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Information and Communication Technology Processing Skills of Elementary School Teachers

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***Abstract*: Information and Communication Technology (ICT) can be utilized in the education sector. Education includes online, distance, and part-time learning. There are countless applications of ICT in the real world. Several studies have measured ICT competencies from the perspective of ICT self-efficacy. However, such indirect measurements tend to have validity issues because they rely on individuals' ability to accurately assess their own ICT competence. This study focuses on teachers' basic ICT processing skills and examines how these relate to their teaching experience. Specifically, it explores teachers' capabilities in using computers, communication skills, information-gathering skills, background knowledge of ICT, and familiarity with basic Microsoft Office applications and related technologies. This study also aims to highlight teachers' experiences in using ICT, the materials and tools they utilize in teaching, and the insights and values they possess in implementing ICT integration and promoting diversity in teaching various subjects. A 65-item survey questionnaire was administered to 100 elementary school teachers. The survey items were adapted from a validated questionnaire developed by previous researchers and used internationally. The items were selected based on the teachers' levels of experience and were answered honestly by the respondents. The questionnaire items were equally distributed to evaluate teachers' basic ICT processing skills. Furthermore, the results indicate that the instrument is particularly reliable for measuring median ability levels. Recommendations for refinement and directions for future research are also discussed.**

***Keywords*: Information and Communication Technology (ICT), ICT Competencies, Teachers', Basic Processing Skills, ICT Integration and Teaching Experience.**

1. Introduction

Despite the growing importance of Information and Communication Technology (ICT) in education and the increasing demand for technology-integrated instruction, there remains a need to assess the ICT competencies of elementary school teachers, particularly in the area of basic Microsoft Office applications and their utilization in teaching. While teachers are expected to integrate technology into classroom instruction, variations in their background knowledge, computer skills, familiarity with Microsoft Office applications, online communication skills, and information competency skills may affect the effectiveness of ICT integration. Furthermore, teaching experience and exposure to ICT-related training may influence teachers' competence and confidence in utilizing technology for educational purposes. Therefore, this study seeks to assess the Information and Communication Technology processing skills of elementary school teachers in Olongapo City Elementary Schools and examine their relationship with teachers' experiences in ICT integration. Specifically, the study aims to determine the teachers' demographic profile in terms of age, gender, position, years of teaching experience, educational attainment, and ICT-related seminars or training attended; assess their ICT skills and competencies; describe their experiences with ICT teaching, ICT materials provided by the Department of Education, and their insights and values toward ICT integration; determine whether a significant relationship exists between ICT processing skills and teaching experience; and propose an intervention plan to further enhance the ICT competencies of elementary school teachers.

2. Methodology

A. Research Design

This study employed a descriptive-correlational survey research design to assess the Information and Communication Technology (ICT) competencies of elementary school teachers in Olongapo City and determine the relationship between their ICT processing skills and teaching experience. A survey questionnaire served as the primary instrument for data collection. The descriptive component of the study was used to determine the respondents' demographic profile, ICT competencies, and experiences in utilizing ICT in teaching. Specifically, it described teachers' background knowledge in computers, computer skills, familiarity with Microsoft Office applications, online communication skills, information competency skills, and their experiences with ICT integration in the classroom. The correlational component was utilized to examine the relationship between teachers' ICT processing skills and their teaching experiences. This approach enabled the researcher to identify whether significant associations existed among the variables under investigation. A structured questionnaire was administered to the respondents to gather the necessary data. The collected data were analyzed using appropriate descriptive and inferential statistical techniques to answer the research questions and achieve the objectives of the study.

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B. Respondents and Location

The study was conducted at Olongapo City Elementary School, located along Rizal Avenue in Barangay West Bajac-Bajac, Olongapo City. The school is considered the largest elementary school in Olongapo City and is classified under the Mega School category. Formerly known as Bajac-Bajac Elementary School from 1945 to 1979, it was renamed Olongapo City Elementary School on November 6, 1979, following the establishment of public schools in the eastern and western barangays of the city.

The respondents of the study consisted of one hundred (100) elementary school teachers employed at Olongapo City Elementary School during the first quarter of School Year 2019–2020. A total population sampling technique, also known as universal sampling, was utilized in the selection of respondents. Under this approach, all teachers in the target population were included in the study, ensuring comprehensive representation and providing sufficient data for the analysis and interpretation of the variables under investigation.

