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Digital Technology Tools (DTT) in Science Teaching: Teachers' Perceptions of Usage and Effectiveness

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Abstract. Digital technology can significantly transform student learning to refine teaching strategies and address diverse student needs. However, not all teachers are prepared for this. Despite this, the sudden changes caused by the COVID-19 pandemic have compelled schools to adopt digital technology tools (DTT) to continue the teaching-learning process. This rapid shift called for greater support and training for educators to adapt effectively. Using a mixed-methods design, this paper explored the usage and effectiveness of DTT in science teaching in public junior high schools in Caloocan City, Philippines. Through purposive sampling, 41 science teachers from three schools participated by answering a questionnaire. It revealed that Messenger, PowerPoint, and Google Meet were the most used DTT during online teaching, while Messenger, PowerPoint, and Canva were the most effective. Messenger facilitates communication, PowerPoint enhances lesson delivery through visual presentations, Google Meet enables virtual interactions, and Canva allows teachers to create engaging and visually appealing materials. Canonical correlation analysis (CCA) did not reveal significant relationships between demographics and DTT usage of science teachers; it suggested other areas to explore, such as years of teaching, which might influence their preferences for specific DTT like Messenger or Zoom. In the face-to-face classes, teachers continued DTT usage – most teachers used PowerPoint, Messenger, and Canva, which were also the most effective DTT for them. Challenges like poor Internet connectivity were encountered, yet most teachers continued using DTT. This shows the critical role of teachers' adaptability in embracing innovations to enrich the learning experience, benefiting both educators and students.

Keywords: digital technology tools; educational technologies; teaching science; online teaching; face-to-face teaching

1. Introduction

Educators must remain versatile to keep pace with the rapid technological advancements shaping our world. Technology has revolutionized education, transforming traditional teaching and learning processes into dynamic and interactive experiences. However, the integration of technology in classrooms has not been without challenges. As Fernández-Batanero et al. (2021) observed, this transition can induce tension and anxiety among teachers, potentially disrupting their routines and complicating their professional roles. Beyond these individual challenges, the overuse of technology may negatively affect students' development of crucial skills, such as fine motor coordination and problem-solving abilities, as noted by Carstens et al. (2021).

Nevertheless, technology holds immense promise for enriching education. Chugh et al. (2023) highlighted that educational technology significantly enhances classroom learning quality, while Himmelsbach (2019) emphasized its role in fostering student engagement. In science education, where hands-on, experimental, and inquiry-based learning are paramount, technology can create interactive and immersive experiences that make complex concepts more accessible. Da Silva (2023) and Shadiev and Yang (2020) further showed how technology supports independent learning and prepares students to meet the demands of the 21st century, redefining collaboration between teachers and students to accommodate diverse learning needs.

In the Philippines, the adoption of digital technology tools (DTT) in education has been hindered by various structural and systemic challenges. Limited resources, insufficient training, lack of motivation, and low levels of information and communication technology (ICT) literacy, as mentioned by Mastul et al. (2023), exacerbate the digital divide. The COVID-19 pandemic amplified these challenges as the abrupt shift to online learning forced teachers and students to adapt quickly to unfamiliar tools and methods. Despite these hurdles, the pandemic has shown the vital role of technology in ensuring the continuity of education and requires that schools modernize their teaching practices. As Nadiyah et al. (2024) claimed, by knowing the technology's role and mitigating the challenges, elementary schools can make learning environments sustainable and impact students and communities. Future studies should focus on further evaluating the effectiveness of technology usage in the context of sustainable education and developing more targeted strategies to address the challenges faced in integrating technology into elementary school curricula.

In the public schools in Caloocan City where the respondents were selected, teachers work in challenging environments with limited instructional resources and large class sizes. A typical public high school science classroom accommodates 50 students, most of whom come from economically disadvantaged backgrounds. Teachers often lack sufficient access to updated laboratory tools, instructional materials, and digital technology provided by their schools. To address these challenges, teachers frequently adapt by using their own financial resources to purchase or create learning materials and incorporate educational technology into their lessons. Despite these constraints, these teachers demonstrate creativity and

resilience in delivering the lesson. They use various methods to engage their students, including repurposing available tools and developing innovative strategies to integrate digital resources into their science lessons. This dedication reflects the commitment of public school teachers to provide quality education even in resource-constrained settings.

