Jurnal Elemen, 11(4), 845-859, October 2025
https:/doi.org/10.29408/jel.v11i4.32134

e- ISSN: 2442 - 4226

Technological proficiency and online resource utilization in mathematics education: A study of higher education instructors in the Philippines

Ma. Kathleen Mae Geremias Acopio *

Education Department, Eastern Visayas State University, Carigara Campus, Carigara, Leyte, Philippines

* Correspondence: makathleenmae.geremias@evsu.edu.ph

Abstract

This study examined the relationship between technological proficiency and online resource utilization among 31 mathematics instructors in higher education institutions (HEIs) in Tacloban City, Philippines. Using a descriptive-correlational design, the research assessed how instructors' competence in key information and communication technology (ICT) domains—such as word processing, video conferencing, electronic presentations, web navigation, and troubleshooting—correlated with their ability to effectively use online instructional resources. Adapted instruments from (Flores, 2019) and (Das, 2019) were employed to measure online resource utilization and technological proficiency, respectively. Data were analyzed using descriptive statistics and Pearson correlation. Results indicated a significant positive association—though not causal—between overall technological proficiency and online resource use, with document scanning and spreadsheet processing showing statistically significant relationships at the 0.05 level. Notably, eleven participants reported no prior professional development in digital pedagogy, highlighting disparities in readiness. Despite this, most instructors reported moderate to high self-efficacy in utilizing online resources. Ethical protocols were followed, and participation was voluntary. The findings emphasize the need for targeted, ongoing professional development and institutional support to strengthen technology integration in mathematics teaching, particularly in resource-constrained settings like the Philippines.

Keywords: higher education institutions; mathematics education; online resource utilization; technological proficiency; Tacloban City; Philippines

How to cite: Acopio, M. K. M. G. (2025). Technological proficiency and online resource utilization in mathematics education: A study of higher education instructors in the Philippines. *Jurnal Elemen, 11*(4), 845-859. https://doi.org/10.29408/jel.v11i4.32134

Received: 22 August 2025 | Revised: 5 October 2025
Accepted: 16 October 2025 | Published: 31 October 2025

Introduction

Quality teaching and competent teachers should be addressed in the academe to hone globally competitive learners. A teacher's knowledge on the subject matter contributes significantly to the quality of teaching, and knowing the material gives a teacher the command in teaching (Agsalud, 2016). The quality of teaching greatly depends on the teacher's standard in deciding the topic and process of instruction as well as the ways of measuring students' learning.

A teacher has to have certain information, aptitudes, and suitable identity profile. All these put together is named as "competencies" (Agsalud, 2016). Teacher competence is a vital requirement in transferring knowledge that conjointly displays the teacher's expertise in their field and contributes to the improvement of performance, both individually and organization. Also, there is an improvement of teachers considering their teaching competencies. In the study of Hakim (2015), teachers' competence has positive impact of 96.7% in the improvement of teaching and learning process. This is supported by Novebri et al. (2018) that competence contributes to the performance of the teachers in the academic.

The year 2020 was a challenging year for the world because of the COVID-19 pandemic and the education sector has been greatly affected. Because of the vulnerability in school settings in Tacloban City, schools shifted from traditional approach to flexible learning to ensure continuity of teaching-learning process. To avoid the risk of spreading the virus to the academic community, the Commission on Higher Education (CHED) promulgated guidelines of flexible learning and released the CHED Memo 04 Series of 2020 for implementation by all institutions in the Higher Education (HEIs), both public and private. Flexible learning gives learners more comfort in online learning where learning content and assessment are given in their most convenient time. The implementation of flexible learning as mode of instruction began in Academic Year 2020-2021. Since 2020, higher education institutions in the Philippines, including universities in Eastern Visayas, have adopted flexible learning modalities to maintain continuity in teaching and learning during the COVID-19 pandemic (Abisado et al., 2020; Bozkurt & Sharma, 2020). These initiatives included capacity-building programs and training activities aimed at supporting faculty in redesigning instructional delivery for online and blended modalities.

Globally, this shift mirrors the emergence of what Hodges et al. (2020) describe as *emergency remote teaching,* a temporary shift of instructional delivery to an alternate mode due to crisis circumstances. While this approach ensured educational continuity, it also revealed disparities in digital readiness and teaching competence across contexts. International research on digital pedagogy (Ertmer & Ottenbreit-Leftwich, 2013; Koehler & Mishra, 2009) emphasizes that effective technology integration depends not only on access to ICT tools but also on teachers' technological, pedagogical, and content knowledge (TPACK) and their confidence in applying these skills in practice. In this light, the CHED initiative reflects not just a local response to the pandemic but part of a global movement toward capacity building in technology-enhanced teaching.