C. Instrument

The instrument used in this study was an adapted questionnaire based on the study of Reyes (2017) on the Information Literacy Competence of Learners in an Elementary School. The original questionnaire was developed at Concordia University to assess computer-related skills and competencies.

For the purposes of this study, the instrument was modified to suit the context of elementary school teachers and to assess their Information and Communication Technology (ICT) processing skills. The questionnaire served as the primary tool for evaluating teachers' computer skills, familiarity with Microsoft Office applications, online communication abilities, and information competency skills. The adapted instrument was utilized as a standardized measure of teachers' ICT competence and literacy.

D. Data Collection

In order to achieve the goal of this study, a floating questionnaire was used to gather the needed data from the respondents. A letter from the researcher requesting permission was submitted to the Schools Division Superintendent for approval to administer the instrument to the target respondents, as well as a separate letter to the Principal of Olongapo City Elementary School where the questionnaire was conducted.

The researcher personally administered the instrument to the respondents after the approval of the Schools Division Superintendent and the school principal. The researcher instructed the teacher-respondents regarding the proper way of accomplishing the questionnaire. The researcher also conducted informal interviews regarding the study immediately after the instrument was administered. Unstructured observation was likewise conducted in order to identify teachers who experience difficulties with the use of technology in this generation.

3. Result and Discussion

A. Teachers' Background Knowledge in Computer

Table 1 shows the distribution of ICT skills and competence of elementary teachers. The teachers demonstrated understanding of file extensions and differences between file types (e.g., .doc, .exe, .gif, .ppt, .mp3, etc.), with a weighted mean of 3.00 and a descriptive rating of Good. They also understand the difference between closing, minimizing, hiding windows, and quitting a program, with a weighted mean of 3.12 and a descriptive rating of Good.

In addition, respondents are familiar with the use of mouse right-click menu functions, with a weighted mean of 2.63 and a descriptive rating of Good. The ability to shut down a computer appropriately obtained the highest weighted mean of 3.77 and a descriptive rating of Proficient. On the other hand, the lowest indicator was using help menus to find answers to questions, with a weighted mean of 2.22 and a descriptive rating of Basic.

Overall, the teachers' background knowledge in computer obtained a weighted mean of 2.95 with a descriptive rating of Good. According to Williams (2003), understanding teachers' ICT skills and knowledge is important in identifying their training needs and planning appropriate professional development programs to enhance their competence.

B. Teachers' Computer Skills

Table 2 shows the distribution of computer skills of elementary teachers. The teachers demonstrated proficiency in organizing, copying, and pasting files (M = 3.85), organizing files into folders and subfolders (M = 3.70), and moving unwanted files to the recycle bin and permanently deleting them

Table 1
Teachers' background knowledge in computer

Teachers background knowledge in Computer	**WX**	**DR**
1. Understand files extensions and differences between files types (ex. .doc, .exe, .gif, .ppt, .mp3, etc.)	3.00	Good
2. Understand the difference between closing/minimizing/hiding windows and quitting program.	3.12	Good
3. Use the mouse right-click menu functions.	2.63	Good
4. Shut down a computer appropriately.	3.77	Proficient
5. Use help menus to find answers to my questions.	2.22	Basic
Overall Weighted Mean	**2.95**	**Good**

Table 2
ICT skills and competence of teachers as to computer skills

Teachers Computer Skills	**WX**	**DR**
1. Navigate through files and directions.	3.39	Good
2. Organize copy and paste files in directions.	3.85	Proficient
3. Move unwanted files into my recycle bin and delete them permanently from my hard drive.	3.52	Proficient
4. Organize computer files in folders and subfolders.	3.70	Proficient
5. Download and install software on a computer.	2.01	Basic
Overall Weighted Mean	**3.29**	**Good**

(M = 3.52), all rated as Proficient. They also showed ability in navigating through files and directories (M = 3.39), rated as Good. However, downloading and installing software on a computer ranked lowest among the indicators (M = 2.01), rated as Basic.

Overall, the teachers' computer skills obtained a weighted mean of 3.29, described as Good.

C. Teachers' Familiarity in Microsoft Processing Skills

Table 3 shows the distribution of teachers' familiarity in Microsoft Processing skills among elementary teachers. The teachers demonstrated highest proficiency in saving, printing, and previewing documents (M = 4.46, Expert), followed by producing text using a word processing program (M = 4.43, Expert). They also showed proficiency in using undo/redo functions (M = 3.67, Proficient). In contrast, changing printer settings such as page numbers, orientation, margins, and proportions ranked lower (M = 2.72, Good), while the use of spreadsheets ranked lowest among the indicators (M = 2.11, Basic).

