INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY: APPLIED BUSINESS AND EDUCATION RESEARCH
2026, Vol. 7, No. 7, 3148 – 3155
http://dx.doi.org/10.11594/ijmaber.07.07.20

Research Article

Teachers' Utilization and Challenges of ICT-Enabled Inquiry in Physics Education

Renalyn V. Perez*, Marc Paul T. Calzada, Rhea M. Cabrera

Mariano Marcos State University, Philippines

Article history:
Submission 12 April 2026
Revised 14 July 2026
Accepted 23 July 2026

**Corresponding author:*
E-mail:
renalynperez901@gmail.com

ABSTRACT

Information and Communication Technology (ICT) has become increasingly important in science education, particularly in supporting Inquiry-Based Learning (IBL) in physics, where learners often encounter difficulties in understanding abstract concepts. This study examined the ICT tools utilized by junior high school physics teachers and the challenges they encountered in implementing inquiry-based learning in the Schools Division of Ilocos Norte, Philippines (SDOIN).

The study employed a descriptive-quantitative research design with qualitative support. Using non-probability purposive sampling, 126 junior high school physics teachers from selected public schools participated in the study, while 25 teachers were interviewed to provide qualitative insights. Data were collected using a researcher-developed survey questionnaire and an expert-validated semi-structured interview guide. Frequency counts and percentages were used to describe the participants' profiles, while mean and ranking were employed to analyze ICT utilization. Qualitative responses were analyzed using thematic analysis.

The findings showed that the most used ICT tools were those that were easily accessible such as multimedia presentation with the use of projector, digital camera or mobile phone, and virtual laboratory or simulation. But the overall use of ICT in inquiry-based learning was found to be moderate. The thematic analysis showed that the use of ICT in inquiry was hindered by time constraints, lack of resources and infrastructural capacity, low readiness of the learners for inquiry, diversity and participation of learners, and communication. These findings highlight the need for targeted professional development, improved access to instructional resources, and stronger institutional support to enhance the implementation of ICT-enabled inquiry in physics education.

Keywords: *inquiry-based learning, ICT integration, digital pedagogy, instructional challenges*

How to cite:
Perez, R. V., Calzada, M. P. T., & Cabrera, R. M. (2026) Teachers' Utilization and Challenges of ICT-Enabled Inquiry in Physics Education. *International Journal of Multidiciplinary: Applied Business and Education Research 7*(7), 3148 – 3155. doi:10.11594/ijmaber.07.07.20

Introduction

Over the last decade, international efforts to reform science education have moved away from traditional science instruction based on facts to inquiry-driven and application-oriented learning. This shift has led to the rapid rise in the use of Information and Communication Technology (ICT) in science education because these technologies can engage learners in learning processes which are immersive, interactive, and personalized. ICT has now become an integral part of science instruction in general and has also been incorporated into the Philippines' core science curricula.

Due to the complex mathematical and abstract nature of physics, understanding its concepts remains challenging for many high school learners. Even with considerable effort, science teachers continue to observe significant gaps in learners' understanding of fundamental physics concepts (Pineda, 2020).

As physics concepts frequently require learners to visualize unseen phenomena and link top-level abstract theory to lower-level observable behaviours, Inquiry-Based Learning (IBL) offers a way to bridge theory, practice and a learners' sense-making of these concepts and processes in a more effective way than through rote or passive approaches (Alarcon et al., 2023). Hence, IBL provides learners with opportunities to ask questions, explore and investigate phenomena, analyse and interpret data, and create explanations, which are similar to the processes used in real-world scientific endeavours as well as how physics is studied as an academic discipline (Strat et al., 2023).

Through inquiry-based learning, ICT has develop abilitiy to visualize abstract concepts, manipulate variables, and test out new ideas in science that would otherwise be impossible in a fixed setting. As a result, physics classrooms are increasingly using digital tools such as computer simulations and instructional videos to enhance the teaching of physics by helping to improve understanding of difficult physics concepts and allow learners to learn interactively. Studies have also shown that virtual simulations lead to opportunities to learn through experience in innovative ways; meanwhile, technology-supported inquiry learning promotes and motivates learners to research concepts more thoroughly and become engaged in science (Abiasen & Reyes, 2021; Makamu & Ramnarain, 2022).