Faculty members from various higher education institutions (HEIs) found difficulty in the preparation of flexible learning. There is a struggle in designing a framework for flexible

learning (Abisado et al., 2020). With this, the CHED Commissioner initiated trainings for universities with limited capacity to prepare their faculty members on flexible learning (Magsambol, 2020). Similar challenges were documented globally, as educators faced difficulties in digital pedagogy, technological integration, and online course design (Bozkurt & Sharma, 2020; Coman et al., 2020; Cutri et al., 2020; Rapanta et al., 2020; Trust & Whalen, 2020). These peer-reviewed studies contextualize the Philippine experience within a broader international landscape, emphasizing that the transition to technology-mediated instruction required not only infrastructural support but also the development of teachers' digital competence and pedagogical adaptability.

The coronavirus pandemic brought a huge growth in teaching and learning (Barry & Kanematsu, 2020). Teachers need to think of approaches that offer variety of learning to students. It is also a great challenge for students to continue learning despite of difficulty in accessibility of technology and internet connectivity. In online mode of flexible learning, students are provided choices that allows them to take action of their own learning. Traditionally, the teaching-learning process is held within the school premises. The exchanges of thoughts, exams, recitations and other forms of evaluation are conducted inside a classroom. Teachers make presentations, assessments and activities with the assumption that they will be interacting with their students, guide them, build good relationships with them, and for most of the time, physically interact with each other. This was the setting where teachers are trained at and are prepared for but it was disrupted due to the global pandemic (Ross-Hain, 2020).

Online teaching is demanding. Albrahim (2020) affirmed that in order to enhance a professional development program for online teachers, teaching skills and competencies have to be determined. Further, a good online teacher is able to facilitate a good instruction when there is a better understanding about the learning environment. Similarly, Farmer and Ramsdale (2016) asserted that teachers need to promote engagement and to facilitate active communication in order to produce a successful online teaching. These characteristics of online teacher contribute to their academic, personal and professional growth. The interaction between the teachers and students provides opportunity to keep the learners on tract and provides feedback to teachers about their teaching strategies.

With the advancement of technology, the competency of teachers should not just be concentrated inside a classroom setting, but it must extend to Information and Communications Technology. Educational institutions are adapting to provide high-quality education that develops 21st-century skills such as critical thinking, creativity, collaboration, and communication (Battelleforkids.org, 2019). Technological developments are very popular in the 21st century for which educators are standing in it and students are adaptive in these advancements. Martha et al. (2018) argued that Information and Communications Technology, which emerged in the 21st century, became more attached to technology. Because of this, education must also adjust to changes (Anwar, 2018).

In this regard, teachers' technological proficiency must be examined through a clear theoretical lens. This study is anchored in two complementary frameworks, namely the Technological Pedagogical and Content Knowledge model and the UNESCO ICT Competency Framework for Teachers. The TPACK framework proposed by Mishra and Koehler (2006)

emphasizes the integration of technology, pedagogy, and content knowledge as essential components of effective teaching in the digital age. Within this framework, technological proficiency corresponds to technological knowledge, which refers to instructors' ability to operate, manage, and adapt various digital tools. Meanwhile, online resource utilization reflects technological pedagogical knowledge, which involves the capacity to select, evaluate, and apply technology to enrich instruction and foster student engagement. In addition, the UNESCO ICT Competency Framework for Teachers highlights progressive stages of teacher competence, ranging from basic digital literacy to advanced knowledge creation, illustrating how teachers' technological capabilities support educational transformation. By aligning these frameworks with the study variables, this research establishes a coherent theoretical foundation for examining the relationship between technological proficiency and online resource utilization among higher education mathematics instructors.

From the foregoing discussions, few studies have empirically examined the relationship between granular ICT skill profiles and online teaching behaviors among mathematics educators in Global South contexts. This study aims to assess the self-reported competence of mathematics teachers in online teaching, with focus on their technological skills practices and utilization of online resources. The assessment of these competencies is essential to enhance the quality of instruction and to support continuous improvement of teaching and learning in higher education. Strengthened digital and pedagogical capacities enable higher education institutions to produce globally competitive and high-quality graduates.

This study was guided by four interrelated research questions aimed at understanding the role of technological proficiency in online mathematics instruction among higher education faculty in Tacloban City, Leyte, Philippines, during the School Year 2020–2021. First, it sought to determine the level of teachers' technological skills across specific domains, including word processing, video conferencing, electronic presentations, document scanning, downloading/uploading and application software use, spreadsheet processing, graphical presentation, web navigation, and troubleshooting. Second, the study explored the types and extent of ICT-related professional development or training that the teachers had attended. Third, it assessed the level of online teaching competence among these mathematics instructors, specifically focusing on their ability to effectively utilize online instructional resources. Finally, the study examined whether a statistically significant relationship exists between the teachers' technological skills and their competence in using online resources for mathematics instruction. Together, these questions aimed to provide a comprehensive understanding of how digital capabilities influence instructional practices in a post-pandemic higher education context.