Overall, the teachers' familiarity in Microsoft Processing Skills obtained a weighted mean of 3.45, described as Proficient.

D. Teachers' Online Communication Skills

Table 4 shows the distribution of online communication skills of elementary teachers. The teachers demonstrated highest proficiency in participating in social networking sites (M = 4.51, Expert), followed by using basic browser commands to surf the internet (M = 4.16, Proficient). They also showed good ability in using search engines to locate desired information (M = 3.37) and attaching or detaching documents to and from email messages (M = 3.30), both rated as Good. In contrast, composing, sending, receiving, replying to, and forwarding email messages obtained a weighted mean of 2.96 (Good), while requesting and activating an email account ranked lower (M = 2.48, Basic). Creating or maintaining blogs or websites ranked lowest among the indicators (M = 1.67, Poor).

Overall, the teachers' online communication skills obtained a weighted mean of 3.16, described as Good.

E. Information Competency Skills of Teachers

Table 5 shows the distribution of information competency skills of elementary teachers. The teachers demonstrated highest proficiency in using information effectively to accomplish a specific purpose (M = 4.52, Expert), followed by critically evaluating information and information sources (M = 4.23, Expert). They also showed proficiency in understanding

Table 3
Teachers' familiarity in Microsoft processing skills

Familiarity in Microsoft Processing Skills	**WX**	**DR**
1. Edit, copy, cut and paste a block of text or selected objects.	3.77	Proficient
2. Use undo/redo function.	3.67	Proficient
3. Save, print and preview documents.	4.46	Expert
4. Select and changes font sizes and types, style (ex. Boldface, italic, underlining, etc.)	3.77	Proficient
5. Create itemized list (ex. Bulleted format)	3.48	Proficient
6. Produce a text using a word processing program.	4.43	Expert
7. Use a spreadsheet (ex. Excel)	2.11	Basic
8. Create a presentation with simple animation functions.	3.21	Good
9. Create a presentation with video or audio clips.	2.84	Good
10. Change printer parameters like page numbers, paper orientation, margins and proportions, etc.	2.72	Good
Overall Weighted Mean	**3.45**	**Proficient**

Table 4
Teachers' online communication skills

Online Communication Skills	**WX**	**DR**
1. Use the browser basic commands to surf the internet.	4.16	Proficient
2. Request and activate my email account.	2.48	Basic
3. Compose, send, receive, reply to and forward email messages.	2.96	Good
4. Attach/detach documents to/from email messages.	3.30	Good
5. Used search engines to locate desired information.	3.37	Good
6. Understand the difference between search engines (ex. Google) and directories (ex. Yahoo)	3.24	Good
7. Participate in social network.	4.51	Expert
8. Understand how I can use gathered information from the internet without violating copyright laws.	3.11	Good
9. Create or maintain blogs or web sites.	1.67	Poor
10. Use basic steps to ensure online privacy and computer security.	2.81	Good
Overall Weighted Mean	**3.16**	**Good**

Table 5
Information competency skills of teachers

Information Competency Skills of Teachers	**WX**	**DR**
1. Determine the nature and the extent of the information I need for writing assignments.	3.97	Proficient
2. Access needed information effectively and efficiently using library information resources in addition to standard internet search engines.	3.53	Proficient
3. Critically evaluate information and information sources.	4.23	Expert
4. Use information effectively to accomplish a specific purpose.	4.52	Expert
5. Understand many of the economic, legal and social issues surrounding the use of the information and access and use information ethically and legally.	4.03	Proficient
Overall Weighted Mean	**4.06**	**Proficient**

the economic, legal, and social issues surrounding information use and in accessing and using information ethically and legally (M = 4.03, Proficient), as well as in determining the nature and extent of information needed for writing assignments (M = 3.97, Proficient). Accessing needed information effectively and efficiently using library resources and standard internet search engines ranked lowest (M = 3.53, Proficient).

Overall, the teachers' information competency skills obtained a weighted mean of 4.06, described as Proficient.

