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In-Service Mathematics Teachers' Technology Proficiency Self-Assessment for 21st Century Learning: A Cross-Sectional Survey

Maegan Asuncion[1], Evangeline Jamisola[1], Angelo Magay[1], Jerome Russel Mayhay[1] and Asher Toledo[1]

[1] *Philippine Normal University*

**Corresponding Author: jamisola.eb@stud.pnu.edu.ph*

Abstract: This study explored the self-assessed technology proficiency of in-service mathematics teachers in Metro Manila using the Technology Proficiency Self-Assessment for 21st Century Learning (TPSA-C21) instrument. As the demand for digital competency continues to grow in the education sector, understanding teachers' readiness to integrate technology into classroom instruction is essential in advancing 21st-century learning. The study aimed to assess teachers' proficiency across six key factors: electronic mail, internet use, integrated applications, teaching with technology, teaching with emerging technologies, and emerging technology skills.

A quantitative, cross-sectional survey design was employed, involving 392 in-service mathematics teachers from 44 public high schools, comprising both regular and science high schools. The TPSA-C21 instrument, based on a five-point Likert scale, was used to gather data on teachers' self-perceptions of their technological abilities. Descriptive statistics, including mean and standard deviation, were used to analyze the data.

Results revealed that participants rated themselves as *Proficient* overall, with some variation across the six factors. Teachers rated themselves as *Highly Proficient* in using electronic mail, reflecting strong foundational communication skills. They were *Proficient* in internet use and integrated applications but showed lower proficiency in producing web content and desktop publishing tasks. In teaching with technology and teaching with emerging technologies, teachers demonstrated conceptual understanding but had difficulties in areas such as budgeting for classroom technology and using collaborative tools like wikis and blogs. Emerging technology skills, particularly mobile integration and cloud management, were rated near the *Highly Proficient* level. These findings highlight the need for continuous professional development focused on advanced content creation, strategic technology integration, and collaborative digital platforms to enhance mathematics instruction in the digital age.

Key Words: technology proficiency; self-assessment; in-service teachers; 21st-century learning; mathematics education

1. INTRODUCTION

1.1 Background of the Study

In today's digital age, technology plays a crucial role in enhancing instructional delivery and student engagement, particularly in mathematics education. As schools increasingly adopt 21st-century learning frameworks, teachers are expected to utilize digital tools not only to improve classroom instruction but also to equip students with skills needed in a technology-driven world. Mathematics, often viewed as a challenging subject, benefits from interactive platforms and visual aids that facilitate deeper understanding of abstract concepts.

1.2 Statement of Purpose

Tupas and Noderama (2020) stressed the need for aligning in-service training with Education 4.0, which requires teachers to develop technological competencies to improve students learning. But, embracing new ways and methodologies presented by emerging new technologies in mathematics education includes considering the acumen of the target implementers – they are the mathematics teachers. Their thoughts and personal assessments with regard to these new offerings for teaching mathematics must be given importance before we dive into the planning of buying and doing training programs. According to Scherer et. al (2019), teachers' attitudes and beliefs about the significance of technology integration were strongly associated with higher levels of technology use in the classroom. Boelens (2018) also mentioned that teachers' attitudes, training in technology use, and the availability of digital tools significantly influenced their (teachers) willingness to integrate technology into classroom instruction. Thus, this survey study was conducted. The researchers value mathematics teachers' self-assessment of their technology proficiency in the determination of their needs with regard to teaching with technology.

1.3 Significance of the Study

Understanding teachers' self-assessed proficiency in technology use is essential in identifying strengths and areas needing improvement. The results of this study serve as a baseline for educational institutions and policymakers to design targeted training programs that enhance digital competencies in the teaching workforce. By focusing on mathematics educators, the research highlights the importance of equipping teachers with the tools necessary to deliver effective and engaging math instruction in a digital learning environment.

1.4 Objectives of the Study

This research aimed to determine the overall level of technology proficiency among in-service mathematics teachers in Metro Manila, as measured by the TPSA-C21 instrument. The study sought to evaluate proficiency across all domains to provide a clear understanding of the current state of technological integration in mathematics education.

2. METHODOLOGY

2.1 Research Design

This study employed a quantitative, cross-sectional survey design to assess the self-perceived technology proficiency of in-service mathematics teachers in relation to 21st-century learning standards. The design enabled the collection of numerical data at a single point in time, allowing for the analysis of trends, patterns, and demographic influences on technology proficiency (Creswell & Creswell, 2018). The structured TPSA-C21 questionnaire quantified teachers' familiarity and competency across various technological domains.