Methods

Research design

The study used a descriptive-correlational survey design to gather data that addressed the research objectives. This design allowed the examination of the association between mathematics teachers' technological proficiency and their competence in using online instructional resources. In this study, online teaching competence was defined as online resource utilization competence, referring to teachers' ability to select, adapt, and apply digital materials and platforms to support effective instruction. This construct focuses on the practical use of digital resources in mathematics education rather than broader aspects of pedagogical design or student learning outcomes.

Research locale

This study was conducted in Tacloban City, Leyte, Philippines, a recognized educational hub in Eastern Visayas that hosts both public and private Higher Education Institutions (HEIs). The participating institutions included Eastern Visayas State University (EVSU) Tacloban Campus and Leyte Normal University (LNU)—state universities offering teacher education, science, and engineering programs that integrate mathematics and quantitative coursework. In addition, the study covered Asian Development Foundation College (ADFC), ACLC College of Tacloban, Doña Remedios Trinidad Romualdez Educational Foundation (DRTREF), and JE Mondejar Computer College (JEMCC)—private HEIs offering degree programs in information technology, business, and allied disciplines where General Education Mathematics (GEM) courses form part of the foundational curriculum.

A complete enumeration of all qualified mathematics teachers (N = 31) from these institutions was undertaken to provide a comprehensive profile of their online teaching competence within the local context. Nonetheless, given the limited sample size and the study's focus on a single urban area, the findings are context-bound and exploratory and should not be generalized to represent the entire population of mathematics educators in the Philippines.

Research respondents

The respondents of this study were tertiary mathematics teachers from Higher Education Institutions (HEIs) in Tacloban City, Leyte, Philippines. Participants met the following inclusion criteria: (1) currently employed as new or tenured faculty members; (2) on study, marital, or sick leave during School Years 2019–2020 to 2020–2021; and (3) teaching at least one General Education Mathematics (GEM) course, including *Mathematics in the Modern World*, *Algebra*, *Trigonometry*, *Calculus*, *Geometry*, or *Solid Mensuration.*

A total of 31 mathematics teachers participated in the study. Of these, 24 were from public institutions—17 from Eastern Visayas State University (EVSU) and 7 from Leyte Normal University (LNU)—while 7 were from private institutions, comprising 3 from Asian Development Foundation College (ADFC), 2 from JE Mondejar Computer College (JEMCC), 1 from ACLC College of Tacloban, and 1 from Doña Remedios Trinidad Romualdez Educational Foundation (DRTREF). Because the population of mathematics teachers in these

institutions was relatively small, a complete enumeration approach was employed rather than sampling.

The dataset provides a detailed profile of mathematics teachers' online teaching competence within Tacloban City. Since the study employed a complete enumeration of 31 participants, the findings should be interpreted with caution. This sampling approach reflects the characteristics of a specific group rather than a representative sample, which limits generalizability. Therefore, the results are intended to offer exploratory and context-specific insights that can inform localized professional development and policy initiatives in higher education.

Ethical consideration

This study did not undergo formal Institutional Review Board (IRB) approval due to the absence of a local ethics review committee within the institution at the time of data collection. However, administrative authorization was secured from the university, and the research strictly followed ethical standards in conducting studies involving human participants. Informed consent was obtained from all respondents prior to their participation. They were informed of the study's objectives, assured of the voluntary nature of their participation, and allowed to withdraw at any point without consequence. All responses were treated with utmost confidentiality and used exclusively for academic purposes.

Research instrument

This study utilized a structured survey questionnaire as the primary tool for data collection. The instrument was adapted from the validated questionnaires of Flores (2019) and Das (2019) to assess the respondents' online teaching competence and ICT skills profile, respectively. Prior permission was obtained from Flores (2019) to use and adapt the instrument for this study. As the adapted instruments were previously standardized and validated, additional pilot testing was deemed unnecessary.

The questionnaire consisted of three parts: Part A gathered the respondents' background information; Part B assessed their ICT skills in areas such as word processing, video conferencing, electronic presentation, document scanning, downloading/uploading and application software use, spreadsheet processing, graphical presentation, web navigation, troubleshooting, and ICT-related trainings attended; and Part C evaluated their online teaching competence, particularly their ability to utilize online instructional resources.