F. Experience with ICT Teaching

Table 6 shows the distribution of teachers' experiences in ICT teaching among elementary teachers. The teachers reported highest usage of computers and/or the internet for preparing lessons (M = 4.61, Always Agree). They also indicated frequent use of ICT for allowing pupils to search the internet for their requirements (M = 4.18, Most of the Time Agree) and using computers and/or the internet in class instruction (M = 3.62, Most of the Time Agree). In contrast, allowing pupils to submit requirements through email (M = 1.84, Rarely Agree) and using social networking sites for submitting requirements (M = 1.88, Rarely Agree) were the least practiced ICT-related activities.

Overall, the teachers' experience with ICT teaching obtained a weighted mean of 3.23, described as Sometimes Agree.

G. Experience in ICT Materials

Table 7 shows the distribution of teachers' experience in using ICT materials among elementary teachers. The teachers reported highest engagement in preparing exercises and tasks for pupils (M = 4.81, Always Agree), followed by communicating online with parents (M = 4.53, Always Agree). They also frequently browse or search the internet to collect learning materials for use during lessons (M = 3.43, Most of the Time Agree), and download or upload materials from educational websites (M = 3.87, Most of the Time Agree). In contrast, creating digital learning materials (M = 1.87, Rarely Agree) and using ICT to provide feedback and assess pupils' learning (M = 1.48, Never Agree) ranked among the lowest indicators. The use of applications for preparing presentations also received a low rating (M = 2.30, Rarely Agree).

Overall, the teachers' experience in ICT materials obtained a weighted mean of 3.23, described as Sometimes Agree.

H. Insights and Values of Teachers towards ICT Teaching

Table 8 shows the distribution of teachers' insights and values towards ICT teaching among elementary teachers. The teachers strongly believed that pupils understand more easily what they learn (M = 4.66, Always Agree), followed by the belief that pupils concentrate more on their learning (M = 4.62, Always Agree) and that ICT enhances motivation and achievement (M = 4.57, Always Agree). They also agreed that ICT improves collaboration among pupils (M = 3.71, Most of the Time Agree), enhances class climate (M = 3.94, Most of the Time Agree), and supports higher-order thinking skills (M =

Table 6
Experience with ICT teaching

Experience with ICT teaching	**WX**	**DR**
1. I use computers and/or the internet for preparing my lessons?	4.61	Always Agree
2. I use computers and/or the internet in my class?	3.62	Most of the time agrees
3. I use social networking sites in giving my pupils requirements (ex. Homework)?	1.88	Rarely agree
4. I let my pupils pass their requirements through emails (ex. Power point presentation?	1.84	Rarely agree
5. I let my pupils search the internet to meet their requirements?	4.18	Most of the time agrees
Overall Weighted Mean	**3.23**	**Sometimes agree**

Table 7
Experience in ICT materials

Experience with the ICT materials	**WX**	**DR**
1. I browse/search the internet to collect information to prepare my lessons.	4.26	Always Agree
2. I browse or search the internet to collect learning material resources to be used by pupils during lessons.	3.43	Most of the time agrees
3. I use applications to prepare presentations on the lessons.	2.30	Rarely agree
4. I create my own digital learning materials for pupils.	1.87	Rarely agree
5. I prepare exercises and tasks for pupils.	4.81	Always Agree
6. I use ICT to provide feedback and/or assess pupils' learning.	1.48	Never agree
7. I communicate online with parents.	4.53	Always Agree
8. I download/upload/browse material from educational sources or websites.	3.87	Most of the time agrees
9. I look for online professional development opportunities.	2.70	Sometimes agree
10. I use existing online materials from established educational sources when teaching.	3.05	Sometimes agree
Overall Weighted Mean	**3.23**	**Sometimes agree**

Table 8
Insights and values of teachers towards ICT teaching

Insights and values of teachers towards ICT Teaching	**WX**	**DR**
1. ICT use in teaching and learning is essential to prepare pupils to live and work in the 21st century.	3.96	Most of the time agrees
2. For ICT to be fully exploited for teaching and learning radical changes in schools are needed.	3.20	Sometimes agree
3. Pupils concentrate more on their learning.	4.62	Always Agree
4. Pupils understand more easily what they learn.	4.66	Always Agree
5. Pupils remember more easily what they have learnt.	4.07	Most of the time agrees
6. ICT facilities collaborative work between pupils.	3.71	Most of the time agrees
7. ICT improves the class climate (pupils more engaged, less disturbing).	3.94	Most of the time agrees
8. Motivation and achievement	4.57	Always Agree
9. Higher order thinking skills critical thinking, analysis, problem solving	4.14	Most of the time agrees
10. Competence in transversal skills (learning to learn, social competence, etc.)	4.05	Most of the time agrees
Overall Weighted Mean	**4.09**	**Most of the time agrees**