This study addresses the need to evaluate the role of digital technology tools (DTT) in science teaching in the context of these challenges in public high schools in Caloocan City. It investigates the digital tools most widely used and perceived as most effective by junior high school (JHS) science teachers during online teaching amid the pandemic, hence their continued application in face-to-face classrooms post-pandemic. Specifically, the study aims to answer the following questions: (a) What digital technology tools (DTT) are used by JHS science teachers during online and face-to-face teaching? (b) What are the most effective DTT utilized as perceived by JHS science teachers in these contexts? (c) Is there a relationship between teachers' demographic backgrounds and their usage of DTT? (d) Is there continuity in the use of DTT in face-to-face classes post-pandemic? By addressing these questions, this study aims to provide insights into the integration of DTT in science teaching, emphasizing the opportunities offered and barriers faced by educators and institutions in fostering modern, inclusive, and effective learning environments.

2. Literature Review

The COVID-19 pandemic brought about an abrupt transformation in the teaching-learning process worldwide, compelling educators to adapt swiftly to online and hybrid modalities. This fast-paced shift emphasized the pivotal role of DTT in ensuring educational continuity amidst global disruptions. This literature review explores the common DTT used in teaching, the challenges faced, their positive outcomes, and the implications for sustainable technology integration in education.

2.1 The Role of Educational Technology

Educational technology systematically utilizes modern tools to enhance the quality of teaching and learning. It involves the implementation and evaluation of teaching practices through advanced technological resources, aiding educators in adopting modern methodologies (Stošić, 2015). Its role in fostering inclusivity and equitable quality education is increasingly recognized. Educators must develop the skills required to integrate technology into their teaching, guiding students in its proper and effective use (Fernández-Batanero et al., 2021; Tuma, 2021). The COVID-19 pandemic heightened awareness of educational technology's significance, urging openness and willingness to adopt digital solutions to maintain equitable learning opportunities for all students, regardless of socioeconomic background (Sousa et al., 2021). Sustainable technology integration is imperative for addressing these disparities, particularly in underserved schools where investment in infrastructure and teacher training is essential (Kim & Jang, 2020; Wahid et al., 2023).

2.2 Challenges in Transitioning to Digital Platforms

One of the most pressing challenges during the pandemic was the exacerbation of the digital divide (Afzal et al., 2023). Disparities in access to devices and reliable Internet connectivity hindered many students from participating effectively in online learning (UNESCO, 2020). Moreover, the sudden transition to online platforms exposed gaps in technological literacy among students and educators, necessitating extensive professional development efforts to equip teachers with the skills to navigate digital tools (Hodges et al., 2020).

The shift to online teaching significantly impacted educators' professional identities, requiring resilience and adaptability in the transition (Daumiller et al., 2021). It also disrupted traditional assessment practices, forcing educators to innovate while addressing concerns about academic integrity (Burmistriva & Makoelle, 2023). The lack of social interaction further impacted students' well-being, amplifying the need for strategies to support mental health (UNESCO, 2020).

2.3 Adoption and Effectiveness of Digital Technology Tools (DTT)

Recent research enumerates the importance of DTT in enhancing educational engagement and learning outcomes. Microsoft PowerPoint remains a widely adopted tool for its ability to organize content and integrate multimedia elements effectively (Ahmad et al., 2023; Rosyiddin et al., 2023). While transitioning from online to face-to-face teaching, tools such as PowerPoint and Canva demonstrated adaptability, aiding both modalities (Pedroso et al., 2023). Communication platforms such as Google Meet and Messenger played important roles during the pandemic. Google Meet facilitated synchronous interactions and collaboration, fostering small-group discussions even in virtual settings (Aguiar et al., 2022; Rofi'i & Herdiawan, 2024). Messenger, widely recognized for its immediacy and accessibility, emerged as an effective communication tool among educators and students, particularly in asynchronous environments (Chang et al., 2022; Pedroso et al., 2023).