Given the paradigm shift in instructional delivery during the pandemic, the instrument was reviewed and contextualized to reflect the realities of online teaching in Tacloban City, Leyte, Philippines. Furthermore, the modified version underwent content validation by the research adviser and panel members to ensure its relevance, clarity, and suitability for the local academic setting prior to administration.

Methods of scoring

The data gathered from the survey were systematically analyzed and interpreted using established scoring and interpretation procedures. Each item in the instrument was rated on a five-point Likert scale, and the resulting weighted mean scores were categorized to determine the respondents' levels of competence. The assessment of ICT skills was based on the instrument adapted from Das (2019)**,** which measured teachers' self-reported proficiency in various computer-related tasks. Weighted mean scores ranging from 4.21 to 5.00 indicated *expert* proficiency; 3.41 to 4.20, *proficient*; 2.61 to 3.40, *competent*; 1.81 to 2.60, *advanced beginner*; and 1.00 to 1.80, *novice*.

Similarly, teachers' ability to utilize online resources was measured using items adapted from Flores (2019) (2019)**.** The weighted mean scores were interpreted as follows: 4.21 to 5.00 as *highly competent* (outstanding), 3.41 to 4.20 as *competent* (very satisfactory), 2.61 to 3.40 as *moderately competent* (satisfactory), 1.81 to 2.60 as *slightly competent* (poor), and 1.00 to 1.80 as *incompetent* (needs improvement). Although Cronbach's α coefficients were not recalculated in the present study, both source instruments reported high internal consistency in their original validations ($\alpha > .80$), supporting their reliability for assessing teachers' technological proficiency and online resource utilization competence. The computed mean scores served as the basis for determining the respondents' overall levels of ICT proficiency and online teaching competence, which were subsequently used in the correlational analysis to examine the relationships among the study variables.

Treatment of data

For data treatment, descriptive statistics such as frequency counts, percentages, means, and standard deviations were used to summarize the respondents' demographic characteristics, ICT skills, and online teaching competence. To examine the relationships among the study variables, Pearson's product-moment correlation coefficient (r) was employed because the variables were continuous and approximately normally distributed. This inferential test determined the extent and direction of the relationship between the respondents' ICT skills and their ability to utilize online teaching resources. Effect sizes were also reported to indicate the strength of the observed relationships. All statistical analyses were performed using appropriate statistical software to ensure accuracy, consistency, and reliability of results.

Results

Technological skills profile of mathematics teacher

Table 1. Technological skills profile of mathematics teachers

Skills Profile	Mean	SD	Description	Interpretation
Word processing skills	4.61	0.5	I can use it very well	Expert
Video conferencing skills	4.45	0.57	I can use it very well	Expert
Electronic presentation skills	4.42	0.67	I can use it very well	Expert
Scanning of documents	4.39	0.8	I can use it very well	Expert

Skills Profile	Mean	SD	Description	Interpretation
Downloading/uploading application software	4.19	0.79	I can use it well	Proficient
Spreadsheet processing skills	4.16	0.9	I can use it well	Proficient
Graphical presentation skills	4.13	0.71	I can use it well	Proficient
Web navigation skills	3.87	1.09	I can use it well	Proficient
Trouble shooting skills	2.97	1.02	I can use it satisfactorily	Competent
Grand Mean	4.13		I can use it well	Proficient
Overall SD	0.2			

Table 1 presents the technological skills profile of mathematics teachers in terms of word processing, video conferencing, electronic presentation, document scanning, downloading and uploading of application software, spreadsheet processing, graphical presentation, web navigation, and troubleshooting skills. The results indicate that, overall, the respondents perceived themselves as proficient in terms of technological competence, with a grand mean of 4.13 (SD = 0.20). These ratings reflect self-reported levels of competence rather than objectively measured performance.

Online teaching competence of teachers by ability to utilize online resources

Table 2. Online teaching competence of teachers by ability to utilize online resources

Ability to Utilize Online Resources	Mean	SD	Description	Interpretation
Use a social networking platform (e.g. Facebook) on the Web to communicate/collaborate with students on the course	4.39	0.76	Outstanding	Highly competent
Use instant messaging/chat (e.g. Skype, Messenger, Hangout, etc.) on the Web to communicate with students in the course	4.35	0.75	Outstanding	Highly competent
Use instant messaging/chat (e.g. Skype, Messenger, Hangout, etc) on the Web to communicate with teachers and administrative staff	4.35	0.75	Outstanding	Highly competent
Use Web-conferencing or video chat to communicate with other students in the course	4.23	0.76	Outstanding	Highly competent
Use the Web to share digital files related to your course (e.g. sharing photos, audio files, movies, digital documents, websites, etc.)	4.16	0.9	Very Satisfactory	Competent