Table 9
Relationship between Information and Communication Technology (ICT) processing skills and teaching experience of the respondents

Source of Correlation	r_{xy}	Interpretation	Sig. (2-tailed)	Decision
ICT skills and Competence Teaching experience	0.16	Negligible Correlation	0.112	Not Significant Accept H_0

4.14, Most of the Time Agree), as well as transversal skills development (M = 4.05, Most of the Time Agree). In contrast, the need for radical school changes for ICT integration ranked lowest among the indicators (M = 3.20, Sometimes Agree).

Overall, the teachers' insights and values towards ICT teaching obtained a weighted mean of 4.09, described as Most of the Time Agree.

I. Relationship between Information and Communication Technology (ICT) Processing Skills and Teaching Experience of the Respondents

Table 9 presents the relationship between ICT processing skills and teaching experience of the respondents. The computed Pearson correlation coefficient shows a negligible positive relationship (r = 0.16, p = 0.112). Since the p-value is higher than the 0.05 level of significance, the relationship is not statistically significant. Thus, the null hypothesis is accepted, indicating that there is no significant relationship between ICT skills and teaching experience among the respondents.

4. Conclusion and Recommendation

The findings of this study provide evidence on the ICT competence, teaching experience, and perceptions of elementary school teachers in relation to technology integration in instruction. Overall, the results indicate that while teachers demonstrate a generally good to proficient level of ICT skills, the actual integration of ICT into teaching practices remains moderate, suggesting a gap between competence and classroom application.

In terms of ICT skills and competence, teachers showed stronger performance in Microsoft Processing Skills and Information Competency Skills, both rated as Proficient. This suggests that teachers are relatively confident in performing productivity-related and information-processing tasks, such as document preparation, information evaluation, and data handling. However, skills related to computer operations and online communication were only rated as Good, indicating that foundational technical skills and digital communication practices are less developed compared to productivity-based competencies. This pattern reflects a common trend in ICT integration literature, where teachers tend to perform better in application-based tasks than in more technical or infrastructure-related ICT functions.

Regarding teaching experience with ICT, the results reveal that teachers frequently use ICT for lesson preparation and instructional support, particularly in accessing online resources and preparing instructional materials. However, low engagement was observed in more advanced pedagogical uses of ICT, such as digital assessment, online submission of requirements, and creation of digital learning materials. This suggests that ICT use among teachers is still largely supportive rather than transformative, aligning with earlier findings that technology is often used to enhance traditional instruction rather than redesign pedagogical practices.

Furthermore, teachers demonstrated highly positive perceptions of ICT, particularly in terms of its perceived benefits for student understanding, motivation, and engagement. Despite this strong positive disposition, the relatively lower implementation levels indicate a disconnect between beliefs and actual instructional practices. This gap may be attributed to limited ICT training exposure, insufficient infrastructure support, or lack of sustained professional development opportunities.

The non-significant relationship between ICT processing skills and teaching experience further suggests that length of service does not necessarily translate to higher ICT competence. This finding supports the view that ICT proficiency is more closely linked to targeted training and exposure rather than teaching tenure alone. Consequently, continuous professional development is essential in ensuring that teachers remain capable of integrating evolving technologies into their teaching practice.

Based on the findings, the study concludes that elementary teachers possess a moderate to high level of ICT competence, with stronger skills in Microsoft applications and information literacy compared to basic computer operations and online communication tools. While teachers demonstrate positive attitudes and strong beliefs regarding the benefits of ICT in teaching and learning, their actual classroom application remains limited and primarily focused on basic instructional support.

The study also concludes that teaching experience is not a determining factor of ICT competence, as no significant relationship was found between ICT processing skills and years of teaching. This highlights the importance of structured ICT training programs rather than reliance on experience alone to enhance digital competence.

Overall, the findings suggest the need for sustained and targeted professional development programs that focus on bridging the gap between ICT knowledge, skills, and classroom integration. Strengthening teachers' technical skills, expanding their pedagogical use of ICT, and enhancing digital assessment practices are essential steps toward achieving more meaningful and transformative ICT integration in elementary education.

References

[1] R. D. Alvisado, "Inquiry-based flipped learning and its effects on senior high school students' critical thinking and conceptual understanding in Chemistry," *Philippine Journal of Education Studies*, vol. 14, no. 1, pp. 45–60, 2022.