2.2 Participants and Sampling

A total of 392 in-service mathematics teachers from 44 public high schools across Metro Manila participated in the study. This included 281 teachers from 29 regular high schools and 111 from 14 science high schools. Stratified sampling was first employed to represent both school types equally, followed by random sampling of teachers within each school. Adjustments were made to account for the actual number of available teachers per school.

2.3 Research Instrument

The primary instrument used was the Technology Proficiency Self-Assessment for the 21st Century Learning (TPSA-C21), adapted from Ropp (1997) and later validated by Christensen and Knezek (2017). The TPSA-C21 consists of a 5-point Likert scale measuring self-assessed proficiency across six domains: electronic mail, internet use, integrated applications, teaching with technology, teaching with emerging technologies, and emerging technology skills.

2.4 Data Gathering Procedure

After obtaining permission from the Division Offices and participating schools, the researchers conducted both in-person and online surveys. For face-to-face administration, printed questionnaires were distributed and collected within 3–5 days. For schools that opted for online participation, Google Forms were used.

2.5 Data Analysis

The results of this study were analyzed using descriptive statistical methods, including frequency, mean, and standard deviation. Frequency was used to present the distribution of participants across different school types, while the mean was calculated to determine the average self-assessed technology proficiency of in-service mathematics teachers across the six factors in the TPSA-C21 survey. Additionally, standard deviation was used to assess the variability of responses within each factor, providing insight into the consistency or dispersion of self-assessment scores among participants. These statistical tools facilitated the generation and summary of results presented in tables, enabling the researchers to identify trends, overall proficiency levels, and specific areas where teachers felt either confident or in need of improvement in their application of technology for 21st-century learning.

2.6 Ethical Considerations

This study complied with the ethical standards of research, including the Republic Act 10173 or Data Privacy Act of 2012. Informed consent was secured from all participants, and anonymity and confidentiality were strictly maintained. Permission to use the TPSA-C21 was also obtained from its authors. Participants were informed of their right to withdraw at any stage of the study.

3. RESULTS AND DISCUSSION

Table 1. Participants Technology Proficiency Self-Assessment Results (Factor 1: Electronic Mail)

Factor 1: Email	Self-assessment of Proficiency			
I feel confident that I could…	From Regular High School (N=281)		From Science High School (N=111)	
	Mean (SD)	INTERPRETATION	Mean (SD)	INTERPRETATION
1. send email to a friend.	4.65 (0.60)	Highly Proficient	4.69 (0.67)	Highly Proficient
2. subscribe to a discussion list.	4.00 (0.90)	Proficient	4.13 (0.91)	Proficient
3. create a distribution list" to send email to several people at once	4.00 (0.94)	Proficient	4.03 (1.01)	Proficient
4. send a document as an attachment to an email message.	4.56 (0.69)	Highly Proficient	4.60 (0.89)	Highly Proficient
5. keep copies of outgoing messages that I send to others.	4.30 (0.84)	Highly Proficient	4.30 (0.94)	Highly Proficient
General Weighted Average (SD) / Interpretation:	4.30 (0.79)	Highly Proficient	4.35 (0.88)	Highly Proficient

In-service mathematics teachers from both regular (M = 4.30, SD = 0.79) and science high schools (M = 4.35, SD = 0.88) rated themselves as *Highly Proficient* in using email tools. The highest scores were seen in sending email to a friend and sending attachments. These results only indicate that they regard electronic mail as an effective communication tool for sharing documents which could be related to learning materials.

Samosa (2021) emphasized that email remains one of the most frequently used digital tools among Filipino teachers, especially during the shift to distance learning, as it supports instructional coordination and administrative tasks.

