08%)
	6–10 years	29 (19.59%)	16 (10.81%)
	11–15 years	30 (20.27%)	8 (5.41%)
	> 15 years	21 (14.19%)	12 (8.11%)
Frequency of CEPMS use	Daily	54 (36.49%)	18 (12.16%)
	Weekly	34 (22.97%)	24 (16.22%)
	Monthly	8 (5.41%)	2 (1.35%)
	Occasionally	6 (4.05%)	0 (0.00%)
	Never	1 (0.68%)	1 (0.68%)

Table 1 presented the demographic profile of the respondents, classified into internal and external users of the City Engineering Project Monitoring System (CEPMS). The findings showed that CEPMS was primarily used by mid-career technical personnel, particularly internal engineers with moderate to long years of service, who accessed the system on a daily basis as part of their responsibilities in project monitoring, validation, and reporting within the Quezon City Department of Engineering (QCDE). External users, composed mainly of contractors and a smaller proportion of city residents, reported less frequent system use, consistent with their role in milestone-based coordination rather than continuous project oversight.

International Journal of Engineering, Industrial, Maritime, and Technological Innovation (INJENI) P - ISSN: 3116-3807 E - ISSN: 3116-3815

PRC-CPD Accredited Provider: PTR-2025-749

NBDB Registration Book Publisher (Print & Digital): 8372

Evaluation of the Internal and External Respondents on CEPMS in terms of the four indicators of Public Value

This section presents the evaluation of the City Engineering Project Monitoring System (CEPMS) by internal and external respondents based on the four indicators of public value.

Table 2. Evaluation of the internal and external respondents on CEPMS in terms of Outcome Achievement

Outcome Achievement	Int Mean	Inter	Ext Mean	Inter
1. CEPMS enables the timely completion of engineering… approved schedules.	3.59	SA	3.47	A
2. The system contributes to the achievement of project… performance targets.	3.59	SA	3.42	A
3. CEPMS provides accurate and up-to-date tracking… informed decision-making.	3.52	SA	3.51	SA
4. The system helps detect project delays early… minimize impacts.	3.57	SA	3.42	A
5. CEPMS supports efficient allocation and utilization… planned results.	3.60	SA	3.44	A
6. The system improves the quality and durability… engineering outputs.	3.55	SA	3.27	A
7. CEPMS enhances compliance with technical standards… requirements.	3.63	SA	3.29	A
8. The system ensures short-term and long-term goals… infrastructure projects.	3.46	A	3.49	A
9. CEPMS facilitates alignment between planned deliverables… actual outcomes.	3.61	SA	3.33	A
10. The system increases the overall success… city engineering initiatives.	3.67	SA	3.47	A
Overall Mean	**3.58**	**SA**	**3.41**	**A**

Legend: *3.51–4.00 = SA - Strongly Agree · 2.51–3.50 = A - Agree · 1.51–2.50 = D -Disagree · 1.00–1.50 = SD -Strongly Disagree*

The results in Table 2 showed that both internal and external respondents evaluated CEPMS positively in terms of outcome achievement, with stronger agreement from internal users who directly engaged in data validation, progress verification, and coordination processes. External respondents likewise provided favorable but more cautious assessments due to their limited access to backend system functions, although both groups recognized CEPMS's contribution to accurate and timely project tracking and improved transparency. Compared with efficiency and service delivery quality, outcome achievement received a relatively higher mean because it reflected tangible and immediately observable results, such as completed projects and documented compliance, rather than process-based improvements. This pattern was consistent with Public Value Theory, which highlights visible outcomes and institutional credibility as core sources of public value (Moore, 1995; Faulkner & Kaufman, 2017), and supported by recent studies showing that monitoring systems are rated most favorably when results and accountability mechanisms are clearly demonstrated to stakeholders (Hamta et al., 2021; Rüdele et al., 2024).

Table 3. Evaluation of the internal and external respondents on CEPMS in terms of Efficiency

Efficiency	Int Mean	Inter	Ext Mean	Inter
1. CEPMS streamlines project monitoring processes… reducing procedural steps.	3.57	SA	3.36	A
2. The system reduces time spent on manual data collection… reporting tasks.	3.57	SA	3.47	A
3. CEPMS improves coordination and communication… project stakeholders.	3.50	A	3.58	SA
4. The system minimizes duplication of tracking … optimizing manpower use.	3.54	SA	3.47	A
5. CEPMS enables real-time data access… faster decision-making.	3.53	SA	3.53	SA
6. The system supports efficient allocation of human resources… monitoring activities.	3.55	SA	3.31	A
7. CEPMS reduces operational costs… paperwork and manual processing.	3.54	SA	3.44	A
8. The system simplifies consolidation of project updates… comprehensive reports.	3.61	SA	3.49	A
9. CEPMS enhances workflow efficiency… organized monitoring procedures.	3.58	SA	3.27	A
10. The system allows better task prioritization… performance-based follow-ups.	3.63	SA	3.51	SA
Overall Mean	**3.56**	**SA**	**3.44**	**A**

Legend: *3.51–4.00 = SA - Strongly Agree · 2.51–3.50 = A - Agree · 1.51–2.50 = D -Disagree · 1.00–1.50 = SD -Strongly Disagree*

International Journal of Engineering, Industrial, Maritime, and Technological Innovation (INJENI)
P - ISSN: 3116-3807
E - ISSN: 3116-3815
PRC-CPD Accredited Provider: PTR-2025-749
NBDB Registration Book Publisher (Print & Digital): 0372

The results in Table 3 showed that efficiency was positively evaluated by both internal and external respondents, with stronger assessments from internal users who directly engaged in backend workflow management and reporting processes. Internal personnel experienced clear benefits in streamlining tasks, reducing manual work, and improving prioritization, resulting in efficiency ratings that were second only to outcome achievement among the public value dimensions. External respondents likewise reported notable efficiency gains, particularly in coordination and access to real-time project information, with efficiency rated higher than service delivery quality and comparable to trust and legitimacy. These patterns indicated that efficiency benefits were clearly recognized across user groups, although the nature of these benefits differed by role. Internal users encountered efficiency improvements through daily operational use, while external stakeholders experienced them indirectly through smoother coordination and information flow. This finding demonstrated that efficiency contributed substantially to public value by optimizing resource use and reducing administrative burden, consistent with recent studies on digital monitoring systems in the public sector (Purchase et al., 2022; Shah et al., 2023; Li & Sun, 2025).

Table 4. Evaluation of the internal and external respondents on CEPMS in terms of Service Delivery

Service Delivery Quality	Int Mean	Inter	Ext Mean	Inter
1. CEPMS ensures timely and accurate project updates… stakeholders.	3.54	SA	3.47	A
2. The system improves transparency in monitoring and reporting… engineering projects.	3.53	SA	3.42	A
3. CEPMS facilitates prompt identification and resolution… implementation issues.	3.59	SA	3.36	A
4. The system delivers reliable and verifiable data… project status validation.	3.53	SA	3.44	A
5. CEPMS improves communication between the engineering office and contractors… collaboration.	3.52	SA	3.60	SA
6. The system ensures complete, well-documented, standardized reports… projects.	3.50	A	3.24	A
7. CEPMS enables easy access to essential project … stakeholders and the public.	3.60	SA	3.38	A
8. The system increases responsiveness to citizen inquiries… project progress.	3.42	A	3.42	A
9. CEPMS ensures consistent application of monitoring guidelines… all projects.	3.49	A	3.40	A
10. The system contributes to higher beneficiary satisfaction… measurable results.	3.61	SA	3.36	A
Overall Mean	**3.53**	**SA**	**3.41**	**A**

Legend: *3.51–4.00 = SA - Strongly Agree · 2.51–3.50 = A - Agree · 1.51–2.50 = D -Disagree · 1.00–1.50 = SD -Strongly Disagree*

The results in Table 4 showed that both internal and external respondents evaluated CEPMS positively in terms of service delivery quality, with stronger agreement from internal users. Internal personnel perceived CEPMS as effective in enhancing transparency, ensuring data accuracy, improving coordination, and supporting responsive service delivery, a perception shaped by their direct involvement in report generation, validation, and issue resolution processes. External respondents likewise provided favorable but more cautious assessments, reflecting their limited interaction with internal reporting and standardization functions and their greater reliance on CEPMS for communication and information access. These role-based differences highlighted how internal users emphasized service execution and measurable outputs, while external stakeholders valued transparency and coordination benefits. When compared with the other public value dimensions, service delivery quality obtained the lowest mean rating for both internal and external respondents, indicating that although CEPMS improved communication and responsiveness, these service-related benefits were perceived as less immediate and less tangible than outcome achievement, efficiency, and trust and legitimacy. This pattern was consistent with evidence showing that users tend to prioritize observable project results and institutional credibility over interaction-based service improvements in digital monitoring systems (Chen et al., 2024; Rane, 2023; Li & Sun, 2025).

Table 5. Evaluation of the internal and external respondents on CEPMS in terms of Trust and Legitimacy

Trust and Legitimacy	Int Mean	Inter	Ext Mean	Inter
1. CEPMS strengthens public trust… projects implemented as planned and	3.59	SA	3.40	A

International Journal of Engineering, Industrial, Maritime, and Technological Innovation (INJENI)
P - ISSN: 3116-3807
E - ISSN: 3116-3815
PRC-CPD Accredited Provider: PTR-2025-749
NBDB Registration Book Publisher (Print & Digital): 0372

reported truthfully.				
2. The system promotes accountability among engineers, contractors… project delivery.	3.51	SA	3.56	SA
3. CEPMS enhances credibility of monitoring reports… decision-making.	3.59	SA	3.51	SA
4. The system fosters confidence in effective and transparent use… public funds.	3.60	SA	3.42	A
5. CEPMS ensures fair and consistent monitoring practices… free from bias.	3.55	SA	3.42	A
6. The system builds mutual trust between the city government… contractors.	3.56	SA	3.31	A
7. CEPMS demonstrates commitment to transparency and ethical governance… infrastructure management.	3.55	SA	3.53	SA
8. The system reduces suspicion of irregularities or corruption… verifiable data.	3.54	SA	3.44	A
9. CEPMS encourages citizen participation… project oversight.	3.54	SA	3.40	A
10. The system upholds ethical and professional standards… monitoring and reporting.	3.59	SA	3.42	A
Overall Mean	**3.56**	**SA**	**3.44**	**Agree**

Legend: *3.51–4.00 = SA - Strongly Agree · 2.51–3.50 = A - Agree · 1.51–2.50 = D -Disagree · 1.00–1.50 = SD -Strongly Disagree*

The results in Table 5 showed that both internal and external respondents regarded CEPMS as a trustworthy and legitimate system, with internal users expressing stronger agreement. Internal personnel demonstrated high confidence in the system's credibility, fairness, and ethical standards in project monitoring and reporting, a perception shaped by their direct involvement in verification, documentation, and compliance processes. External respondents also provided positive but more reserved assessments, reflecting their limited engagement with backend validation and reporting functions. Despite these differences, both groups agreed that CEPMS enhanced accountability and strengthened the credibility of monitoring reports, reinforcing its role in transparent infrastructure governance. In comparison with the other public value dimensions, trust and legitimacy ranked among the highest-rated indicators for both internal and external respondents, reflecting the importance placed on credible reporting, accountability mechanisms, and ethical compliance, which were more visible and widely experienced than service delivery-related benefits. These role-based variations were consistent with previous studies indicating that trust and legitimacy are rated more highly by internal users due to closer interaction with compliance mechanisms, while external stakeholders continue to recognize improvements in transparency and accountability through accessible reporting systems (Flyvbjerg, 2021; Chen et al., 2024).