The emerging trend toward inquiry-based teaching in the science classroom is not only gaining momentum all over the world but is also reflected in recent curriculum developments in the Philippines. Recognizing the need to develop scientifically literate learners equipped with critical thinking, problem-solving, and technological competencies, the Department of Education (DepEd) has progressively shifted toward learner-centered and inquiry-driven instruction. Evidence of this shift can be found in the K to 12 Science Curriculum and in the MATATAG Curriculum, which position scientific inquiry as the primary method by which learners build evidence-based explanations for the world around them, develop their own explanations, and apply scientific knowledge to authentic contexts. These national curriculum initiatives, aligned with globally recognized inquiry-based learning frameworks, reinforce the relevance of ICT-supported IBL in physics education and underscore the importance of examining how teachers implement these approaches in classroom practice.

While these curriculum reforms actually have potential to assist inquiry-based learning with the help of ICT, implementation of these tools in a classroom is sporadic. The literature available shows that most teachers generally use only a few familiar traditional digital tools such as PowerPoint presentations, videos, projectors, etc. and do not use any advanced or sophisticated emerging technology that could be helpful in enabling inquiry-based learning (Hinostroza et al., 2024).

A systematic review on using digital technology for inquiry-based learning indicates that the most widely used technologies in schools are still traditional, which shows that technology can be used more extensively for ICT-enabled opportunities (Hinostroza et al., 2024). Similarly, studies on technology use in science education shows that the implementation of Inquiry-based learning in physics (or any other content area) has been limited by many contextual factors including a shortage of resources and infrastructure, and also the level of teacher readiness varies considerably (Rosli & Ishak, 2024). In the context of Physics education, inquiry-based instructional methods require a flexible pedagogy as well as appropriate digital technologies and laboratory resources.

In the Schools Division of Ilocos Norte, efforts to strengthen technology-enhanced instruction have been reinforced through division-wide initiatives that promote ICT integration and teacher capacity building. Among these is the Technology Fortified 8K Initiatives, which promotes ICT integration through smart classrooms, multimedia applications, learning management systems, and continuous ICT training towards the implementation of the DepEd Computerization Program and the MATATAG Curriculum. All these initiatives have placed the Schools Division of Ilocos Norte in a good position as an appropriate setting to study ICT-supported inquiry-based instruction. Nevertheless, the use of ICT in inquiry-based physics lessons is not yet well documented. There is insufficient empirical data on what ICT tools are used by the Junior High School (JHS) teachers and the challenges associated with implementing inquiry-based instruction using ICTs.

Although numerous studies have demonstrated the value of ICT in supporting inquiry-based science instruction, most of the existing literature has concentrated on the effectiveness of one particular kind of technology, such as simulations or virtual laboratories or the use of technology integration in science education overall. Very little has been written about the ways in which teachers make use of different kinds of ICT tools in their practice of inquiry-based teaching of physics and the difficulties they face. This gap is particularly evident in localized Philippine contexts, where evidence specific to junior high school physics teachers remains limited. In the Schools Division of Ilocos Norte, there is still a need for empirical data on the ICT tools teachers use in implementing inquiry-based learning and the constraints that shape their classroom practice. Addressing this gap may provide a more grounded understanding of ICT-enabled inquiry in physics education and inform context-responsive instructional support and professional development.

Methods

This section presents the research design, participants, sampling procedure, research instrument, data collection procedures, and data analysis techniques employed in the study.

Research Design

This study employed a descriptive-quantitative research design with qualitative support. The quantitative component was used to describe the profile of junior high school physics teachers of the Schools Division of Ilocos Norte (SDOIN) and determine the ICT tools they utilized in implementing inquiry-based learning (IBL). The qualitative component, on the other hand, was used to examine the challenges teachers encountered through their open-ended responses.

Population and Sampling

This study employed non-probability purposive sampling, targeting 126 JHS Physics teachers from Grades 7 to 10 in the 54 selected public schools under the SDOIN. In the study, 126 JHS Physics teachers answered the survey questionnaire and 25 Physics teachers were selected for the one-on-one interview done through face-to-face and Google meet depending on the teachers' preference and available time.