Table 2. Participants Technology Proficiency Self-Assessment Results (Factor 2: World Wide Web)

Factor 2: WWW	Self-assessment of Proficiency			
I feel confident that I could…	From Regular High School (N=281)		From Science High School (N=111)	
8. create my own web page.	2.72 (1.20)	Nearly Proficient	2.83 (1.29)	Nearly Proficient
9. keep track of Web sites I have visited so that I can return them later. (An example is using bookmarks.)	3.79 (1.12)	Proficient	4.11 (1.11)	Proficient
10. find primary sources of information on the Internet that I can use in my teaching.	4.30 (0.77)	Highly Proficient	4.42 (0.09)	Highly Proficient
General Weighted Average (SD) / Interpretation:	3.84 (0.96)	Proficient	4.02 (1.00)	Proficient

Teachers from both groups rated themselves as *Proficient* in this factor, with regular school teachers (M = 3.84, SD = 0.96) and science high school teachers (M = 4.02, SD = 1.00). *High proficiency* was seen in searching for educational content online, yet a notable weakness emerged in creating their own web pages (M = 2.72 for regular; M = 2.83 for science high schools), which fell into the *Nearly Proficient* range. This gap reveals a significant challenge, while teachers consume digital content efficiently, they struggle to produce or design their own online instructional materials. Alvarez (2020) highlighted

that many teachers still lack training in content creation tools, limiting their ability to support blended learning models.

Table 3. Participants Technology Proficiency Self-Assessment Results (Factor 3: Integrated Applications)

Factor 3: Integrated Applications	Self-assessment of Proficiency			
I feel confident that I could…	From Regular High School (N=281)		From Science High School (N=111)	
12. create a newsletter with graphics.	3.35 (1.12)	Nearly Proficient	3.50 (1.07)	Proficient
13. save documents in formats so that others can read them if they have different word processing programs (e.g., saving Word, pdf, RTF, or text).	4.32 (0.95)	Highly Proficient	4.44 (1.03)	Highly Proficient
14. use the computer to create a slideshow presentation.	4.58 (0.67)	Highly Proficient	4.68 (1.01)	Highly Proficient
15. create a database of information about important authors in a subject matter field.	3.50 (1.16)	Proficient	3.63 (1.04)	Proficient
General Weighted Average (SD) / Interpretation:	3.94 (0.97)	Proficient	4.05 (1.05)	Proficient

Teachers showed overall *Proficient* levels in this factor (M = 3.94, SD = 0.97 for regular; M = 4.05, SD = 1.05 for science high schools). Strengths were observed in creating slide presentations and saving documents in compatible formats. However, items like "create a newsletter with graphics" (M = 3.35 regular) revealed *Nearly Proficient* performance for some, indicating gaps in the use of more advanced document editing and desktop publishing tools. Tondeur et al. (2016) suggested that without continuous support, teachers often fail to progress beyond basic ICT functionalities.

Table 4. Participants Technology Proficiency Self-Assessment Results (Factor 4: Teaching with Technology)

Factor 4: Teaching with Technology	Self-assessment of Proficiency			
I feel confident that I could…	From Regular High School (N=281)		From Science High School (N=111)	
17. create a lesson or unit that incorporates subject matter software as an integral part.	3.74 (0.99)	Proficient	3.87 (1.03)	Proficient
18. use technology to collaborate with teachers or students, who are distant from my classroom.	4.26 (0.82)	Highly Proficient	4.29 (1.03)	Highly Proficient
19. describe 5 software programs or apps that I would use in my teaching.	3.67 (1.06)	Proficient	3.77 (1.04)	Proficient
20. write a plan with a budget to buy technology for my classroom.	3.53 (1.07)	Proficient	3.32 (1.04)	Nearly Proficient
General Weighted Average (SD) / Interpretation:	3.80 (0.99)	Proficient	3.80 (1.04)	Proficient

Both teacher groups averaged *Proficient* in this factor (M = 3.80, SD = 0.99 for regular; M = 3.80, SD = 1.04 for science high schools). Teachers were confident in writing about technology integration and collaborating online. However, regular high school teachers scored only M = 3.53 on budgeting for classroom technology—just above *Nearly Proficient*. This suggests that while most teachers understand how to integrate technology conceptually, practical planning and application remain areas for improvement. Ertmer and Ottenbreit-Leftwich (2017) emphasized that true integration requires not just using tools, but strategic instructional planning, including budget allocation and resource evaluation.