Observed strengths and weaknesses of CEPMS in its process flow from project registration to completion

Table 6. Observed strengths and weaknesses of CEPMS in its process flow from project registration to completion

Strengths **and weaknesses** of CEPRM	Strength Overall Mean	Interpretation	**Weaknesses** Overall Mean	Interpretation
Data Encoding and Validation	**3.52**	Strongly Agree	1.46	Strongly Disagree
Field Monitoring and Updating	**3.52**	Strongly Agree	1.48	Strongly Disagree
Report Generation and Utilization	**3.51**	Strongly Agree	1.47	Strongly Disagree

Legend: *3.51–4.00 = Strongly Agree · 2.51–3.50 = Agree · 1.51–2.50 = Disagree · 1.00–1.50 = Strongly Disagree*

The results in Table 6 showed that CEPMS performed strongly across all major stages of its process flow, from project registration to completion. Respondents consistently perceived the system as effective in supporting accurate data encoding and validation, timely field monitoring and updating, and reliable report generation and utilization. The minimal identification of weaknesses across these process areas indicated that users generally did not experience operational difficulties or functional gaps in the system. This pattern suggested that CEPMS's core processes were well-integrated and supported smooth information flow from project initiation to completion. Rather than isolated system components, the findings reflected a cohesive monitoring framework that enabled continuity, accuracy, and accountability throughout the project lifecycle. Such perceptions aligned with studies showing that integrated digital monitoring systems with strong validation, real-time updating, and reporting capabilities tend to

International Journal of Engineering, Industrial, Maritime, and Technological Innovation (INJENI)
P - ISSN: 3116-3807
E - ISSN: 3116-3815
PRC-CPD Accredited Provider: PTR-2025-749
NBDB Registration Book Publisher (Print & Digital): 0372

demonstrate high operational reliability and low perceived deficiencies among users (Piccardo & Hughes, 2022; Shah, 2023).

Assessment of the specified Challenges Encountered in the Use of CEPMS

Table 7. Assessment of the specified Challenges Encountered in the Use of CEPMS

Challenges Encountered in CEPMS Use	Mean	Interpretation
1. Internal personnel experience difficulty navigating the CEPMS … limited user-friendliness.	2.11	Disagree
2. Accredited contractors face delays in securing system access… timely updates.	2.13	Disagree
3. The system experiences occasional technical glitches… incomplete or lost entries.	2.03	Disagree
4. Internet connectivity issues… hinder real-time system updating.	2.04	Disagree
5. Inconsistent compliance with data encoding protocols… record discrepancies.	1.99	Disagree
6. Contractors find uploading large documentation files… system size limits challenging.	2.07	Disagree
7. Internal staff lack sufficient training… advanced CEPMS functions.	2.02	Disagree
8. Absence of a mobile-friendly interface… on-site data entry.	2.03	Disagree
9. Overlapping responsibilities… confusion in data submission.	2.02	Disagree
10. Lack of integration with other government databases… redundant data entry.	2.02	Disagree
11. Contractors encounter difficulty interpreting required data formats… system entries.	2.05	Disagree
12. Project delays are not always reflected in real time… reporting misalignment.	2.05	Disagree
13. Internal personnel struggle with prioritizing CEPMS updates… workload demands.	1.95	Disagree
14. Time-consuming validation processes… multiple approval levels.	1.91	Disagree
15. Inadequate technical support availability… operational interruptions.	2.02	Disagree
16. Limited contractor awareness of timely and accurate updates… project tracking.	2.05	Disagree
17. System reports sometimes lack narrative detail… in-depth decision-making.	2.11	Disagree
18. Security protocols… slow down frequent data entry.	1.95	Disagree
19. Differences in digital literacy… inconsistent system utilization.	2.13	Disagree
20. Absence of automated alerts… missed deadlines or updates.	2.05	Disagree
Overall Mean	**2.04**	**Disagree**

Legend: *3.51–4.00 = Strongly Agree · 2.51–3.50 = Agree · 1.51–2.50 = Disagree · 1.00–1.50 = Strongly Disagree*

The results in Table 7 showed that respondents generally did not perceive the identified issues as significant challenges to the implementation of CEPMS. Concerns related to contractor access, variations in digital literacy, system navigation, report narration, connectivity, file uploads, and validation processes were viewed as occasional and manageable rather than as structural or systemic problems. The overall pattern indicated that these issues were treated as part of the normal adjustment process associated with the use of digital monitoring systems, rather than barriers that undermined system performance or effectiveness. Respondents' assessments suggested that CEPMS's core functions remained reliable and stable despite minor usability, coordination, and access-related concerns during regular system use. This finding was consistent with studies indicating that implementation challenges in digital monitoring platforms are often perceived as operational adjustments when system design, functionality, and data reliability are strong and well-integrated (Rüdele et al., 2024; Shah, 2023).

Conclusions

The findings showed that both groups assessed CEPMS positively across all indicators, with internal respondents consistently expressing stronger agreement than external users. Results indicated that CEPMS effectively supported timely project completion, improved monitoring efficiency, enhanced transparency and communication, and strengthened accountability and credibility in infrastructure governance. The assessment of the system's process flow further revealed strong performance in data encoding and validation, field monitoring and updating, and report generation and utilization, with minimal perceived weaknesses. In addition, respondents generally disagreed with the identified challenges, suggesting that issues related to system access, usability, connectivity, and reporting were manageable and did not significantly hinder implementation. These findings demonstrate that CEPMS contributes to

International Journal of Engineering, Industrial, Maritime, and Technological Innovation (INJENI)
P - ISSN: 3116-3807
E - ISSN: 3116-3815
PRC-CPD Accredited Provider: PTR-2025-749
NBDB Registration Book Publisher (Print & Digital): 0372

public value by enabling outcome achievement, operational efficiency, service delivery quality, and trust and legitimacy, thereby functioning as a results-based governance mechanism that strengthens infrastructure management in Quezon City.

Recommendations

Based on the findings and conclusions of the study, several recommendations are proposed. First, the Department of Public Works and Highways may consider developing national guidelines that promote interoperability among local government monitoring systems to reduce data redundancy and streamline project documentation. Second, the Quezon City Department of Engineering may prioritize system enhancements such as automated alerts, improved report customization, clearer narrative sections, and faster credential processing to address areas rated more moderately by external users. Third, engineers and contractors may benefit from targeted training on data encoding standards, report formats, and system navigation, as well as mobile-friendly tools to support real-time field updating. Fourth, community transparency may be strengthened through simplified public dashboards with clearer visual summaries and explanatory notes. Finally, future research is encouraged to adopt mixed-method designs to further examine usability, digital literacy, and workflow alignment issues, providing deeper insight into user experiences and system improvement strategies.

SWOC Strategic Plan

Table 8. SWOC Strategic Plan based on the results of the study

SWOC	Strategic Plan	Expected Outcome
STRENGTH	Expand CEPMS for planning, forecasting, and performance evaluation	Stronger results-based management
	Enhance geotagging, photo/video uploads, and evidence-based monitoring	Reliable, audit-ready documentation
	Develop advanced dashboards highlighting priority tasks and risks	Faster and smarter decision-making
WEAKNESSES	Improve report standardization + add narrative sections	Better comprehension and transparency
	Include quality metrics dashboards.	Stronger link to output quality
	Add visual summaries and simplified information sections	Improved accessibility for citizens
OPPORTUNITIES	Develop enhanced report templates and analytics tools	More credible, standardized reports
	Link CEPMS to QCDE quality assurance/inspection modules	Clearer quality monitoring
	Add variance analysis and deviation alerts.	Better project control
CHALLENGES	Automate credential processing within 24–48 hours	Faster participation & reporting
	Develop beginner and advanced training pathways.	More uniform system use.
	Redesign interface + add guided walkthroughs	Easier system learning

REFERENCES

Agbaxode, P. D. K., Saghatforoush, E., Dlamini, S., & Korsah, J. K. (2024). Integrated project delivery enablers to enhance conventional project delivery toward improving design documentation quality. *Built Environment Project and Asset Management, 14*(6), 817–834. https://doi.org/10.1108/BEPAM-09-2023-0158

Alhosani, K., & Alhashmi, S. M. (2024). Opportunities, challenges, and benefits of AI innovation in government services: A review. *Discover Artificial Intelligence, 4*, Article 18. https://doi.org/10.1007/s44163-024-00111-w

Amede, E. A., Woldesenbet, A. K., Bahiru, A. K., et al. (2025). Transforming construction in emerging economies: Overcoming barriers to the adoption of industrialized building systems. *Discover Applied Sciences, 7*, Article 765. https://doi.org/10.1007/s42452-025-06963-w

Chen, L., Hu, Y., Wang, R., et al. (2024). Green building practices to integrate renewable energy in the construction sector: A review. *Environmental Chemistry Letters, 22*, 751–784. https://doi.org/10.1007/s10311-023-01675-2

Department of the Interior and Local Government. (2024). *Updated guidelines on the harmonization of local development planning, investment programming, resource mobilization, budgeting, expenditure management, and performance monitoring* (Joint Memorandum Circular No. 1, s. 2024). https://www.dilg.gov.ph/issuances/jc/Updated-Guidelines-on-the-Harmonization-of-Local-Development-Planning-Investment-Programming-Resource-Mobilization-Budgeting-Expenditure-Management-and-Performance-Monitoring-and-Coordination-in-Fiscal-Oversight-for-Enhanced-Local-Service-Delivery-in-line-with-the-Supreme-Court-Ruling-on-the-Mandanas-Garcia-Petitions

International Journal of Engineering, Industrial, Maritime, and Technological Innovation (INJENI)
P - ISSN: 3116-3807
E - ISSN: 3116-3815
PRC-CPD Accredited Provider: PTR-2025-749
NBDB Registration Book Publisher (Print & Digital): 0372

Evans, M., Farrell, P., Elbeltagi, E., & Dion, H. (2022). Competency framework to integrate lean construction and integrated project delivery on construction megaprojects. *Benchmarking: An International Journal*. https://doi.org/10.1108/BIJ-02-2021-0066

Faulkner, N., & Kaufman, S. (2017). Avoiding theoretical stagnation: A systematic review and framework for measuring public value. *Australian Journal of Public Administration, 77*(1), 69–86.

Flyvbjerg, B. (2021). Top ten behavioral biases in project management: An overview. *Project Management Journal,* 52(6), 531–546. https://doi.org/10.1177/87569728211049046

Hall, D., & Bonanomi, M. (2021). Governing collaborative project delivery as a common-pool resource scenario. *Project Management Journal*. https://doi.org/10.1177/8756972820982442

Hamta, N., Ehsanifar, M., & Sarikhani, J. (2021). Presenting a goal programming model in the time–cost–quality trade-off. *International Journal of Construction Management*. https://doi.org/10.1080/15623599.2018.1502930

Iandolo, F., La Sala, A., & Turriziani, A. (2024). Stakeholder engagement in managing systemic risk management. *Business Ethics: A European Review*. https://doi.org/10.1111/beer.12694

Jelodar, M. B. (2021). Integration of project management services for international engineering, procurement, and construction projects. *Built Environment Project and Asset Management, 11*(2), 330–347. https://doi.org/10.1108/BEPAM-06-2020-0106

Kim, S. (2021). Dynamic modeling for analyzing the impacts of skilled labor shortage on construction project management. *Journal of Management in Engineering*. https://doi.org/10.1061/(ASCE)ME.1943-5479.0000720

Kokogho, E., Odio, P., & Ogunsola, O. (2024). Transforming public sector accountability: The critical role of integrated financial and inventory management systems in ensuring transparency and efficiency. *The Management Journal*, *1(1), 15*. https://doi.org/10.54660/IJMOR.2024.3.6.84-107

Li, H., & Sun, Y. (2025). Digital transformation pathways and quality improvements in public sector project monitoring. *Technological Forecasting and Social Change, 208*, 121000. https://doi.org/10.1016/j.techfore.2025.124270

Moore, M. H. (1995). *Creating public value: Strategic management in government*. Harvard University Press.