Selection was based on predefined criteria to ensure that the participants were directly relevant to the study's focus on IBL in physics education. Specifically, only teachers with at least one year of experience in teaching physics will be considered as participants in the study. Participants must have demonstrable experience in implementing inquiry-based learning (IBL) in their teaching practice for a minimum of six months in physics instruction, having participated in relevant professional development or training on IBL, and/or having been involved in IBL-related projects, or action research at the school, division, or regional level should be considered eligible and included as qualified participants. These criteria will be clearly communicated to potential participants to ensure that only qualified individuals who can provide informed and relevant insights are included.

Meanwhile, teachers will be excluded if they are on leave, have no teaching load, and are assigned exclusively to senior high school levels or non-physics subjects. Additionally, teachers without experience in implementing IBL, such as those who have not undergone any relevant training, have not integrated IBL into their instruction, or have no involvement in IBL projects will also be excluded. This strategy is to ensure the study remains accurate and avoids including participants who cannot provide useful information for the research goals.

Research Instrument

This study utilized two research instruments to collect both quantitative and qualitative data: a survey questionnaire for physics teachers and an interview guide to explore their experiences with inquiry-based learning (IBL). The survey questionnaire consisted of two parts, with researcher-developed items. Part I was a researcher-made section that gathered data on the personal and professional profiles of the physics teachers, including teaching experience, highest educational attainment, and relevant training. Part II identified the instructional technologies currently used to support IBL in physics instruction. Lastly, the researcher-developed interview guide was semi-structured and designed to gain in-depth qualitative insights into teachers' challenges with IBL implementation in the classroom. All research instruments used were subjected to expert validation.

Data Collection Procedure

Proper procedures were strictly adhered to in gathering the data. The whole process of data gathering was done in just one month from November to December, 2025, A.Y. 2025-2026.

Firstly, the researchers have secured the consent of the Mariano Marcos State University Research Ethics Review Board (MMSU-URERB) regarding the ethical rights of the participants of the study. After securing the ethical clearance, the researchers then asked for the permission of the Department of Education – Schools Division of Ilocos Norte to conduct the research.

The validated questionnaires were then administered physically using printed copies to 126 physics teachers from the 54 public JHS. The respondents were given about five (5) minutes to answer the questionnaires. After conducting the surveys, 25 Physics teachers were chosen for the conduct of the one-on-one interviews. The researcher explained the rationale behind the interviews, obtained their consent, and made sure that the interview was done physically or using Google Meet, depending on the respondent's preference. A set of open-ended questions contained in an interview guide that was pre-validated by experts prior to data collection was employed to provide consistency. Each interview lasted approximately five (5) to ten (10) minutes, with probing questions used as needed to clarify responses.

The data collected through the survey questionnaire and interviews were analysed using appropriate tools for data analysis. Confidentiality of the data collected was ensured by storing them safely and making sure that no other people except for the researchers had access to them.

Data Analysis

This study utilized frequency counts and percentages for the personal information of the participants, mean, and ranking for the results of the quantitative data from the survey questionnaire. For the qualitative data, the study employed thematic analysis following Braun and Clarke's (2006) framework. Once potential themes were identified, they were reviewed and refined to ensure their relevance to the research questions.

Result and Discussion

This part focused on the results and discussion of the quantitative and qualitative data gathered in the study, addressing the research goals.

Profile of the Teachers

Table 1 shows the distribution of JHS physics teachers across SDOIN. It reflected the participants' age, sex, highest educational attainment, teaching position, number of years of teaching experience, and number of trainings related to IBL.

The table highlighted that the majority of the teachers were 36–41 years old (26.98%), followed by 30–35 years old (21.43%), with most of the participants being female-dominated at 85.71%. A Number of the participants hold a Master's Degree at 38.10%, or a Bachelor's degree with MA/MS units at 38.10%. It was also noted that the majority of the participants were Teacher III (71.43%). Most teachers had 5–9 years (35.71%), followed by 10–14 years (27.78%) teaching experience. Lastly, more than half of them do not have any training in IBL (54.73%).

Table 1. Distribution of teachers according to personal and professional characteristics (n=126).