Ability to Utilize Online Resources	Mean	SD	Description	Interpretation
Create and present multimedia shows as part of your course (e.g. PowerPoint)	4.1	0.65	Very Satisfactory	Competent
Download or access online audio/video recordings to revise the content of lectures	4	0.68	Very Satisfactory	Competent
Create and present audio/video as part of your course	3.94	0.81	Very Satisfactory	Competent
Use an e-Portfolio system to record your achievements for future use	3.23	0.95	Satisfactory	Moderately Competent
Design and Build Web pages as part of your course	2.48	0.96	Poor	Slightly competent
Grand Mean	3.92		Very Satisfactory	Competent
	Overall SD	0.11		

As shown in Table 2, mathematics teachers percieved themselves as competent in terms of online teaching competence, with a grand mean of 3.92 (SD = 0.11)**.** Respondents rated themselves highly in the use of social networking platforms (M = 4.39, SD = 0.76)**,** instant messaging tools (M = 4.35, SD = 0.75), and video conferencing applications (M = 4.23, SD = 0.76)**,** indicating strong confidence in communication and collaboration technologies frequently used for online instruction. In contrast, web page design (M = 2.48, SD = 0.96) and use of e-Portfolio systems (M = 3.23, SD = 0.95) were rated lowest, suggesting limited engagement with advanced or integrative online resource creation.

These findings represent self-assessed levels of competence rather than direct measures of actual teaching performance.

Correlation matrix between online resources utilization and technological skills profile

Test of correlations was done between online teaching competencies including ability to utilize online resources and the teachers' technological skills profile in terms of word processing skills, video conferencing skills, electronic presentations skills, scanning of documents, downloading/uploading application software, spreadsheet processing skills, graphical presentations skills, web navigation skills, and trouble shooting skills. The results and findings are presented in table 3. Pearson's correlation coefficient (r**)** was employed to determine the strength and direction of the relationships between the variables at 0.05 and 0.01 levels of significance**.**

A correlation matrix was generated to provide a comprehensive view of inter-variable associations. All correlations were statistically significant ($p < .05$), with coefficients ranging from $r = 0.378$ to $r = 0.596$, indicating moderate to strong positive associations between teachers' ICT skills and their online teaching competence. Notably, troubleshooting skills exhibited a significant but comparatively weaker correlation, suggesting that while foundational ICT skills strongly support online instructional delivery, more technical competencies contribute in a complementary rather than dominant manner.

Table 3. Correlation matrix between online teaching competence and technological skills profile

Technological Skills Profile	Online Teaching Competence Ability to Utilize Online Resources		
	r-value	p-value	Interpretation
Word Processing Skills	0.585**	0.001	Highly significant
Video Conferencing Skills	0.588**	0.001	Highly significant
Electronic Presentation Skills	0.564**	0.001	Highly significant
Document Scanning Skills	0.378*	0.036	Significant
Downloading/Uploading & Application Software Use	0.531**	0.002	Highly significant
Spreadsheet Processing Skills	0.391*	0.03	Significant
Graphical Presentation Skills	0.589**	0.001	Highly significant
Web Navigation Skills	0.595**	0.001	Highly significant
Troubleshooting Skills	0.596**	0.001	Highly significant

Legend:
ns - not significantly correlated
* - significantly correlated at $\alpha = 0.05$
** - highly significantly correlated at $\alpha = 0.01$

Professional development in digital pedagogy

Table 4 presents the number and types of professional development activities in digital pedagogy attended by mathematics teachers. These include Moodle Training, Effective Use of ICT Tools in Teaching, ICT Training for Teachers, Two-Day In-Service Training, Training on Enhancing the ICT Skills of Educators, Strategic Planning 2019, ICT Virtual Conference, In-Service Training for Teachers in Using ICT, and In-Service Training on Learner Information System.

Table 4. Professional development in digital pedagogy attended (n=31)

Professional development in digital pedagogy attended	Frequency	Percent (%)
Moodle Training	17	54.8
Effective Use of ICT Tools in Teaching	14	45.2
ICT Training for Teachers	10	32.3
2-Day In-Service Training	6	19.4
Training on Enhancing the ICT Skills of Educators	6	19.4
Strategic Planning 2019	5	16.1
ICT Virtual Conference	3	9.7
In-Service Training for Teachers in Using ICT	3	9.7
In-Service Training on Learner Information System	1	3.2
No Professional development in digital pedagogy attended	11	35.5
	mean = 2.1	

As shown in Table 4**,** twenty out of thirty-one teachers (64.5%) participated in at least one professional development activity, while eleven teachers (35.5%) reported no participation. On average, teachers attended 2.1 training sessions (SD = 0.84), with with attendance ranging from 0 to 9 sessions. Moodle Training (54.8%) and Effective Use of ICT Tools in Teaching (45.2%) were the most common activities. The range from 0 to 9 sessions indicates substantial variability in engagement, suggesting that while some teachers participated in multiple technology-enhanced teaching workshops, others had minimal or no exposure within the study locale.