National Economic and Development Authority. (2023). *Philippine Development Plan 2023–2028: Chapter 14 – Advancing digital transformation*. https://pdp.depdev.gov.ph/wp-content/uploads/2023/07/Chapter-14.pdf

Panwar, A., & Jha, K. (2021). Integrating quality and safety in construction scheduling time–cost trade-off model. *Journal of Construction Engineering and Management*. https://doi.org/10.1061/(ASCE)CO.1943-7862.0001979

Piccardo, C., & Hughes, M. (2022). Design strategies to increase the reuse of wood materials in buildings. *Journal of Cleaner Production*. https://doi.org/10.1016/j.jclepro.2022.133083

Purchase, C. K., Al Zulayq, D. M., O'Brien, B. T., et al. (2022). Circular economy of construction and demolition waste: Lessons, challenges, and benefits. *Materials, 15*(1), Article 76. https://doi.org/10.3390/ma15010076

Rane, N. (2023). Integrating building information modelling (BIM) and artificial intelligence (AI) for smart construction schedule, cost, quality, and safety management. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.4616055

Rüdele, K., Wolf, M., & Ramsauer, C. (2024). Synergies and trade-offs between ecological and productivity-enhancing measures in industrial production. *Management of Environmental Quality: An International Journal, 35*(6), 1315–1353. https://doi.org/10.1108/MEQ-07-2023-0195

Schäfer, F., Hirsch, B., & Nitzl, C. (2022). Stakeholder pressure as a driver of risk management practices in public administrations. *Journal of Accounting & Organizational Change, 18*(1), 33–56. https://doi.org/10.1108/JAOC-11-2020-0188

Shah, F. H., Bhatti, O. S., & Ahmed, S. (2023). Effects of project management practices on cost overrun in construction projects. In *Engineering Proceedings* (Vol. 44, No. 1, Article 1). MDPI. https://doi.org/10.3390/engproc2023044001

International Journal of Engineering, Industrial, Maritime, and Technological Innovation (INJENI)
P - ISSN: 3116-3807
E - ISSN: 3116-3815
PRC-CPD Accredited Provider: PTR-2025-749
NBDB Registration Book Publisher (Print & Digital): 0012

Readiness of the Philippine Coast Guard in the Surveillance and Monitoring of Radioactivity in its Maritime Jurisdiction

John Richard M. Muring
Philippine Merchant Marine Academy Zambales, Philippines

Abstract

Aim: This thesis examined the readiness of the Philippine Coast Guard (PCG) in radiation monitoring and surveillance within the country's maritime jurisdiction. This study evaluated the current capabilities, infrastructure, and protocols of the PCG to handle radiological incidents effectively.
Methodology: To thoroughly examine the Philippine Coast Guard's (PCG) capacity building and readiness for the surveillance and monitoring of radioactivity for maritime safety and coastal environment preservation, this study employed qualitative research methods. Specifically, the study utilized interviews, document analysis, and inventory assessment.
Results: The Philippine Coast Guard (PCG) workforce mostly holds Bachelor's degrees, but lacks specialized training in radioactivity monitoring and regulatory procedures. While the PCG has received some training from the USA Defense Threat Reduction Agency, it has only been offered once. The PCG has limited yet critical equipment, including the Polimaster Gamma-Neutron Personal Radiation Detector and the RadSeeker CS Smith Detection radioisotope identifier device. However, more equipment and effective training on their use and maintenance are urgently needed. The PCG currently lacks a strategic framework for radioactivity surveillance and there is no comprehensive policy to guide radioactivity monitoring activities in alignment with international standards.
Conclusion: The analysis of the PCG's preparedness for this role reveals a mixed picture. On the one hand, the PCG boasts a workforce with a solid educational foundation, predominantly composed of individuals with Bachelor's Degrees, indicating a well-educated team. On the other hand, there are significant gaps in specialized training, particularly in radioactivity monitoring and regulatory procedures, which are essential for effective environmental protection and compliance.

Keywords: Surveillance and monitoring, Radiation, Philippine Coast Guard

INTRODUCTION

The escalating threat posed by radioactive materials to maritime safety and environmental protection has emerged as a significant global concern. This study centers on the Philippine Coast Guard (PCG), aiming to carefully evaluate its readiness in responding to radiological contaminants, such as iodine-129 (I-129) which was determined to be a prevailing radioactive contaminant in most of the maritime jurisdiction of the Philippines. The study of Cruz et al. (2020) proved that scientists found that there is a significant risk of exposure to radioactive materials in coastal areas of the Philippines, particularly in areas with high levels of shipping traffic. Another study conducted by the Philippine Nuclear Research Institute (PNRI) investigated the potential use of natural radiation as a tracer for environmental studies (Mendoza et al., 2018). The objective is to comprehensively assess the PCG's preparedness, particularly its response capabilities concerning radiological emergencies and contaminants, emphasizing the potential impact of these on the maritime environment.

The initial objective of this study is to conduct a comprehensive examination of the PCG's existing capacity for radiation surveillance in both marine and coastal areas. The emphasis here lies on understanding the PCG's level of preparedness for this eminent emergency. This involves a thorough assessment of the technological infrastructure, monitoring equipment, and operational protocols employed by the PCG in detecting and responding to radiological threats. Additionally, the study will delve into the training programs and initiatives implemented by the PCG to ensure the proficiency of its personnel in handling radiological emergencies. This phase of the research will involve in-depth interviews with key stakeholders within the PCG, including members of the Marine Environmental Protection Command (MEPCOM), Maritime Safety Service Command (MSSC), Deputy Chief of Coast Guard Staff for Marine Environment Protection (CG-9), and Deputy Chief of Coast Guard Staff for Maritime Safety Service (CG-8). By

International Journal of Engineering, Industrial, Maritime, and Technological Innovation (INJENI)
P - ISSN: 3116-3807
E - ISSN: 3116-3815
PRC-CPD Accredited Provider: PTR-2025-749
NBDB Registration Book Publisher (Print & Digital): 0012

engaging with these personnel, the study aims to gain a nuanced understanding of the PCG's operational framework, challenges faced in radiation surveillance, and the specific measures in place to address incidents involving I-129.

The second objective is to identify and analyze specific areas of strengths and weaknesses within the PCG's readiness strategy for radiological incidents, with a particular focus on I-129 contamination. This involves a multifaceted approach, examining personnel resources, financial allocations, facilities, and equipment dedicated to radiation monitoring and surveillance. The study is scrutinized the adequacy of human resources within the PCG, evaluating the training and expertise of personnel responsible for radiation surveillance. Key personnel involved in radioactivity monitoring and response are identified, and their training records, qualifications, and experience is assessed to ensure a comprehensive understanding of the human element in the PCG's readiness strategy. The physical infrastructure supporting radiation surveillance efforts are evaluated. This includes the examination of monitoring stations, laboratories, and other facilities crucial for radiation detection and analysis. The study assessed the geographical distribution of these facilities, ensuring comprehensive coverage in areas prone to radiological threats.

The effectiveness of the PCG's readiness strategy heavily relies on the technological assets at its disposal. The study assessed the adequacy and functionality of monitoring equipment, including gamma spectrometers, radiation detectors and counters, and other specialized tools employed in the surveillance. Additionally, the study investigated the maintenance protocols and calibration practices to ensure the reliability of these instruments.

As part of this collaborative partnership, the Philippine Coast Guard (PCG) has undergone training and received technical assistance aimed at the detection and monitoring of radioactive materials.

For example, in 2017, the PCG engaged in a joint exercise with the International Atomic Energy Agency (IAEA), simulating a response to a radiological emergency in a maritime setting (International Atomic Energy Agency, 2017). This exercise involved the use of specialized equipment, such as handheld radiation detectors and gamma spectrometers, to identify and quantify radioactive materials.

In addition to collaborating with international partners, the PCG has taken independent initiatives to build its capabilities for nuclear safeguarding. Notably, the PCG established a Radiation Safety Office in 2020, tasked with overseeing the implementation of radiation safety measures and the training of personnel (Philippine Coast Guard, 2020). Furthermore, the PCG has invested in acquiring specialized equipment, including radiation detectors and dosimeters, to augment its monitoring and detection capabilities (Cruz et al., 2020).

Despite the PCG's proactive measures in capacity-building for nuclear safeguarding, evident through the establishment of the Radiation Safety Office, personnel training, and the acquisition of advanced equipment, there is an essential need to assess the current state of readiness. This evaluation is imperative to determine the relevance and effectiveness of the PCG's preparation in light of evolving challenges and emerging threats related to radiation monitoring. While commendable progress has been made, there remains a critical requirement to further enhance skills in radiation monitoring to ensure the PCG's continuous preparedness in the face of dynamic and evolving radiological scenarios.

Objectives

This study sought to evaluate the readiness of the PCG in radiation monitoring, identifying gaps and proposing enhancements to ensure the agency can effectively fulfill its mandate in protecting public health and maritime security.

Specifically, this study answered the following:

1. How prepared is the PCG in the surveillance and monitoring of radioactivity in the Philippine maritime jurisdiction in terms of:
    - 1.1 Human resource
    - 1.2 Physical resources and Logistics
2. What are the current initiatives in the surveillance and monitoring of radioactivity in terms of:
    - 2.1 Policies
    - 2.2 Strategies
3. What are the challenges in the surveillance and monitoring of radioactivity in terms of:
    - 3.1 Policies
    - 3.2 Strategies
4. Based on the findings, what can be recommended to ensure the readiness of the Philippine Coast Guard in the surveillance and monitoring of radioactivity in the Philippine maritime jurisdiction?

International Journal of Engineering, Industrial, Maritime, and Technological Innovation (INJENI)
P - ISSN: 3116-3807
E - ISSN: 3116-3815
PRC-CPD Accredited Provider: PTR-2025-749
NBDB Registration Book Publisher (Print & Digital): 0812

METHODS

Research Design

This study employed qualitative research methods. Specifically, the study utilized interviews, document analysis, and inventory assessment.

Population and Sampling

Ten (10) participants hailed from various PCG ranks and units, including senior officers, technical experts, maritime safety officers, and environmental officers. This diversity ensured a comprehensive understanding of capacity-building requirements and challenges across all levels and areas of PCG activities. They possessed significant expertise in environmental protection and maritime safety, contributing valuable insights into the real-world implications of radiation monitoring and surveillance. Many had technical knowledge in data interpretation, radiation safety protocols, and radiological monitoring, enhancing the precision and reliability of data gathered during monitoring activities

Instrument

Interview guide was used to collect the necessary data in this study. Said instrumnet was validated by experts in the field.

Data Collection

The data were gathered and read following the objective of the study and in adherence to all protocols in the conduct of research**.** The interview protocol underwent validation to enhance its reliability. This process involved two key steps. First, an expert review was conducted, where feedback was sought from professionals experienced in qualitative research, radiation monitoring, and maritime safety. This step ensured that the protocol was both comprehensive and relevant to the study's objectives. Second, pilot interviews were conducted with a small group of participants. These initial interviews helped assess the clarity and effectiveness of the interview guide, allowing for adjustments to be made before the full-scale interviews commenced.

The interview guide was developed based on the research goals and insights gleaned from the quantitative survey. This guide was structured to facilitate in-depth exploration of participants' perspectives and experiences. It included several open-ended questions designed to invite participants to share detailed viewpoints, challenges, achievements, and suggestions for improving radiation monitoring capacity. These questions aimed to elicit comprehensive responses that would provide a deeper understanding of the issues at hand.