Characteristics		Frequency, f	Percentage
Age	60-65	3	2.38%
	54-59	7	5.56%
	48-53	12	9.52%
	42-47	23	18.25%
	36-41	34	26.98%
	30-35	27	21.43%
	24-29	20	15.87%
Sex	Male	18	14.29%
	Female	108	85.71%
Highest Educational Attainment	Ed.D./Ph.D.	0	0.00%
	Master's degree with Ed.D./Ph.D.	0	0.00%
	Master's degree	48	38.10%
	Bachelor's degree with MA/MS units	48	38.10%
	Bachelor's degree	30	23.80%
Teaching Position	Teacher VI	6	4.76%
	Teacher V	0	0.00%
	Teacher IV	0	0.00%
	Teacher III	90	71.43%
	Teacher II	12	9.52%
	Teacher I	18	14.29%
Number of Years of Teaching Experience	35-39	1	0.79%
	30-34	1	0.79%
	25-29	5	3.97%
	20-24	8	6.35%
	15-19	19	15.08%
	10-14	35	27.78%
	5-9	45	35.71%
	0-4	12	9.52%
Number of Trainings related to Inquiry-based Learning	2	9	7.14%
	1	48	38.10%
	0	69	54.76%

Despite the participants generally appearing professionally established, a majority reported having no training related to inquiry-based learning. This suggested that while the physics teachers possess substantial teaching experience, their implementation of ICT-enabled inquiry may still be shaped by limited formal preparation in IBL. This may have implications for the consistency and depth of IBL implementation in physics classrooms. In fact, studies have noted that limited training and lack of inquiry-based materials remain among the recurring barriers to effective inquiry-oriented instruction, particularly in Philippine science classrooms (Gutierez, 2015; Strat et al., 2023).

ICT Tools Utilized in Inquiry-Based Physics Instruction

As transpired in Table 2, JHS physics teachers utilized a range of ICT tools in implementing IBL, with an overall mean of 3.34, interpreted as "Sometimes." Among the listed tools, projector-based multimedia presentations obtained the highest mean of 4.92, interpreted as "Always", followed by digital cameras or mobile phones for investigations and documentation with a mean of 4.49, interpreted as "Often", and virtual laboratories or simulations with a mean of 4.45, interpreted as "Often", all of which reflect teachers' preference for highly accessible and instructionally practical technologies. Learning management systems, with a mean of 4.05, and educational video platforms, with a mean of 4.14, were also used often, suggesting that teachers are integrating digital platforms that support content delivery, communication, and visual explanation. Despite the frequent use of several commonly available ICT tools, the relatively low utilization of many other digital technologies reduced the overall mean to the "Sometimes" category, indicating that ICT integration remained selective rather than comprehensive.

Table 2. Technologies/ICT tools that teachers use

	IBL Technology Tools	Mean	Descriptive Interpretation
1	*Projector with Multimedia Presentation* (e.g., PowerPoint, Canva, Prezi)	4.92	A
2	*Learning Management System* (e.g., Google Classroom, Edmodo)	4.05	O
3	*Educational Video Platdorms* (e.g., Youtube Edu, Edpuzzle)	4.14	O
4	*Online Collaboration Tools* (e.g., Jamboard, Padlet, Miro)	3.03	S
5	*E – Assessment tools/ Gamified tools apps* (e.g., Kahoot!, Quizizz)	3.79	O
6	*Google Docs or Slides* (for collaboration or group tasks)	2.63	S
7	*Virtual Labs or Simulations* (e.g., PhET, Ophysics, Geogebra, Gizmos)	4.45	O
8	*Online Research Tools* (e.g., Google, Britannica, ResearchGate)	3.10	S
9	*Digital Cameras or Mobile Phones* (for investigations/documentation)	4.49	O
10	*Video Conferencing Tools* (e.g., Zoom, MS Teams)	3.48	S
11	*AI Generative Tools* (e.g., ChatGPT, Cici, Gemini)	3.28	S
12	*Learning Blogs or Wikis* (e.g., Edublogs,Wikispaces)	2.61	S
13	*Augmented Reality (AR) Apps* (e.g., Google Expeditions, AR Flashcards)	2.39	R
14	*Mind Mapping Tools* (e.g., MindMeister, Coggle)	2.37	R
15	*Podcasting Tools* (e.g., Audacity, Anchor)	2.67	S
16	*Digital Storytelling Tools* (e.g., Storybird, Book Creator)	2.21	R
17	*Digital Quiz and Poll Tools* (e.g., Mentimeter, Socrative)	2.63	S
18	*Digital Note-taking Apps* (e.g., OneNote, Evernote)	3.95	O
19	*Digital Rubric Tools* (e.g., Rubistar, Quick Rubric)	3.29	S
20	*Flipped Classroom Tools* (e.g., Edpuzzle, Flipgrid)	3.33	S
	Overall Mean	3.34	S