Discussion

Majority of teachers reported moderate to high confidence in performing ICT-related tasks that support their instructional responsibilities in mathematics. The highest-rated skills were word processing (M = 4.61, SD = 0.50) and video conferencing (M = 4.45, SD = 0.57)**,** both described as "expert," reflecting teachers' familiarity with tools essential for preparing instructional materials and conducting synchronous online classes. This lower score may reflect common challenges in Global South contexts, where teachers often contend with unreliable internet connectivity, limited access to technical support, and inconsistent ICT infrastructure (Dhakal, 2018). These contextual constraints can hinder teachers' ability to effectively address technical problems despite proficiency in other ICT tasks These findings align with Hunter et al. (2018), who emphasized that teachers across educational levels are increasingly required to integrate digital tools into classroom practices. Similarly, Turayev (2018) noted that higher education institutions are progressively leveraging technology to enhance instruction and curriculum delivery. While the results suggest that teachers' technological proficiency is associated with their readiness to deliver online mathematics instruction, this interpretation remains correlational and should not be construed as implying causation.

Teachers' online teaching competence, operationalized as online resource utilization, was strongest in communication-oriented technologies but less developed in content creation and web-based instructional design. These results suggest that technological knowledge (TK in TPACK) is necessary for confidence in using digital resources but insufficient alone for full pedagogical integration (TPK), particularly for tools requiring higher-order design skills. The findings underscore the TPACK assertion that technology integration requires the interplay of technological, pedagogical, and content knowledge (Ertmer & Ottenbreit-Leftwich, 2013; Koehler & Mishra, 2009).

Correlation analysis revealed that all technological skill areas were positively correlated with teachers' ability to utilize online resources. Although all correlations were significant, document scanning and spreadsheet processing skills showed comparatively weaker relationships, remaining significant only at the 0.05 level. These findings indicate associations; higher ICT proficiency is associated with greater confidence in using digital resources, but ICT skills alone do not determine online teaching competence. Within the TPACK framework, this suggests that technological knowledge (TK) supports teachers' ability to use digital resources, but pedagogical knowledge (PK) and the integration of content knowledge (CK) remain

essential for effective online instruction. It is difficult to integrate online resources to higher education (Dhakal, 2018). Since teachers are the essential factor to effectively utilize online resources in teaching, their competence in technological skills is necessary. This is also supported in the study of Alemu (2015) which concludes that instructors play the professional role in implementing technology in teaching and learning. As the findings suggest, teachers are able to utilize online resources in mathematics education.

The Commission on Higher Education (CHED) mandates that pre-service teachers complete the ICT 101 course (CMO No. 31, Series of 2004), contributing to teachers' foundational competence in information and communication technology. This policy aligns with global educational directives emphasizing digital literacy as a core teaching competency (UNESCO, 2018). However, participation in ongoing professional development varied considerably among respondents, with 35.5% reporting no engagement in technology-enhanced teaching workshops. This disparity highlights equity concerns, suggesting that some teachers may lack access to institutional support necessary for continuous skill development. Engagement in professional development was positively associated with teachers' technological skills profiles, though this association should be interpreted cautiously, as correlational evidence does not establish causation. The observed disparities mirror international patterns noted by (UNESCO, 2018) during the shift to emergency remote teaching**,** where educators with greater exposure to structured digital training adapted more effectively to online modalities. Similarly, Das (2019) emphasized the importance of continued technology-based training to improve the integration of ICT in specific subject areas such as mathematics.

Overall, the findings suggest an association between teachers' proficiency in commonly used communication technologies and their perceived competence in online instruction**,** without implying a direct causal relationship. Strengthening training programs in multimedia development and web-based instructional design could further enhance teachers' ability to utilize a wider range of online resources effectively. While many mathematics teachers demonstrate proficiency in basic ICT use, sustained participation in technology-enhanced teaching workshops remains essential to strengthen their pedagogical integration of digital tools. Institutions may therefore consider strategic capacity-building programs aimed at enhancing digital pedagogy competencies, particularly for educators with limited training exposure. It is important to note that the reported competence levels are based on self-assessment and may be influenced by social desirability bias, particularly in the post-pandemic context where digital skills are highly valued.