Additionally, the guide encouraged narrative exploration, prompting participants to provide rich, qualitative insights through their personal stories and experiences. This approach allowed the research to capture the nuanced and contextual factors influencing the PCG's capacity-building initiatives in radiation monitoring. By incorporating both structured and open-ended elements, the interview guide aimed to gather detailed, meaningful data that would complement the quantitative findings and contribute to a holistic understanding of the subject.

Participants shared qualitative narratives and insights, offering a deeper understanding of the PCG's capacity-building initiatives. The data collected through interviews complemented and enriched the quantitative findings, providing a holistic view of the PCG's readiness for radiation monitoring and surveillance.

Data Analysis

Thematic analysis was conducted to extract common themes and patterns from the qualitative interview data after transcription and initial analysis. Codes and themes were processed using Dedoose®, a free web-based qualitative analytic software.

Ethical Considerations

The researcher ensured that all research protocols involving ethics in research were complied with for the protection of all people and institutions involved in the conduct of the study.

RESULTS and DISCUSSION

1. How prepared is the PCG in the surveillance and monitoring of radioactivity in the Philippine maritime jurisdiction in terms of:

International Journal of Engineering, Industrial, Maritime, and Technological Innovation (INJENI) P - ISSN: 3116-3807 E - ISSN: 3116-3815

PRC-CPD Accredited Provider: PTR-2025-749

NBDB Registration Book Publisher (Print & Digital): 0012

1.1 Human resources

Figure 1

Distribution of Higher Educational Attainment of the Participants

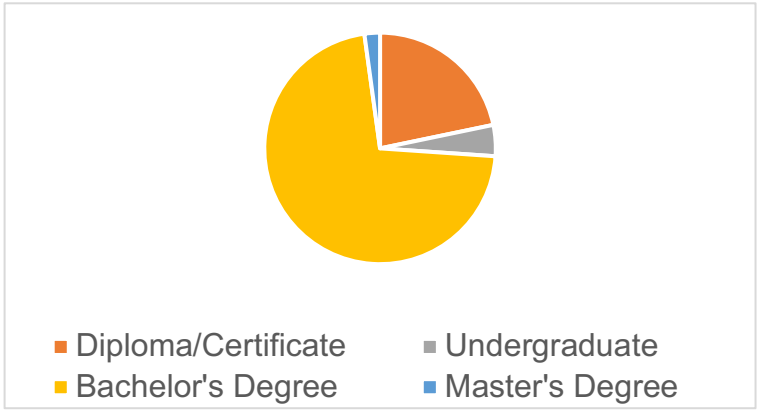


Figure 1 illustrates the educational background of the participants. Understanding their education levels is crucial for evaluating their qualifications and potential for performing specialized tasks within the organization.

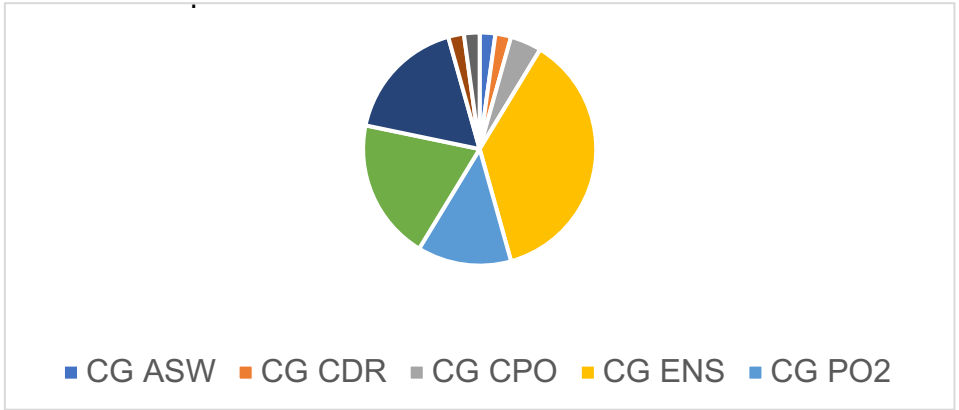
The data shows that out of the total participants, 10 hold a Diploma/Certificate, 2 are undergraduates, 33 possess a Bachelor's Degree, and 1 holds a Master's Degree. This indicates a range of educational achievements among the participants.

The data reveals that the majority of participants (33) have completed a bachelor's degree, indicating a well-educated workforce. The presence of 10 individuals with Diplomas/Certificates suggests that a portion of the team has received technical or vocational training, which can be valuable for specific operational tasks. The single respondent with a Master's Degree points to a limited number of highly specialized or advanced academic qualifications within the group**.**

Figure 2 provides an overview of the ranks held by the participants. This information helps in understanding the hierarchical structure and distribution of responsibilities within the organization. The ranks are diverse, with 1 CG ASW, 1 CG CDR, 2 CG CPO, 17 CG ENS, 6 CG PO2, 9 CG PO3, 8 CG SN1, 1 CG SN2, and 1 CG SW1. This distribution highlights the range of positions from junior to mid-level roles within the organization.

Figure 2

Distribution of rank of the Participants.



The majority of participants are CG ENS (17) and CG PO3 (9), indicating a significant presence of personnel at the Ensign and Petty Officer Third Class levels. This suggests a workforce primarily composed of junior to mid-level

International Journal of Engineering, Industrial, Maritime, and Technological Innovation (INJENI)
P - ISSN: 3116-3807
E - ISSN: 3116-3815
PRC-CPD Accredited Provider: PTR-2025-749
NBDB Registration Book Publisher (Print & Digital): 0012

officers who are likely involved in both operational and support roles. The smaller numbers in higher ranks such as CG ASW and CG CDR imply fewer high-ranking officers, which could indicate a more streamlined command structure.

Figure 3
Distribution of position/ designation of the Participants.

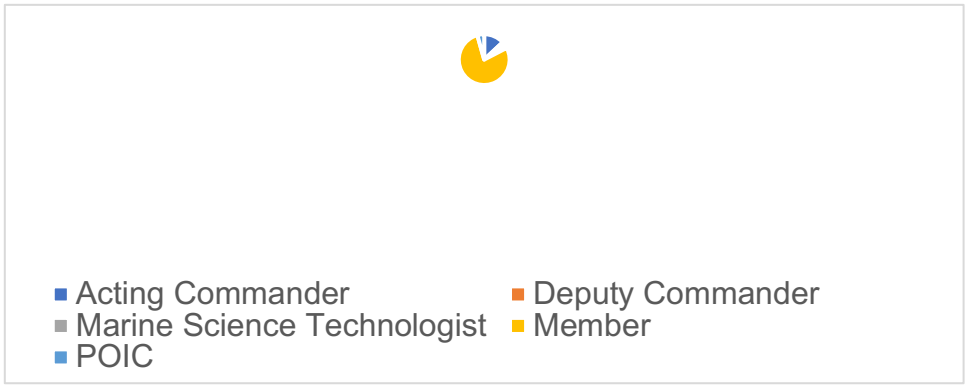


Figure 3 details the various positions or designations held by the participants, shedding light on the specific roles and responsibilities within the organization. The positions include 6 Acting Commanders, 1 Deputy Commander, 1 Marine Science Technologist, 36 Members, and 2 POICs. This distribution highlights the roles from leadership to specialized technical positions.

The majority of participants (36) are Members, indicating that most personnel are involved in regular operational roles. The presence of 6 Acting Commanders and 1 Deputy Commander suggests a small but essential leadership group overseeing operations. The Marine Science Technologist position indicates specialized roles that require specific technical expertise. The 2 POICs represent a small number of individuals responsible for oversight and management of specific operational areas.

Figure 4
Distribution of tenure/ years in service of the Participants.

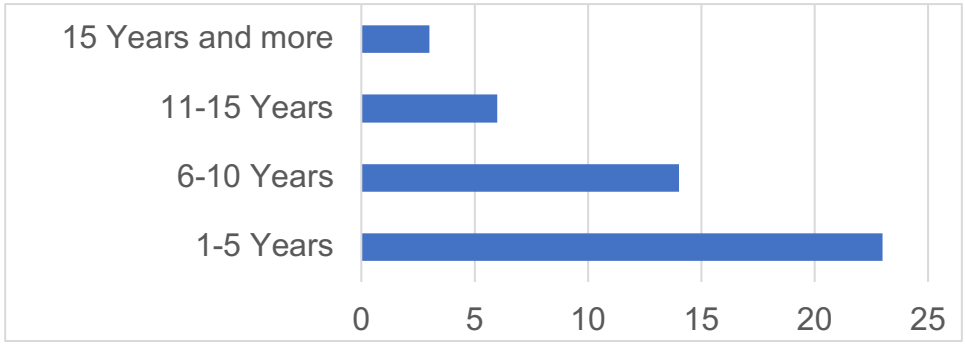


Figure 4 shows the participants' years of service, providing insight into their experience levels within the organization. The data indicates that 23 participants have 1-5 years of service, 14 have 6-10 years, 6 have 11-15 years, and none have more than 15 years of service.

The majority of participants (23) are relatively new, with 1-5 years of service, suggesting a youthful and potentially adaptable workforce. The 14 participants with 6-10 years of service indicate a substantial mid-level experience base, while the 6 participants with 11-15 years show that there is a smaller, more seasoned group within the organization. The absence of personnel with over 15 years of service may point to high turnover or a young organization.

Figure 5

International Journal of Engineering, Industrial, Maritime, and Technological Innovation (INJENI) P - ISSN: 3116-3807 E - ISSN: 3116-3815

PRC-CPD Accredited Provider: PTR-2025-749

NBDB Registration Book Publisher (Print & Digital): 0012

Distribution of training status of participants in environmental monitoring and surveillance.

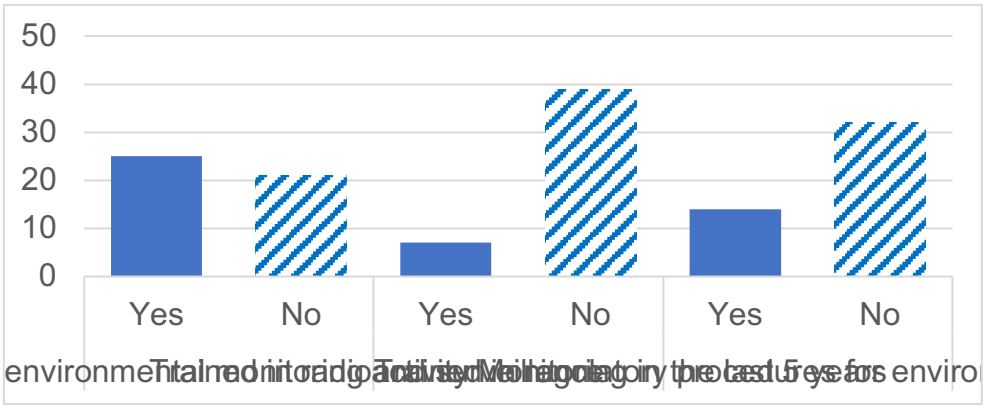


Figure 5 examines the training status of participants in environmental monitoring and surveillance, providing an understanding of their preparedness for specific environmental tasks. The data reveals that 25 participants have received training in environmental monitoring and surveillance, while 21 have not. Additionally, 7 participants have been trained in radioactivity monitoring in the last five years, and 39 have not. Furthermore, 14 participants have been trained in regulatory procedures for environmental protection, while 32 have not.

The majority of participants are not trained in radioactivity monitoring (39), indicating weak preparation in this critical area. However, the split in environmental monitoring and surveillance training (25 trained vs. 21 not trained) suggests a need for more comprehensive training programs. The lower number of participants trained in regulatory procedures (14) compared to those not trained (32) highlights a significant gap in regulatory knowledge, which could impact compliance and procedural adherence.