In contrast, some specialized and emerging technologies remained less frequently utilized. Augmented reality applications (M = 2.39), mind mapping tools (M = 2.37), and digital storytelling tools (M = 2.21) were all interpreted as "Rarely" used. Meanwhile, AI generative tools obtained a mean of 3.28, indicating that they were "Sometimes" utilized, suggesting that AI has begun to emerge in classroom practice more frequently than other newer instructional technologies. Overall, the findings indicate that while ICT is present in inquiry-based physics instruction, teachers tend to rely more on familiar and readily available tools than on advanced or less commonly adopted digital applications.

This pattern is consistent with existing literature suggesting that digital technologies in inquiry-based learning are often implemented through conventional or familiar tools rather than through a broad range of emerging technologies. Although AI generative tools were sometimes utilized by the participants, other emerging technologies such as augmented reality, digital storytelling, and mind mapping tools remained rarely used. This indicates that although teachers have started using AI as a tool, many other emerging technologies have not been extensively used in inquiry-based physics instruction. In their systematic review, Hinostroza et al. (2024) indicated that digital tools that are mostly used for inquiry-based learning in schools are usually conventional even though there are new technologies which can provide further chances of engaging learners.

In the same manner, Abiasen and Reyes (2021) found that computer simulations in secondary physics classes were highly appreciated due to the fact that they made abstract ideas more comprehensible to learners and were constructivist in nature. However, they were incorporated according to classroom constraints.

Implementation Challenges in ICT-Enabled Inquiry-Based Physics Teaching

The qualitative findings revealed that the challenges encountered by junior high school physics teachers in implementing ICT-enabled inquiry-based learning were multifaceted. Some of the most common themes identified include time constraints and workload demands, limited resources and inadequate infrastructure, learners' weak foundational knowledge and conceptual readiness, difficulty transitioning to learner-centered learning, learner diversity and classroom management issues, and communication and collaboration difficulties. Out of all these, time constraints and lack of resources appear to be especially prominent in view of the frequent occurrence of inadequate class time, concurrent duties in school, lack of laboratory equipment and inconsistent availability of internet facilities. Furthermore, in some of the respondents' answers, it was observed that there were many problems faced by learners with regard to the open-ended approach of inquiry due to poor prior knowledge, poor communication skills, and adjustment difficulties in moving from teacher-centered learning to inquiry-based learning. These findings suggest that the implementation of ICT-enabled inquiry in physics is shaped not only by access to technology, but also by broader instructional, contextual, and learner-related factors.

Table 3. Themes of Implementation Challenges in ICT-Enabled Inquiry-Based Physics Instruction.

	Themes	Representative Codes
1	Time Constraints and Workload	extensive preparation time; limited class periods; rushed inquiry cycles; overlapping activities; reporting demands
2	Limited Resources and Infrastructure	lack of materials; limited laboratory space/equipment; no internet connection; device incompatibility
3	Learners' Weak Readiness for IBL	weak prior knowledge; misconceptions; poor comprehension; difficulty with calculations; limited self-directed learning

	Themes	Representative Codes
4	Learner Diversity and Participation Issues	heterogeneous learners; slow learners; weak cooperation; introversion; off-task behavior
5	Communication Difficulties	difficulty expressing ideas; weak oral/written communication; limited English proficiency; poor group discussion

Hence, the challenges were not limited to technology access alone; rather, they reflected a combination of structural, pedagogical, and learner-related constraints that affected the full implementation of ICT-enabled inquiry in physics instruction. In the context of public secondary schools in the Philippines, these challenges may be associated with everyday classroom realities, including limited instructional time, large and diverse class sizes, competing teaching and administrative responsibilities, and the need to share ICT equipment and laboratory resources across several teachers or departments. Although schools have increasingly adopted ICT initiatives, access to digital tools and infrastructure remains uneven, making it difficult for teachers to consistently implement inquiry-based activities that require careful planning, collaboration, and sustained learner engagement.