Conclusion

This study demonstrates that while Philippine mathematics educators are confident in using communication-oriented ICT tools, their capacity for advanced digital pedagogy remains uneven, highlighting a gap between emergency remote teaching and sustainable online instruction. Correlational analysis showed positive associations between teachers' technological skills profiles and their use of online instructional resources, indicating that

higher ICT proficiency is associated with greater confidence in employing digital tools, though causality cannot be inferred. Teachers showed moderate competence in tasks such as troubleshooting and web-based instructional design, reflecting challenges common in Global South contexts where infrastructure and technical support are limited.

The findings show that 35.5% of teachers had not participated in any digital pedagogy training, highlighting the need for equitable institutional support. Providing structured professional development that combines pedagogical strategies with practical ICT tools such as GeoGebra and Desmos can improve teachers' confidence and effectiveness in online mathematics instruction. Sustained training and institutional investment are essential to strengthen technology-mediated teaching in higher education.

Based on the findings and contextual limitations of this study, it is recommended that Higher Education Institutions (HEIs) prioritize institutional strategies to strengthen faculty capacity for online instruction. HEIs should embed TPACK-aligned training in faculty development programs rather than relying on one-off workshops. Structured professional development should combine pedagogical guidance with practical use of mathematics-specific digital tools such as GeoGebra, Desmos, and spreadsheet software for problem solving and data visualization. Faculty should also design learning management system (LMS)-based activities and assessments that enhance engagement and conceptual understanding.

Administrators must ensure consistent institutional support by providing reliable technological infrastructure, including stable internet access, sufficient digital devices, and licensed educational software. Institutional initiatives should address systemic challenges such as limited connectivity and inequitable access to technology, which can constrain instructional effectiveness even among proficient teachers.

Future research should employ mixed-methods designs, combining classroom observations with surveys, to move beyond self-reported competence and gain a more comprehensive understanding of how technological skills relate to online teaching performance. Expanding the study to include a larger and more diverse population of HEIs across regions can also improve generalizability and inform scalable interventions.

Acknowledgment

The author would like to express sincere gratitude to the late Prof. Ferdinand T. Abocejo[+], the research adviser, for his invaluable guidance, expertise, and encouragement that greatly contributed to the completion of this study. Heartfelt appreciation is also extended to the research panel members for their constructive feedback and support. The author is deeply thankful to the Geremias family for their unwavering love and understanding, and to friends who offered motivation along the way. Special thanks are given to Miguel Paulo A. Acopio and Kaelus Leon G. Acopio, her husband and son**,** for their patience, inspiration, and steadfast support that made this research possible.

Conflicts of Interest

The author declare no conflict of interest regarding the publication of this manuscript. In addition, the author have completed the ethical issues, including plagiarism, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancies.

Funding Statement

This work received no specific grant from any public, commercial, or not-for-profit funding agency.

Author Contributions

The author solely conducted all aspects of this work, including the study conception and design, data collection and analysis, interpretation of results, and manuscript preparation. The author approved the final version of the manuscript and is fully accountable for all aspects of the research.

References

Abisado, M., Unico, M. G., Umoso, D. G., Manuel, F. E., & Barroso, S. S. (2020). A flexible learning framework implementing asynchronous course delivery for Philippine local colleges and universities. *International Journal of Advanced Science and Engineering*, *9*(1.3), 413–421. https://doi.org/10.30534/IJATCSE/2020/6591.32020

Agsalud, P. L. (2016). Teaching effectiveness of the teacher education faculty members in Pangasinan State University Asingan Campus. *Philippines Asia Pacific Journal of Multidisciplinary Research*, *5*(1), 16–22. https://oaji.net/articles/2017/1543-1514870594.pdf

Albrahim, F. (2020). Online teaching skills and competencies. *The Turkish Online Journal of Educational Technology*, *19*(1). https://www.tojet.net/articles/v19i1/1912.pdf

Alemu, B. M. (2015). Integrating ICT into teaching-learning practices: Promise, challenges and future directions of higher educational institutes. *Universal Journal of Educational Research*.