Document analysis reports the training manuals and modules provided for capacity building in radiological/nuclear (RN) emergency response preparedness of the Philippine Coast Guard (PCG). The key documents reviewed include two comprehensive training courses designed and implemented by the USA Defense Threat Reduction Agency (DTRA) under the cooperative program on Weapons of Mass Destruction (WMD) Philippine Maritime Proliferation Prevention of the Philippine National Coast Watch System. Both courses were held in February 2019 and aimed to equip the PCG with the necessary skills and knowledge to handle RN emergencies effectively. The training manuals and modules analyzed offer a robust framework for building capacity in radiological/nuclear emergency response within the Philippine Coast Guard. The one-day CBRN course provides essential introductory knowledge and skills for entry-level Coast Guards, equipping them to perform their roles as competent WMD inspectors. The more intensive five-day WMD Inspectors Training course offers a comprehensive curriculum that covers both theoretical and practical aspects of RN emergency response, ensuring that inspectors are well-prepared to handle a wide range of scenarios.

The CBRN Course designed and implemented by the USA Defense Threat Reduction Agency is a one-day, in-person training program targeted at entry-level Coast Guards. The course focuses on radiation control and detection, emergency response, and prevention. It introduces the basic principles of radiological and nuclear safety, providing foundational knowledge essential for Coast Guards. Trainees acquire initial skills in radiation detection and control, crucial for their role in preventing the proliferation of weapons of mass destruction (WMDs).

In addition to imparting foundational knowledge, the CBRN course emphasizes emergency response preparedness. The training ensures that Coast Guards can act swiftly and efficiently in the event of a radiological or nuclear incident. By the end of the training, participants are expected to become competent inspectors capable of identifying and managing potential WMD threats. This competency-building aspect is central to the course, as it prepares participants for real-world scenarios.

The WMD Inspectors Training, also provided by the USA Defense Threat Reduction Agency, is a more intensive five-day course with 28 hours of classroom discussions and 12 hours of practical exercises. This course is designed for WMD inspectors and aims to ensure they master the procedures and equipment used in WMD inspections. The curriculum is comprehensive, with 13 out of 20 lessons specifically focused on radio nuclear awareness, technical fundamentals, detection, response, and management.

International Journal of Engineering, Industrial, Maritime, and Technological Innovation (INJENI)
P - ISSN: 3116-3807
E - ISSN: 3116-3815
PRC-CPD Accredited Provider: PTR-2025-749
NBDB Registration Book Publisher (Print & Digital): 0812

The course's detailed discussions on technical concepts significantly enhance the inspectors' ability to detect, respond to, and manage radiological/nuclear threats. Practical exercises included in the training ensure that inspectors can apply theoretical knowledge to real-world scenarios, increasing their effectiveness in the field. The course also covers routine and standard inspection procedures, promoting consistency and thoroughness in WMD inspections. Additionally, a case study on radionuclear interdictions provides practical insights into managing real-life RN interdiction scenarios, helping inspectors understand the complexities and nuances of such operations.

Since their implementation in February 2019, the CBRN Course and the WMD Inspectors Training by the USA Defense Threat Reduction Agency have only been offered once. Despite their critical importance in equipping Coast Guards and WMD inspectors with essential skills in radiation detection, control, and emergency response, these comprehensive training programs have not been repeated. This limited offering highlights a gap in ongoing training and continuous capacity building for radiological and nuclear emergency preparedness within the Philippine Coast Guard.

1.2. Physical resources and Logistics

The Philippine Coast Guard (PCG) has a limited yet critical inventory of physical resources and logistics to ensure radionuclear emergency response readiness. A key piece of equipment in their arsenal is the Polimaster Gamma-Neutron Personal Radiation Detector (PRD), specifically the PM1703GNA-II model. This active detector is equipped with a high-sensitive scintillator capable of measuring personal dose rates up to 300 μSv/h. The PRD provides continuous monitoring and ensures high-performance detection in various scenarios. It offers users peace of mind by alerting them through visual, audible, and vibration alarms when preset radiation thresholds are exceeded, thereby enhancing personal safety during radiation exposure events.

Another essential device in the PCG's inventory is the RadSeeker CS Smith Detection radioisotope identifier device. This next-generation portable and handheld system excels in identifying and locating sources of suspicious substances, even in shielded or concealed conditions. The RadSeeker displays detection results in real-time on a high-contrast OLED colour display, ensuring clear visibility of data with a screen resolution of 428px x 272px. The device also features high-sensitivity detection alarms for both gamma and neutron radiation, providing audio, visual, earphone, vibrator, and discrete ultra-bright LED alarm indications, with adjustable audio alarm thresholds. This versatility and precision make the RadSeeker an invaluable tool for accurate radiation detection and identification.

These critical pieces of equipment were provided to the PCG during the 2019 Weapons of Mass Destruction (WMD) Inspectors Training. This training was a collaborative effort between the USA Defense Threat Reduction Agency and the Philippine National Coast Watch System. The provision of these devices underscores the importance of equipping the PCG with state-of-the-art technology to enhance their capability to detect, respond to, and manage radio-nuclear threats effectively. These resources are fundamental to maintaining a high level of readiness and operational efficiency in the face of potential radiological or nuclear incidents.

Despite the advanced capabilities of the Polimaster PRD and RadSeeker, the infrequency of training sessions and the limited inventory pose significant challenges to the PCG's overall preparedness. Continuous training and an expanded inventory are essential to ensuring that the PCG can effectively utilize these resources and respond swiftly to any radiological or nuclear emergency. Therefore, it is crucial to address these gaps to bolster the PCG's capacity for sustained readiness and robust emergency response in the face of evolving radio-nuclear threats.

Figure 6
Polimaster Personal Radiation Detector PM1703GNA; (R) RadSeeker CS Smith Detection radioisotope identifier

International Journal of Engineering, Industrial, Maritime, and Technological Innovation (INJENI) P - ISSN: 3116-3807 E - ISSN: 3116-3815

PRC-CPD Accredited Provider: PTR-2025-749

NBDB Registration Book Publisher (Print & Digital): 0012

2. What are the current initiatives in the surveillance and monitoring of radioactivity in terms of:

2.1. Policies

Insufficient and Inadequate Training Programs and Expertise Driven by the available PCG Policies

Participants consistently highlighted the inadequacy and novice status of current personnel, underscoring a pervasive lack of expertise. This deficiency is compounded by the absence of a robust, established training program within the PCG, with training efforts largely outsourced to external agencies such as the DOE and PNRI. Moreover, past training initiatives have not been sustained or regularly updated, leading to a stagnation in skills development. The analysis indicates a critical need for comprehensive, in-house capacity-building initiatives to equip PCG personnel with the necessary knowledge and practical skills. Addressing these issues through structured training programs and continuous professional development is essential for enhancing the PCG's operational readiness and effectiveness in radioactivity surveillance and monitoring. Most personnel lack adequate training, with some describing their expertise as "novice" or non-existent. Training that has been provided is primarily at an awareness and operational level, with only a few individuals receiving more specialized instruction.

Lack of Comprehensive and Sustained Capacity-Building Effort Driven by the available PCG Policies.

The ongoing capacity-building initiatives aimed at enhancing the skills and knowledge of Philippine Coast Guard (PCG) staff in radioactivity monitoring highlights several significant challenges and gaps. The primary issues identified include a lack of budget, inadequate prioritization, and an absence of long-term or continuous training programs. Several participants pointed out that there are no established policies or regulations mandating the development of capabilities in responding to radioactive materials or Weapons of Mass Destruction (WMD), resulting in this area not being a priority. Additionally, there are logistical challenges such as insufficient funding, political will, and a clear implementation plan. While there are proposals for establishing a Chemical, Biological, Radiological, and Nuclear (CBRN) Unit and procuring relevant equipment, these efforts have not been fully realized.

The need for updating and refreshing training, especially for new personnel, was also mentioned, underscoring the critical gap in ongoing capacity-building efforts. To address these challenges, a structured and well-funded long-term plan, backed by strong leadership commitment and clear policies, is essential to ensure the continuous development of PCG personnel's skills and knowledge in radioactivity monitoring.

Inadequate and Insufficient Equipment for Radioactivity Surveillance Driven by the available PCG Policies.

The equipment and technology currently in use for radioactivity surveillance within the Philippine Coast Guard (PCG) reveals a significant disparity and inadequacy in available resources. The majority of participants indicated that the PCG primarily relies on Personal Radiation Detectors (PRDs) and, to a lesser extent, Radio Isotope Identifier Devices. While some mention the presence of protective equipment such as HAZMAT suits, it is evident that the overall procurement and availability of specialized equipment are severely lacking. Several participants explicitly stated that there is no established equipment for comprehensive radioactivity surveillance, highlighting an urgent need for substantial investment in technology and resources. The absence of subunits equipped with the necessary tools further underscores the critical gaps in the PCG's capability to effectively monitor and respond to radioactive threats. This analysis points to a pressing requirement for a systematic approach to equip the PCG with advanced, reliable technology and equipment to enhance their operational readiness and effectiveness in managing radioactivity surveillance.

2.2. Strategies

Need for Establishment and Regular Review of Strategic Framework for Radioactivity Surveillance.

A unanimous recognition of its absence and a strong consensus on the need for its establishment. Most of the participants explicitly stated that there is currently no strategic framework in place. They emphasized the importance of developing such a framework to guide and enhance the PCG's capabilities. They have pointed out the necessity of having a comprehensive contingency plan and legal mandates to bolster the country's readiness against threats like Weapons of Mass Destruction (WMD). There is also a suggestion for collaboration with other government agencies such as the Department of Science and Technology (DOST) and the Philippine Nuclear Research Institute (PNRI) to establish this framework. Overall, the responses highlight a critical gap in policy and strategic planning that needs to be addressed to ensure the PCG is adequately prepared for radioactivity surveillance and monitoring. In terms of reviewing and updating strategies for radioactivity surveillance to align with international standards indicate that there are currently no established policies or strategies in place.

International Journal of Engineering, Industrial, Maritime, and Technological Innovation (INJENI)
P - ISSN: 3116-3807
E - ISSN: 3116-3815
PRC-CPD Accredited Provider: PTR-2025-749
NBDB Registration Book Publisher (Print & Digital): 0012

Limited and Fragmented Networking and Partnerships for Radiological Preparedness

The existence of an established networking and collaborations framework for the PCG in determining prospect institutions for radioactivity surveillance and monitoring indicate a minimal presence of formal frameworks. National Coast Watch System (NCWS) through the National Maritime Center (NM Center) as a potential model for determining these prospect institutions. This suggests that while there might be some foundational structures in place, such as the NCWS, there is no explicit, well-established framework dedicated specifically to radioactivity surveillance and monitoring collaborations. The lack of additional detailed responses highlights a gap in structured networking and collaboration efforts in this specific area, suggesting a need for the development of a more robust and dedicated framework.

Joint initiatives or partnerships aimed at strengthening the overall network for radiological preparedness reveal limited engagement in such activities. AJD recalls the establishment of the NCW Center (now NM Center) with funding from the Defense Threat Reduction Agency (DTRA) as part of efforts to enhance the country's Maritime Domain Awareness and its Weapons of Mass Destruction Proliferation Prevention Program (WMD-PPP). This indicates a significant, albeit historical, partnership aimed at improving radiological preparedness. While B mentions individual training through a partnership with the Japan International Cooperation Agency (JICA). The overall responses highlight sporadic and limited joint initiatives, indicating the need for more comprehensive and ongoing partnerships to enhance the PCG's radiological preparedness.