In fact, according to Gutierrez (2015), one of the most common barriers to inquiry-based instruction are time constraints, inadequate support, lack of materials, and the laboriousness of an inquiry approach. Moreover, Hinostroza et al. (2024) observed that despite digital technologies' capability to assist in various aspects of the inquiry-based learning process, their classroom application is still affected by practical considerations related to contexts.

These research findings support the findings of this study in that effective ICT-mediated inquiry requires not only digital technologies' availability but also the appropriate conditions of instruction in terms of having enough time, necessary materials, and students' readiness to engage in inquiry activities.

Conclusions and Recommendations

The JHS Physics teachers utilize a range of ICT tools in implementing inquiry-based learning, with stronger reliance on accessible and familiar technologies such as multimedia presentations, mobile devices, and virtual simulations. However, the level of overall ICT utilization across all inquiry-based instruction indicates that ICT tools have not been effectively optimized for use in all inquiry-based instruction. ICT-enabled inquiry implementation in physics was also limited by time constraints, access to and availability of resources and infrastructure, readiness of students to work in inquiring ways, and difficulties associated with classroom participation. These findings indicate that there is a need to provide professional development opportunities targeted at enhancing how to better integrate ICT into inquiry-based physics instruction, continuing to work toward improving access to instructional resources and support at the institutional level for the effective integration of ICT into inquiry-based physics teaching.

Acknowledgement

The authors would like to express their sincere gratitude to Mariano Marcos State University for the academic support and guidance provided throughout the conduct of this research. They are equally grateful to the Physics teachers of junior high school in the Schools Division of Ilocos Norte for participating and cooperating in this study. The authors equally wish to thank their research advisers for their continued guidance, advice, and encouragement throughout this study. They are very thankful to their family and friends who have supported them through this process of research. Most of all, it is their desire to thank God almighty for His guidance throughout this research process.

References

Abiasen, J. T., & Reyes, G. A. (2021). Computer simulation integration in secondary physics: Understanding its nature, impacts, and challenges. International

Journal of Asian Education, 2(4), 480–492. https://doi.org/10.46966/ijae.v2i4.185

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. Qualitative Research in Psychology, 3(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Department of Education. K to 12 curriculum framework and 21st century skills. Department of Education.

Department of Education. MATATAG science curriculum guide. Department of Education.

Department of Education. (2019). Policy guidelines on the K to 12 basic education program (DepEd Order No. 21, s. 2019). Department of Education.

Gutierez, S. B. (2015). Collaborative professional learning through lesson study: Identifying the challenges of inquiry-based teaching. Issues in Educational Research, 25(2), 118–134.

Hinostroza, J. E., Armstrong-Gallegos, S., & Villafañe, M. (2024). Roles of digital technologies in the implementation of inquiry-based learning (IBL): A systematic literature review. Social Sciences & Humanities Open, 9, Article 100874. https://doi.org/10.1016/j.ssaho.2024.100874

Makamu, G., & Ramnarain, U. (2022). Physical sciences teachers' enactment of simulations in 5E inquiry-based science teaching. Education Sciences, 12(12), Article 864. https://doi.org/10.3390/educsci12120864

Pineda, C. I. S. (2020). Effectiveness of validated teaching-learning package in projectile motion for grade 9 science. Journal of Science and Science Education, 1(1), 26–29. https://doi.org/10.29303/jossed.v1i1.454

Rosli, R., & Ishak, N. A. (2024). Integration of virtual labs in science education: A systematic literature review. Jurnal Pendidikan Sains Dan Matematik Malaysia, 14(1), 81–103. https://doi.org/10.37134/jpsmm.vol14.1.8.2024

Strat, T. T. S., Henriksen, E. K., & Jegstad, K. M. (2024). Inquiry-based science education in science teacher education: A systematic review. Studies in Science Education, 60(2), 191–249. https://doi.org/10.1080/03057267.2023.2207148

Urdanivia Alarcon, D. A., Talavera-Mendoza, F., Rucano Paucar, F. H., Cayani Caceres, K. S., & Machaca Viza, R. (2023, May). Science and inquiry-based teaching and learning: a systematic review. In *Frontiers in Education* (Vol. 8, p. 1170487). Frontiers.