Table 5. Participants Technology Proficiency Self-Assessment Results (Factor 5: Teaching with Emerging Technologies)

Factor 5: Teaching with Emerging Technology	Self-assessment of Proficiency			
I feel confident that I could…	From Regular High School (N=281)		From Science High School (N=111)	
22. use social media tools for instruction in the classroom. (ex. Facebook, Twitter, etc.)	4.01 (1.04)	Proficient	4.15 (0.99)	Proficient
23. create a wiki or blog to have my students collaborate.	3.17 (1.14)	Nearly Proficient	3.32 (1.21)	Nearly Proficient
24. use online tools to teach my students from a distance.	4.15 (0.89)	Proficient	4.17 (0.98)	Proficient
25. teach in a one-to-one environment in which the students have their own device.	3.76 (1.02)	Proficient	3.99 (1.05)	Proficient
26. find a way to use a smartphone in my classroom for student responses.	3.99 (0.95)	Proficient	4.13 (0.97)	Proficient
27. use mobile devices to connect to others for my professional development.	4.27 (0.77)	Highly Proficient	4.33 (0.83)	Highly Proficient
General Weighted Average (SD) / Interpretation:	3.91 (0.96)	Proficient	4.00 (1.00)	Proficient

This factor showed consistent *Proficient* ratings overall (M = 3.91 for regular; M = 4.00 for science high schools), but teachers were *Nearly Proficient* in using wikis or blogs for collaboration (M = 3.17 for regular; M = 3.32 for science high schools). Despite strong scores in mobile integration and social media use, the inability to create collaborative online platforms reveals a major challenge in fostering 21st-century student engagement. Ruggiero and Mong (2015) stated that such tools are underutilized despite their significance in participative and student-centered learning environments.

Table 6. Participants Technology Proficiency Self-Assessment Results (Factor 6: Emerging Technology Skills)

Factor 6: Emerging Technology Skills	Self-assessment of Proficiency			
I feel confident that I could…	From Regular High School (N=281)		From Science High School (N=111)	
29. download and listen to podcasts/audio books.	3.79 (1.08)	Proficient	3.95 (1.07)	Proficient
30. download and read e-books.	3.93 (1.04)	Proficient	4.04 (1.07)	Proficient
31. download and view streaming movies/video clips.	4.14 (0.93)	Proficient	4.23 (0.91)	Highly Proficient
32. send and receive text messages.	4.55 (0.71)	Highly Proficient	4.65 (0.66)	Highly Proficient
33. transfer photos or other data via a smartphone.	4.53 (0.71)	Highly Proficient	4.56 (0.75)	Highly Proficient
34. save and retrieve files in a cloud-based environment.	4.16 (0.94)	Proficient	4.10 (0.99)	Proficient
General Weighted Average (SD) / Interpretation:	4.18 (0.90)	Proficient	4.27 (0.90)	Highly Proficient

Teachers scored near the *Highly Proficient* threshold (M = 4.18 for regular; M = 4.27 for science high schools). They showed strong confidence in using mobile devices, managing cloud storage, and transferring data. This factor reflects their comfort with using technology in personal and instructional contexts. Saad and Sankaran (2020) noted that mobile-based technology use has become

increasingly normalized in classrooms, particularly as schools explore more flexible and remote learning models. However, slightly lower scores on engaging with podcasts and e-books (around M = 3.79–3.95) suggest untapped opportunities in diversifying digital content sources for learning.

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5. CONCLUSIONS

This study examined the self-assessed technology proficiency of in-service mathematics teachers from both regular and science high schools, revealing an overall rating of *Proficient* across six key factors. In electronic mail, teachers demonstrated strong foundational communication skills, earning a *Highly Proficient* rating, which indicates that email remains a well-integrated tool for instructional and administrative purposes. Regarding the World Wide Web, teachers were effective in searching for online educational resources; however, their *Nearly Proficient* ratings in web page creation suggest a limited capacity for producing instructional content, highlighting the need for digital content creation training. In integrated applications, educators confidently performed basic tasks such as preparing presentations and saving files in compatible formats, yet their weaker performance in creating newsletters with graphics underscores a gap in using advanced productivity and publishing tools.

For teaching with technology, teachers demonstrated confidence in conceptual integration and online collaboration, but lower ratings in budgeting for classroom technology point to challenges in the practical planning and implementation of tech-integrated instruction. In teaching with emerging technologies, teachers excelled in mobile integration and social media use, though they rated themselves *Nearly Proficient* in using collaborative tools like wikis and blogs, indicating an untapped potential to engage students through participatory online platforms. Lastly, in emerging technology skills, teachers scored near *Highly Proficient*, particularly in mobile device use and cloud storage management, although slightly lower ratings in engaging with podcasts and e-books suggest certain digital content types remain underutilized. These findings underscore the need for ongoing professional development that extends beyond basic ICT use, with a focus on enhancing content creation, strategic integration, and collaborative teaching tools. Strengthening these areas is crucial for fostering a more dynamic, student-centered, and future-ready mathematics education.

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