[2] R. L. D. Cagas and J. E. Salvaña, "The effectiveness of flipped classroom model in teaching research in higher education," *American Journal of Educational Research*, vol. 13, no. 9, pp. 547–556, 2025.

[3] F. Chen, A. M. Lui, and S. M. Martinelli, "A systematic review of the effectiveness of flipped classrooms in medical education," *Medical Education*, vol. 53, no. 6, pp. 585–597, 2019.

[4] J. W. Creswell and J. D. Creswell, *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*, 5th ed. Thousand Oaks, CA, USA: SAGE Publications, 2018.

[5] Department of Education, *Strengthened Senior High School Curriculum Framework*. Manila, Philippines: DepEd Philippines, 2025.
[6] L. De Vera and L. Cabigon, "Impact of flipped learning on senior high school students' engagement and science performance," *Asia Pacific Journal of Education Research*, vol. 3, no. 2, pp. 112–126, 2021.
[7] C. Donohue and L. Bornfreund, "Modern instructional strategies for 21st-century classrooms," *Journal of Digital Learning*, vol. 9, no. 3, pp. 210–225, 2023.
[8] N. Foldnes, "The flipped classroom and cooperative learning: Evidence from a randomized experiment," *Active Learning in Higher Education*, vol. 20, no. 1, pp. 39–50, 2017.
[9] J. R. Fraenkel, N. E. Wallen, and H. H. Hyun, *How to Design and Evaluate Research in Education*, 10th ed. New York, NY, USA: McGraw-Hill Education, 2019.
[10] S. Freeman, S. L. Eddy, M. McDonough, M. K. Smith, N. Okoroafor, H. Jordt, and M. P. Wenderoth, "Active learning increases student performance in science, engineering, and mathematics," *Proc. Natl. Acad. Sci.*, vol. 111, no. 23, pp. 8410–8415, 2014.
[11] P. C. Fulgueras and R. V. Bautista, "Flipped classroom: Its effects on ESL learners' critical thinking and reading comprehension levels," *Int. J. English Lang. Teach.*, vol. 8, no. 4, pp. 35–50, 2020.
[12] A. Gillette *et al*., "Enhancing higher-order thinking through flipped instruction in university science courses," *Journal of Science Education*, vol. 25, no. 3, pp. 189–204, 2018.
[13] K. F. Hew and C. K. Lo, "Flipped classroom improves student learning in health professions education: A meta-analysis," *BMC Medical Education*, vol. 18, no. 1, Art. no. 38, 2018.
[14] I. Y. Kazu and M. Kurtoğlu Yalçın, "Effectiveness of flipped learning: A meta-analytic review," *Educational Research Review*, vol. 37, 2022.
[15] B. Kim and T. Reeves, "The effects of enhanced instructional design on student performance: A comparative study," *Journal of the Learning Sciences*, vol. 30, no. 4, pp. 512–533, 2021.
[16] R. Luna, J. Romero, A. Cusi, D. Jarapa, and H. Kusuma, "Flipped classroom approach for enhancing vocabulary skills among senior high school students in the Philippines," *Journal of Language Teaching Innovations*, vol. 7, no. 1, pp. 54–69, 2025.
[17] P. Strelan, A. Osborn, and E. Palmer, "The flipped classroom: A meta-analysis of effects on student performance across disciplines," *Educational Research Review*, vol. 30, Art. no. 100314, 2020.
[18] D. C. D. Van Alten, C. Phielix, J. Janssen, and L. Kester, "Effects of flipping the classroom on student learning outcomes: A three-level meta-analysis," *Educational Research Review*, vol. 28, Art. no. 100281, 2019.
[19] M. ZainalVillalobos, "Enhancing analytical thinking through flipped teaching in General Physics," *Manila Journal of Science Education*, vol. 10, no. 1, pp. 33–47, 2022.
[20] N. Zainal Abidin, M. Benić, and Y. Asefuaba, "Flipped classroom impact on student learning performance: A systematic review," *Journal of Learning Analytics*, vol. 11, no. 2, pp. 65–82, 2024.
[21] Q. Zhang, E. S. T. Cheung, and C. S. T. Cheung, "The impact of flipped classroom on college students' academic performance: A meta-analysis," *Science Insights Education Frontiers*, vol. 8, no. 2, pp. 835–856, 2021.