3. What are the challenges in the surveillance and monitoring of radioactivity in terms of:

3.1 Policies

The consistent message from the participants is that the PCG has not yet developed a policy to guide its radioactivity monitoring activities, and therefore, there are no existing strategies to review or update. This lack of an established framework suggests that the PCG is not in alignment with international standards and best practices, highlighting an area that requires immediate attention. Establishing a policy and regular review process is essential for the PCG to stay current with global standards and ensure effective radioactivity surveillance and response capabilities. The feedback underscores the necessity for initiating policy development and setting up a system for continuous evaluation and improvement.

3.2 Strategies

There is a heavy reliance on international training opportunities, which highlights a gap in domestic training infrastructure. Some participants pointed out that the PCG lacks comprehensive training programs and established policies or regulations mandating the development of capabilities in responding to radioactive incidents or Weapons of Mass Destruction (WMD). This lack of prioritization reflects a broader issue within the organization, where the importance of specialized training is not fully recognized or implemented. Furthermore, there are logistical challenges, such as improper turnover of trained personnel and insufficient follow-up on initial training efforts. To address these deficiencies, the PCG must develop and implement a thorough, in-house training program that is continuously updated and mandated by clear policies to ensure all personnel are adequately prepared to handle radioactivity surveillance and monitoring.

The majority of participants indicated that there is either a complete lack of equipment or outdated technology that has not been updated or maintained since 2020. Key issues include the absence of an established unit responsible for handling radioactivity monitoring, which results in budget allocations being directed elsewhere. Existing equipment, such as personal radiation detectors and radio isotope identifier devices, are mentioned but are not effectively utilized due to a lack of trained personnel. Furthermore, some equipment is under the custody of other entities, such as MSIF, with no clear status updates post-deployment. The responses reveal a significant deficiency in both the availability of appropriate technology and the capacity to effectively use and maintain the equipment necessary for comprehensive radioactivity surveillance and monitoring within the PCG.

4. Based on the findings, what can be recommended to ensure the readiness of the Philippine Coast Guard in the surveillance and monitoring of radioactivity in the Philippine maritime jurisdiction?

The Philippine Coast Guard (PCG) is tasked with surveillance and monitoring of radioactivity within the Philippine maritime jurisdiction. A review of their preparedness reveals several key points. In terms of human

International Journal of Engineering, Industrial, Maritime, and Technological Innovation (INJENI)
P - ISSN: 3116-3807
E - ISSN: 3116-3815
PRC-CPD Accredited Provider: PTR-2025-749
NBDB Registration Book Publisher (Print & Digital): 0812

resources, the PCG presents a varied educational background among its participants, with the majority holding a Bachelor's Degree, indicating a well-educated workforce. However, there is a notable lack of personnel with advanced academic qualifications and specialized training in radioactivity monitoring, suggesting a need for more targeted training programs. The PCG's organizational structure is represented by a diverse range of ranks, with a significant number of junior to mid-level officers. This suggests a workforce primarily involved in operational and support roles, with fewer high-ranking officers. The distribution of positions within the PCG reveals a focus on regular operational roles, with a smaller number of personnel in leadership and specialized technical positions. This indicates a potential need for enhanced leadership and technical expertise development.

Regarding experience, the PCG's workforce is relatively new, with the majority having 1-5 years of service, indicating a youthful and potentially adaptable workforce. However, the absence of personnel with over 15 years of service may suggest high turnover or a young organization. The PCG's training status in environmental monitoring and surveillance shows a concerning gap, with a significant number of personnel not trained in radioactivity monitoring and regulatory procedures, which could impact their ability to comply with and adhere to necessary protocols. The PCG has received training through comprehensive courses provided by the USA Defense Threat Reduction Agency, which include a one-day CBRN course and a five-day WMD Inspectors Training course. These courses aim to equip the PCG with the necessary skills and knowledge to handle RN emergencies effectively. However, these training programs have only been offered once, highlighting a significant gap in ongoing training and continuous capacity building.

The PCG's inventory of physical resources includes the Polimaster Gamma-Neutron Personal Radiation Detector and the RadSeeker CS Smith Detection radioisotope identifier device. Despite the advanced capabilities of these devices, the infrequency of training sessions and limited inventory pose challenges to the PCG's overall preparedness. In terms of policies and strategies, the PCG lacks a strategic framework for radioactivity surveillance, and there are no established policies or regular review processes. This indicates a need for the development of a comprehensive contingency plan and legal mandates to bolster the country's readiness against threats like Weapons of Mass Destruction (WMD). The PCG faces challenges in networking and partnerships for radiological preparedness, with limited engagement in joint initiatives and a lack of a well-established framework for collaborations. This suggests the need for more structured and ongoing partnerships to enhance radiological preparedness.

While the PCG has received some critical training and equipment to handle radioactivity surveillance and monitoring, there are significant gaps in personnel expertise, training programs, equipment availability, and strategic planning. Addressing these gaps is essential for enhancing the PCG's operational readiness and effectiveness in managing radioactivity surveillance and monitoring within the Philippine maritime jurisdiction.

To ensure the readiness of the Philippine Coast Guard (PCG) in the surveillance and monitoring of radioactivity within the Philippine maritime jurisdiction, several key recommendations are proposed. Firstly, enhancing training and expertise is essential. Developing comprehensive, in-house training programs that are regularly updated to keep pace with evolving threats and technologies is crucial. Providing specialized training in radioactivity monitoring and regulatory procedures to all relevant personnel will ensure a skilled and knowledgeable workforce. Additionally, establishing a system for continuous professional development will maintain and enhance the expertise of PCG personnel.

Strengthening policy and strategic planning is necessary for effective radioactivity surveillance. Creating a strategic framework that includes a comprehensive contingency plan and legal mandates will guide the PCG's activities. Regularly reviewing and updating policies and strategies to align with international standards and best practices will ensure the PCG remains current and effective. Expanding equipment and technology is also vital. Investing in advanced, reliable technology and equipment will provide the PCG with the necessary tools to monitor and respond to radioactive threats effectively. Establishing a dedicated unit responsible for handling radioactivity monitoring will ensure proper budget allocation and equipment maintenance.

Fostering networking and partnerships and addressing logistical challenges are critical components. Developing a robust framework for networking and collaboration with other government agencies, international organizations, and industry experts will facilitate the sharing of knowledge, resources, and best practices. Engaging in joint initiatives and partnerships will strengthen the overall network for radiological preparedness. Improving the turnover and follow-up processes for trained personnel will ensure that skills and knowledge are effectively transferred and utilized within the organization. Securing adequate funding and political support will help overcome logistical challenges and implement long-term capacity-building efforts. Implementing a review and evaluation system to regularly assess the PCG's readiness and effectiveness will help identify areas for improvement and measure the impact of implemented strategies.

International Journal of Engineering, Industrial, Maritime, and Technological Innovation (INJENI) P - ISSN: 3116-3807 E - ISSN: 3116-3815

PRC-CPD Accredited Provider: PTR-2025-749

NBDB Registration Book Publisher (Print & Digital): 0812

Summary

The Philippine Coast Guard (PCG) workforce mostly holds Bachelor's degrees, but lacks specialized training in radioactivity monitoring and regulatory procedures. While the PCG has received some training from the USA Defense Threat Reduction Agency, it has only been offered once. The PCG has limited yet critical equipment, including the Polimaster Gamma-Neutron Personal Radiation Detector and the RadSeeker CS Smith Detection radioisotope identifier device. However, more equipment and effective training on their use and maintenance are urgently needed. The PCG currently lacks a strategic framework for radioactivity surveillance and there is no comprehensive policy to guide radioactivity monitoring activities in alignment with international standards.

In addition, the PCG needs to improve networking and partnerships. Currently, it has limited engagement in joint initiatives and partnerships for radiological preparedness. More structured and ongoing partnerships are necessary to enhance radiological preparedness and ensure a collaborative approach to managing radiological threats.

To enhance training and expertise, it is crucial to develop comprehensive, in-house training programs that are regularly updated to reflect the latest advancements and methodologies. Strengthening policy and strategic planning involves creating a strategic framework that includes a comprehensive contingency plan and legal mandates to guide operations. Expanding equipment and technology requires investing in advanced tools and establishing a dedicated unit for radioactivity monitoring to ensure effective and timely responses. Fostering networking and partnerships is essential, and can be achieved by developing a robust framework for collaboration with other agencies and international organizations to share knowledge and resources. Addressing logistical challenges, such as securing adequate funding and political support, is necessary for implementing long-term capacity-building efforts. Lastly, implementing a review and evaluation system to regularly assess the PCG's readiness and effectiveness in managing radioactivity surveillance and monitoring is imperative for continuous improvement and adaptation to emerging threats.

Conclusion

The Philippine Coast Guard (PCG) is tasked with the critical responsibility of monitoring radioactivity within the Philippine maritime jurisdiction. The analysis of the PCG's preparedness for this role reveals a mixed picture. On the one hand, the PCG boasts a workforce with a solid educational foundation, predominantly composed of individuals with Bachelor's Degrees, indicating a well-educated team. On the other hand, there are significant gaps in specialized training, particularly in radioactivity monitoring and regulatory procedures, which are essential for effective environmental protection and compliance.

The PCG's inventory of physical resources and logistics, while limited, includes advanced equipment such as personal radiation detectors and radioisotope identifier devices. However, the effectiveness of this equipment is undermined by a lack of comprehensive training and a limited number of trained personnel. This situation is exacerbated by the absence of a dedicated unit to focus on radioactivity monitoring, which could lead to inadequate maintenance and proper utilization of the equipment.

In terms of policies and strategies, the PCG lacks a strategic framework to guide its activities in radioactivity surveillance. The absence of regularly reviewed and updated policies means that the PCG's approach to this critical area does not align with international standards and best practices. This gap in strategic planning could hinder the PCG's ability to respond effectively to radiological threats.

The PCG's efforts in networking and partnerships for radiological preparedness are also found to be limited. While there have been some collaborative initiatives with other government agencies and international organizations, these appear to be sporadic and not part of a structured, ongoing engagement. This limitation could impede the PCG's ability to leverage external expertise and resources to enhance its capabilities.

Recommendations

Based on the findings and implications outlined in the study, several recommendations are proposed to enhance the preparedness and effectiveness of the Philippine Coast Guard (PCG) in radiologic surveillance and monitoring. These recommendations aim to bridge the gap between theoretical readiness and practical application, ensuring comprehensive and sustained capacity-building initiatives.

1. Develop Comprehensive Training Programs

Implement robust, continuous in-house training programs that are regularly updated. Focus on advanced and specialized training in radiologic surveillance and emergency response.

2. Enhance Policy Implementation

International Journal of Engineering, Industrial, Maritime, and Technological Innovation (INJENI) P - ISSN: 3116-3807 E - ISSN: 3116-3815

PRC-CPD Accredited Provider: PTR-2025-749

NBDB Registration Book Publisher (Print & Digital): 0812

Strengthen the strategic policies supporting radiologic monitoring and surveillance. Ensure policies are clearly communicated and consistently enforced across all levels of the PCG.

3. Address Logistical Challenges

Secure adequate funding to support long-term training and development programs. Foster political will and commitment to sustain these initiatives. Implement proper personnel turnover procedures to maintain continuity in trained staff.

4. Establish a Dedicated CBRN Unit

Create a specialized Chemical, Biological, Radiological, and Nuclear (CBRN) Unit within the PCG. Equip this unit with the necessary tools and resources to effectively manage radiologic threats.

5. Foster International Partnerships

Strengthen collaborations with key organizations such as the Philippine Nuclear Research Institute Nuclear Regulatory Division (PNRI NRD) and the International Atomic Energy Agency (IAEA). Engage with Southeast Asian countries to share best practices and enhance regional cooperation.