Anwar, M. (2018). Inovasi sistem pendidikan [Innovation in the education system. *Inspiratif Pendidikan*, *7*(2), 161–170. https://doi.org/10.24252/ip.v7i2.7851

Barry, D. M., & Kanematsu, H. (2020). *Teaching during COVID-19 pandemic (ED6060170*. ERIC. https://files.eric.ed.gov/fulltext/ED606017.pdf

Battelleforkids.org. (2019, 2019). *Framework for 21st century learning*. https://www.battelleforkids.org/networks/p21/frameworks-resources

Bozkurt, A., & Sharma, R. C. (2020). Emergency remote teaching in a time of global crisis due to the CoronaVirus pandemic. *Asian Journal of Distance Education*, *15*(1), 1–6. https://doi.org/10.5281/zenodo.3778083

Coman, C., Tîru, L. G., Meseșan-Schmitz, L., Stanciu, C., & Bularca, M. C. (2020). Online teaching and learning in higher education during the coronavirus pandemic: Students' perspective. *Sustainability*, *12*(24), 10367. https://doi.org/10.3390/su122410367

Cutri, R. M., Mena, J., & Whiting, E. F. (2020). Faculty readiness for online crisis teaching: Transitioning to online teaching during the COVID-19 pandemic. *European Journal of Teacher Education*, *43*(4), 523–541. https://doi.org/10.1080/02619768.2020.1815702

Das, K. (2019). Role of ICT for better mathematics teaching. *Shanlax International Journal of Education*, *7*(4), 19–28. https://doi.org/10.34293/education.v7i4.641

Dhakal, P. K. (2018). Use of ICT tools in teaching mathematics in higher education: A case of Mid-Western University. *International Journal of Multidisciplinary Perspectives in Higher Education*, *3*(1), 81–88. https://doi.org/10.32674/jimphe.v3i1.636

Ertmer, P. A., & Ottenbreit-Leftwich, A. T. (2013). Teacher technology change: How knowledge, confidence, beliefs, and culture intersect. *Journal of Research on Technology in Education*, *42*(3), 255–284. https://doi.org/10.1080/15391523.2010.10782551

Farmer, H., & Ramsdale, J. (2016). Teaching competencies for the online environment. *Canadian Journal of Learning and Technology*, *42*(3). https://doi.org/10.21432/T2V32J

Flores, I. (2019). Competencies of mathematics teachers in the Province of Batangas, Philippines: Basis for direction on continuing education for the K to 12 curriculum. *Asia Pacific Journal of Multidisciplinary Research*, *7*(4), 26–35. https://doi.org/10.22158/jar.v3n3p206

Hakim, A. (2015). Contribution of competence teacher (pedagogical, personality, professional competence and social) on the performance of learning. *The International Journal of Engineering and Science*, *4*(2), 2319–1805. www.theijes.com/papers/v4-i2/Version-3/A42301012.pdf

Hodges, C., Moore, S., Lockee, B., Trust, T., & Bond, A. (2020). The difference between emergency remote teaching and online learning. *EDUCAUSE Review*. https://er.educause.edu/articles/2020/3/the-difference-between-emergency-remote-teaching-and-online-learning

Koehler, M. J., & Mishra, P. (2009). What is technological pedagogical content knowledge (TPACK)? *Contemporary Issues in Technology and Teacher Education*, *9*(1), 60–70. https://doi.org/10.1177/002205741319300303

Magsambol, B. (2020). 6 PH universities offer free 'flexible learning' training for faculty members. https://www.rappler.com/philippines/266126-universities-offer-free-flexible-learning-training-faculty-members-philippines/

Martha, Z., Adi, E., & Soepriyanto, Y. (2018). E-book berbasis mobile learning [Mobile learning-based e-book. *Jurnal Kajian Teknologi Pendidikan*, *1*(2), 109–114. https://journal2.um.ac.id/index.php/jktp/article/view/3705

Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record*, *108*(6), 1017–1054. https://doi.org/10.1111/j.1467-9620.2006.00684.x

Novebri, N., Rukun, K., & Sabandi, A. (2018, 2018). *Relationship between pedagogical competence and teacher performance in public elementary school* International Conferences on Educational, Social Sciences and Technology, https://doi.org/10.29210/20181139

Rapanta, C., Botturi, L., Goodyear, P., Guàrdia, L., & Koole, M. (2020). Online university teaching during and after the COVID-19 crisis: Refocusing teacher presence and learning activity. *Postdigital Science and Education*, *2*, 923–945. https://doi.org/10.1007/s42438-020-00155-y

Ross-Hain, L. (2020). *Transitions in Tumultuous times: Teachers' experiences with distance learning amidst The COVID-19 Pandemic* [Ph.D. Thesis, https://commons.und.edu/theses/3387/

Trust, T., & Whalen, J. (2020). Should teachers be trained in emergency remote teaching? Lessons learned from the COVID-19 pandemic. *Journal of Technology and Teacher Education*, *28*(2), 189–199. https://doi.org/10.70725/307718pkpjuu

Turayev, O. (2018). *Educational Technology Integration among Community College Instructors* [Ph.D. Thesis, https://www.proquest.com/docview/2063075672

UNESCO. (2018, 2018). *ICT competency framework for teachers (Version 3)*. UNESCO. https://unesdoc.unesco.org/ark:/48223/pf0000265721