6. Regular Evaluation and Feedback

Conduct regular assessments of training programs and policy implementation to identify areas for improvement. Solicit feedback from PCG personnel to ensure training programs meet their needs and address any emerging challenges

REFERENCES

Al-Azmi, D., Gudmestad, B., Hauge, S., & Tafjord, B. (2021). Training medical responders in the management of radiation incidents: A systematic review. Radiation Protection Dosimetry, 196(4), 380–387. https://doi.org/10.1093/rpd/ncaa126

Carvalho, F. P., Alberto, G., & Silva, L. (2016). Emergency Preparedness and Response to Radiological Accidents: A Review of Approaches and Techniques. Journal of Environmental Radioactivity, 157, 67-77. https://doi.org/10.1016/j.jenvrad.2016.03.018

Chang, S. Y., Kang, H. S., & Kim, S. H. (2016). Analysis of the Emergency Response Exercise for a Radiation Accident in Korea. Radiation Protection Dosimetry, 170(1-4), 175-178. https://doi.org/10.1093/rpd/ncw207

Cha S, Kim S, Song S, Yu M, Pak M, An S, et al . Examining the effectiveness of initial response training program for nuclear emergency preparedness. Int J Radiat Res 2020; 18 (4) :715-721
URL: http://ijrr.com/article-1-3284-en.html

Chen, S. L., Wu, W. T., & Wang, J. D. (2018). Impact of an Emergency Response Training Program on Hospital Staff's Knowledge, Attitude, and Behavior Regarding Radiation Emergency Response. Journal of Medical Systems, 42(5), 84. https://doi.org/10.1007/s10916-018-0946-4

Chen, B., Li, Z., & Yang, Z. (2022). Nuclear accident emergency response system: Radiation Field estimation and evacuation. *Sustainability*, *14*(9), 5663. https://doi.org/10.3390/su14095663

Cho, Y. S., Kim, M. S., Kim, Y. S., Kim, S. I., Kim, J. W., & Choi, Y. S. (2021). Evaluation of the Effectiveness of Radiation Emergency Response Training for Health and Safety Personnel in the Wake of the Fukushima Daiichi Nuclear Power Plant Accident. Journal of Occupational and Environmental Hygiene, 18(1), 11-18. https://doi.org/10.1080/15459624.2020.1832351

Cruz, C. P., Lopez, E. C., Pabroa, P. C. B., & Sucgang, R. J. (2020). Measurement of natural and anthropogenic radionuclides in coastal waters and sediments of Manila Bay, Philippines. Marine Pollution Bulletin, 157, 111300. https://doi.org/10.1016/j.marpolbul.2020.111300

International Atomic Energy Agency. (2014). Philippines and IAEA to Strengthen Cooperation in Nuclear and Radiation Safety. https://www.iaea.org/newscenter/pressreleases/philippines-and-iaea-to-strengthen-cooperation-in-nuclear-and-radiation-safety

International Journal of Engineering, Industrial, Maritime, and Technological Innovation (INJENI)
P - ISSN: 3116-3807
E - ISSN: 3116-3815
PRC-CPD Accredited Provider: PTR-2025-749
NBDB Registration Book Publisher (Print & Digital): 0012

International Atomic Energy Agency. (2017). Philippines Conducts First Joint IAEA Emergency Preparedness and Response Exercise. https://www.iaea.org/newscenter/news/philippines-conducts-first-joint-iaea-emergency-preparedness-and-response-exercise

Ji, Y., Wang, X., Zou, Y., Li, D., Zhang, Y., & Ning, J. (2022). A simulation system of radiation field and its detection for nuclear and radiological emergency preparedness and response training. *Journal of Radiological Protection*, *42*(2), 021526. https://doi.org/10.1088/1361-6498/ac7361

Kawamura, H., Komatsu, Y., Tanaka, K., Kanamoto, M., Tobe, M., Usami, C., Hinohara, H., Oshima, K., Kitada, Y., Tsuda, K., Ogano, T., Shimada, H., & Ohno, T. (2022). Implementation of a rapid response system at an isolated radiotherapy facility through simulation training. *BMJ Open Quality*, *11*(1), e001578. https://doi.org/10.1136/bmjoq-2021-001578

Kim, H. J., Choi, J. Y., Park, J. H., & Kim, J. S. (2020). Impact of radiation emergency response training on the knowledge and skills of medical staff. Radiology and Oncology, 54(1), 80-86. https://doi.org/10.2478/raon-2020-0006

Lave, J., & Wenger, E. (1991). Situated learning: Legitimate peripheral participation. Cambridge university press.

Lebaron-Jacobs, L., & Herrera-Reyes, E. (2021). Basic concepts of radiation emergency medicine. *Journal of Radiological Protection*, *41*(4), S371-S390. https://doi.org/10.1088/1361-6498/ac270e

Li, Q., Zhang, Y., Sun, Q., Zhang, Y., & Wang, X. (2019). Rapid Detection of Radioactive Materials Based on Gamma Spectroscopy. IEEE Transactions on Nuclear Science, 66(10), 2207-2212. https://doi.org/10.1109/TNS.2019.2938423

Mendoza, E. T., Garcia-Tenorio, R., & Cruz-Zaragoza, E. (2018). Natural radiation sources as tracers for environmental studies. Journal of Environmental Radioactivity, 192, 444-453. https://doi.org/10.1016/j.jenvrad.2018.06.001

Miller, R. L., Mayer, C. W., & Ahlers, R. L. (2017). Evaluation of Radiation Safety Training for First Responders. Health Physics, 113(6), 451-459. https://doi.org/10.109

Nasir, T., Hameed, M. A., & Hussain, S. (2020). Quality Assurance of Radioactivity Monitoring Data: An Overview. Radiation Physics and Chemistry, 170, 108641. https://doi.org/10.1016/j.radphyschem.2019.108641

Philippine Nuclear Research Institute. (2021). Radiation Monitoring. https://www.pnri.dost.gov.ph/index.php/services/radiation-monitoring

Palacios, D. M., Shultz, M., King, J. R., Pacheco, P., & O'Connor, T. P. (2019). Utilizing Unmanned Aerial Vehicles (UAVs) for Radiological Monitoring in Support of Nuclear and Radiological Incident Response: A Review. Journal of Environmental Radioactivity, 208-209, 106002. https://doi.org/10.1016/j.jenvrad.2019.106002

Park, H. S., Kang, J. M., Kim, J. S., Choi, S. Y., & Park, K. S. (2018). Decision Support System for Radiological Emergency Preparedness and Response. Journal of Radiological Protection, 38(2), 615-625. https://doi.org/10.1088/1361-6498/aaa562

International Journal of Engineering, Industrial, Maritime, and Technological Innovation (INJENI)
P - ISSN: 3116-3807
E - ISSN: 3116-3815
PRC-CPD Accredited Provider: PTR-2025-749
NBDB Registration Book Publisher (Print & Digital): 0012

Song, D. (2023). Safety Is Everything: Design of an AR·VR Training Simulator for Radiation Emergency Response. In: Jung, T., tom Dieck, M.C. (eds) XR-Metaverse Cases. Business Guides on the Go. Springer, Cham. https://doi.org/10.1007/978-3-031-30566-5_8

Salame-Alfie, A., Whitcomb, R. C., Evans, C. L., Howard, G., Gilstrap, J., Gill, A., & Hardrick, H. (2022). Developing a radiation-savvy public health workforce. *Environmental Advances*, *9*, 100269. https://doi.org/10.1016/j.envadv.2022.100269

Winters, T. A., Cassatt, D. R., Harrison-Peters, J. R., Hollingsworth, B. A., Rios, C. I., Satyamitra, M. M., Taliaferro, L. P., & DiCarlo, A. L. (2023). Considerations of medical preparedness to assess and treat various populations during a radiation public health emergency. *Radiation Research*, *199*(3). https://doi.org/10.1667/rade-22-00148.1

Younghee Park, Park Suhyung, Kim Jeongsik, Kim Byeongjik, and Kim Namhoon. (2022). Analysis of the current status of artificial intelligence application for radiation emergency response and suggestions for future research directions. Journal of the Korean Society of Industrial Engineers , 48 (6), 626-635, 10.7232/JKIIE.2022.48.6.626

International Journal of Engineering, Industrial, Maritime, and Technological Innovation (INJENI)
P - ISSN: 3116-3807
E - ISSN: 3116-3815
PRC-CPD Accredited Provider: PTR-2025-749
NBDB Registration Book Publisher (Print & Digital): 0372

Integrating Technology in Teaching Science: A Quasi-Experimental Study

Johna Mae B. Banguis*[1], Roel P. Villocino, EdD[2]
[1, 2] Assumption College of Nabunturan, Poblacion, Nabunturan, Davao de Oro

Abstract
Aim: This study aimed to investigate the impact of integrating educational videos into science instruction on students' academic performance. Specifically, it evaluated the effectiveness of technology-enhanced teaching compared to traditional instruction through a quasi-experimental design.
Methodology: A quantitative one-group pretest-posttest quasi-experimental design was employed. A lesson plan incorporating educational videos was implemented, and students' knowledge, comprehension, and application skills were assessed using a validated multiple-choice test administered before and after the intervention. Data were analyzed using mean scores and paired sample t-tests.
Results: Findings revealed that students had low to moderate pretest scores, indicating limited understanding and misconceptions in science concepts. After exposure to technology-integrated instruction, students demonstrated notable improvement in academic performance. Statistical analysis confirmed a significant difference between pretest and posttest scores, indicating that educational videos effectively enhanced learning outcomes.
Conclusion: The integration of educational videos in teaching science significantly improved students' academic performance. The findings suggest that technology-based teaching strategies are effective in promoting comprehension and engagement in science instruction.
Keywords: *technology integration, educational videos, science instruction, academic performance, quasi-experimental design*

INTRODUCTION

Teaching science is a fundamental subject that equips learners with the knowledge and skills needed to understand the world around them. However, teaching science effectively at the elementary level poses challenges due to its abstract concepts and the limited availability of engaging instructional resources. There has been a growing interest in the integration of educational technology into science classrooms. Research suggests that digital learning tools can improve motivation, deepen conceptual understanding, and support differentiated instruction (Kirkwood & Price, 2013; Carvajal et al., 2025).

Globally, science education has been recognized as a key driver of economic growth, technological innovation, and sustainable development. International education systems have increasingly emphasized the need for inquiry-based, student-centered approaches to science teaching. However, despite reforms, many countries still face challenges in making science education accessible, engaging, and relevant to students' lives (OECD, 2019). Global studies show that student performance in science is heavily influenced by teaching strategies, availability of learning resources, and the integration of technology. According to the Programme for International Student Assessment (PISA), students from systems that employ more hands-on, interactive, and technology-supported methods in science instruction tend to outperform those from systems relying solely on memorization or textbook-based teaching (OECD, 2019; Pangilinan, 2025).

Similarly, Bybee (2013) emphasized that 21st-century science teaching should include digital literacy, inquiry-based learning, and collaboration, aligning closely with the use of platforms like Khan Academy, Kahoot, and educational videos in classrooms around the world. Countries such as Singapore, Finland, and South Korea have invested in professional development for teachers and have adopted national strategies for integrating ICT in science education. These efforts have been associated with higher student achievement and motivation in science (UNESCO, 2021; Carvajal et al., 2024). Such global examples provide a model and rationale for localized studies, like this one, which seek to understand how technology integration can improve science instruction in specific contexts such as Grade 5 classrooms in the Philippines.

In Monkayo, Davao de Oro, the effectiveness of technology integration in basic education classrooms continues to face significant challenges despite advancements in access and resources. At Monkayo Central Elementary School, the common problems faced by Grade 5 students include difficulties in technology use, such as trouble navigating learning platforms or using tools like educational apps. Another issue is distractions while using technology, especially when students access non-educational content. Additionally, inconsistent access to devices or

International Journal of Engineering, Industrial, Maritime, and Technological Innovation (INJENI)
P - ISSN: 3116-3807
E - ISSN: 3116-3815
PRC-CPD Accredited Provider: PTR-2025-749
NBDB Registration Book Publisher (Print & Digital): 0372

the internet at home creates equity issues that hinder the effective use of digital tools for learning (Amihan & Sanchez, 2023).

Despite the growing availability of digital tools and technological resources in education, the effective integration of technology into science instruction at the elementary school level remains inconsistent and underutilized. As a result, there is a need to examine whether and how integrating technology into science instruction can significantly impact students' academic performance and engagement in elementary science education. This study seeks to address this gap through a quasi-experimental design, evaluating the effectiveness of technology-enhanced instruction compared to traditional teaching methods.

Objectives

This research project investigated technology integration in grade 5 classrooms at Monkayo Central Elementary School to understand and assess its effectiveness.

The following questions guided the investigation:

1. What is the students' academic performance level based on pretest results?
2. What is the students' academic performance level based on posttest scores?
3. Is there a significant difference between the pretest and posttest scores?

Hypothesis

In order to treat the problems extensively and accurately, the following hypothesis is formulated at 0.05 level of significance:

H_0: There is no significant difference between the students' academic performance in the pretest and posttest results.

METHODS

Research Design

This study employed a quantitative one-group quasi-experimental approach to collect data. A pre-test and post-test design was utilized to assess the effectiveness of integrating technology into science instruction. The design focused on measuring the academic performance of one group of students before and after their exposure to technology-based teaching strategies. Such a design is often used to determine changes in learning outcomes as a result of instructional interventions (Pangilinan, 2025).

Population and Sampling

The respondents of this study were the Grade 5 students in Section Luna from Monkayo Central Elementary School, located in Monkayo, Davao de Oro. The selection of this grade level was based on the curriculum requirements that introduce more complex science concepts, which are ideal for assessing the impact of technology integration in teaching. The subject was chosen through universal sampling, considering the availability of students, their exposure to similar academic content, and the school's support for the research initiative. As emphasized by Amihan et al. (2023), aligning research participants with curriculum standards and institutional support strengthens the validity and applicability of educational research.

Instrument

The researchers prepared a lesson plan designed to effectively assess how technology integration impacts student learning outcomes by gauging knowledge and skill levels before and after the intervention. The Grade 5 students served as the recipients of the treatment. The test included multiple-choice questions that measured knowledge, comprehension, and application skills. The test was divided into a pre-test to measure baseline knowledge before the intervention and a post-test to measure learning outcomes after the intervention. A Table of Specifications (TOS) was also developed to ensure that the test items were aligned with various comprehension skills. The questionnaire consisted of 20 multiple-choice items, each with four options. This systematic alignment of test instruments with intended learning outcomes mirrors best practices in curriculum and assessment design (Carvajal et al., 2025).

Data Collection

International Journal of Engineering, Industrial, Maritime, and Technological Innovation (INJENI)
P - ISSN: 3116-3807
E - ISSN: 3116-3815
PRC-CPD Accredited Provider: PTR-2025-749
NBDB Registration Book Publisher (Print & Digital): 0372

For data collection, the researchers first secured an endorsement letter from the Dean of the Graduate School at Assumption Academy of Nabunturan and a request letter to the Office of the Schools Division Superintendent of Davao de Oro for approval to conduct the study. After approval, the researchers submitted the permission letters to the school principal. The research participants were then informed of their involvement in the quasi-experimental study. A pre-test was administered to the respondents, followed by a post-test after the intervention to measure learning outcomes. This systematic process of securing institutional approval and obtaining participant cooperation reflects ethical and professional research standards (Carvajal & Sanchez, 2023).

Treatment of Data

In the current study, appropriate statistical tools were applied to analyze the data. Based on the study's objectives, the mean and paired t-test were used. The mean provided a concise numerical value that represented the average performance of the respondents in both tests. Meanwhile, the paired t-test was used to calculate the t-value by comparing the mean difference between the pre- and post-intervention scores with the variability or standard error of the differences.

Ethical Considerations

The researchers ensured that all ethical guidelines were followed, including obtaining informed consent from participants and ensuring the confidentiality and privacy of their responses throughout the study. Upholding ethical research practices is vital for maintaining integrity and credibility in educational research (Sanchez, 2025).

RESULTS and DISCUSSION

This chapter presents the results obtained from the collected data and the descriptive analyses and interpretation based on the problems presented.

Students' academic performance level based on pretest results

This section presents the result of the first statement of the problem that examines the academic performance level of the students' pretest scores during the conduct of science lesson without the integration of technology.

Table 1

Pre-test Performance of the Grade 5 Students			
	No. of Students	Mean	Std. Deviation
Pretest	51	11.6863	3.12083

Table 1 basically shows the academic performance level of students taking science lessons without integration of technology use. Students performed at a low level suggested that the students had limited knowledge or understanding of the science concept covered in the study. The standard deviation indicates some variation in students' performance but overall, most scores clustered around the mean.

Students' academic performance level based on posttest scores

This section presents the result to the second statement of the problem that examines the academic performance level of the students' posttest scores during the conduct of science lesson with the integration of technology.

Table 2
Posttest Performance of Grade 5 Students

	No. of Students	Mean	Std. Deviation
Post Test	51	14.2549	2.79172

International Journal of Engineering, Industrial, Maritime, and Technological Innovation (INJENI) P - ISSN: 3116-3807 E - ISSN: 3116-3815

PRC-CPD Accredited Provider: PTR-2025-749

NBDB Registration Book Publisher (Print & Digital): 0372

The table indicates that on average, students scored relatively well after the integration of educational videos in science instruction. The standard deviation reflects a moderate variability in student scores, suggesting that while most students performed above the passing level, there were some differences in the levels of achievement.

Significant Differences between the Pretest and posttest

Table 3 presents the test difference of means in pre-test and post-test performances of the Grade 5 students taking science lesson with and without the integration of technology.

Table 3
Paired Samples Test

	Paired Differences					t-value	df	p-value
	Mean	Std. Deviation	Std. Error Mean	95% Conficence Interval of the Difference				
				Lower	Higher			
Pair 1 Pretest-Post test	-256863	1.76924	.24774	-3.06623	-2.07102	-10.368	50	.000

The results show a mean difference between the pretest and posttest scores, indicating an increase in student performance after the intervention. This means that the difference between pre-test and post-test scores is statistically significant. Therefore, we reject the null hypothesis and conclude that integrating technology in teaching science had a significant positive effect on the students' academic performance. This was supported by Kirkwood and Price (2024) which believed that digital learning tools can improve motivation, deepen conceptual understanding, and support differentiated instruction.

Conclusions

The view of foregoing findings, the researchers concluded that students achieved a higher level of academic performance in science following the integration of technology such video, Kahoot and Khan Academy. There is a significant difference in pre- test and post- test scores which means, the students have improved their academic performance during the integration of technology. The average score increase indicates that technology-based teaching strategies were effective in enhancing comprehension and engagement. These findings support existing literature advocating for the use of educational technology to improve learning outcomes and underscore its relevance in modern science education.

Overall, students' scores during the intervention of technology in science lessons positively increased. The data suggests that the intervention had a positive impact on the performance of the students in learning science subject.

Recommendations

Given the significant improvement in students' academic performance, school should promote the consistent integration of educational technologies such as simulation, digital quizzes and science applications into daily teaching practices. Also, regular training and professional development workshops should be conducted for science teachers to effectively use technology tools in instruction. Teachers' competence in using digital tools is crucial to maximizing student engagement and learning outcomes. Hence, DepEd should allocate resources to provide reliable internet access, updated devices and appropriate software for classroom use. Ensuring access for all students is the key to equitable learning opportunities. Moreover, further studies should be conducted across different grade levels and subject areas to explore the broader effectiveness of enhanced technology learning, including long term impact on student achievement and motivation.

REFERENCES

Amihan, S. R., & Sanchez, R. D. (2023). Connecting Workplace Literacy Gaps through Innovative Academe-Industry Collaboration. *International Journal of Open-access, Interdisciplinary and New Educational Discoveries of ETCOR Educational Research Center (iJOINED ETCOR),* 2(2), 515-528.

International Journal of Engineering, Industrial, Maritime, and Technological Innovation (INJENI)
P - ISSN: 3116-3807
E - ISSN: 3116-3815
PRC-CPD Accredited Provider: PTR-2025-749
NBDB Registration Book Publisher (Print & Digital): 0372

Amihan, S. R., Sanchez, R. D., & Carvajal, A. L. P. (2023). Sustained quality assurance: Future-proofing the teachers for an ASEAN higher education common space. *International Journal of Open-access, Interdisciplinary and New Educational Discoveries of ETCOR Educational Research Center (iJOINED ETCOR),* 2(4), 276-286. https://etcor.org/storage/iJOINED/Vol.%20II(4),%20276-286.pdf

Bybee, R. W. (2013). *The case for STEM education: Challenges and opportunities*. National Science Teachers Association Press. https://doi.org/10.5281/zenodo.7945344

Carvajal, A. L. P., & Sanchez, R. D. (2023). Strategic Considerations, Challenges, and Opportunities in Establishing the International Journal of Open-access, Interdisciplinary, and New Educational Discoveries (iJOINED). *International Journal of Open-access, Interdisciplinary and New Educational Discoveries of ETCOR Educational Research Center (iJOINED ETCOR),* 2(2), 539-546.

Carvajal, A. L. P., Fernandez, T. M., Pangilinan, A. M., Obod, M. M., Amihan, S. R., Sanchez, R. D., Sanchez, A. M. P., Sanchez, J. J. D. (2025). Future-Proofing Teachers in Reframing Teacher Education Curriculum in the Philippines: Basis for Policy Recommendations. *International Journal of Open-access, Interdisciplinary and New Educational Discoveries of ETCOR Educational Research Center (iJOINED ETCOR)*, 4(2), 235-252. https://doi.org/10.63498/nxz2st271

Carvajal, A. L. P., Bondoc, B., & Sanchez, R. D. (2025). From Stigma to Self-Expression: Uncovering the Motivations and Symbolic Meanings of Tattoos in Modern Society. *International Journal of Open-access, Interdisciplinary and New Educational Discoveries of ETCOR Educational Research Center (iJOINED ETCOR)*, 4(2), 446-464. https://doi.org/10.63498/etcor288

Kirkwood, A. & Price, L., (2013). *Using technology for teaching and learning in higher education: A critical review of the role of evidence in informing practice*. The Open University / University of Bedfordshire. https://doi.org/10.1080/07294360.2013.841643

OECD. (2019). *Trends Shaping Education 2019*. OECD Publishing. https://fundaciobofill.cat/uploads/docs/7/a/4/0/g/n/1/p/h/trendsshapingeducation_traceyburns_fjb_4-juliol-2013.pdf

Pangilinan, A. M. (2025). Challenges and Commitment to Teaching: A Quantitative Descriptive-Correlational Study of Filipino Teachers in Select Coastal Villages. *International Journal of Open-access, Interdisciplinary and New Educational Discoveries of ETCOR Educational Research Center (iJOINED ETCOR)*, 4(2), 1684-1692. https://doi.org/10.63498/etcor397

Sanchez, Richard D. (2025). *Embracing the culture of research with Dr. Richard D. Sanchez: Research from the lens of the founder*. ETCOR Educational Research Center Research Consultancy Services. https://doi.org/10.63498/book309

UNESCO. (2021). *ICT in Education: A Global Perspective*. Paris: UNESCO Institute for Statistics. https://doi.org/10.20429/ijsotl.2019.130310