Assessment tools like Quizizz, Kahoot, and Google Forms support gamified learning and formative evaluations. Kahoot, for instance, encouraged active participation and competitiveness, enhancing student engagement (Maraza-Quispe et al., 2024). Google Forms provided a straightforward platform for creating quizzes and surveys, aiding teachers in data collection and analysis (Lim et al., 2024). Emerging studies reveal that digital tools such as these also play a significant role in sustainable education, allowing for more personalized and inclusive learning experiences (Shishakly et al., 2024).

2.4 Innovations in Pedagogy and Sustainable Technology Integration

The rapid transition to online learning catalyzed innovation, with educators exploring diverse technologies and instructional strategies to deliver engaging lessons. Platforms such as ClassPoint enhanced student participation and performance, particularly in mathematics (Querido et al., 2023). Virtual collaboration tools enabled students to work on group projects, fostering a collaborative learning environment transcending geographical barriers.

The transition back to face-to-face teaching after the pandemic revealed the long-term benefits and challenges of technology integration. Studies show that many educators and students prefer blended teaching modalities, combining the flexibility of online tools with the personal interaction of traditional classrooms (Stoian et al., 2021; Wahid et al., 2023). Sustainable technology use in education must emphasize eco-responsible practices and focus on developing high-level cognitive abilities (Meylani, 2024; Parmaxi et al., 2024).

2.5 Future Directions

While the pandemic exposed disparities in access to technology and digital literacy skills, it also spurred innovation, collaboration, and professional development. Moving forward, addressing equity issues and upgrading educational technology is essential for creating resilient, adaptable educational systems. Further research should explore DTT in diverse educational contexts, including underserved schools and regions with limited infrastructure (Kim & Jang, 2020; Lahiri, 2024). Additionally, longitudinal studies examining the transition from online to face-to-face teaching with technology can provide deeper insights into sustainable integration practices.

The COVID-19 pandemic serves as a turning point, illustrating the challenges and opportunities associated with digital technology. By fostering a culture of innovation and inclusivity, the education sector can harness the transformative potential of digital tools, paving the way for a more equitable and dynamic learning environment.

3. Methodology

3.1 Design

The study employed a mixed-methods approach. This approach allowed a holistic examination of combining quantitative data from the questionnaire with qualitative insights from follow-up interviews included in the open-ended questions.

3.2 Participants

The study involved forty-one (41) junior high school science teachers from public schools in Caloocan City, selected through purposive sampling. This method ensured that participants possessed specific characteristics relevant to the study, particularly their direct involvement in utilizing at least one DTT in online and face-to-face teaching contexts. These teachers were selected for their unique perspectives and firsthand experiences in utilizing DTT in their instructional practices, making them important sources of insight for the study. The participants varied in age, educational background, designation, and years of teaching. The age of the respondents ranged from 23 to 56 years, with the highest number of participants falling in the 33 and 45 age groups (9.8% each). Other notable age clusters included teachers aged 29 (7.3%) and those between 36 and 40 years (4.9%). In terms of professional designation, the majority of the participants were Teacher I (43.9%), followed by Teacher III (29.3%) and Teacher II (22%). A smaller percentage held advanced roles as Master Teacher I (2.4%) and

Master Teacher II (2.4%). They also differed in their undergraduate or bachelor's degree specializations.

3.3 Development and Validation of the Digital Technology Tools (DTT) Questionnaire

The development of the DTT Questionnaire followed a rigorous process outlined by Creswell (2015), encompassing four distinct phases: planning, construction, quantitative evaluation, and validation. The questionnaire was meticulously crafted to gather comprehensive data on teachers' perceptions and experiences with DTT in online and face-to-face teaching environments. Drawing on established frameworks and guidelines, the researchers integrated various elements to ensure the reliability and validity of the instrument.

The questionnaire comprised three main sections, each designed to elicit specific information from the respondents. The first section consisted of 10 questions adapted from the Basic Education Services Key Result Area Objectives of the Individual Performance Commitment and Review Form (IPCRF), as outlined in DepEd Order No. 42, s.2017. These questions assessed the respondents' proficiency and adherence to the standards set out by the Department of Education (DepEd) of the Philippines.

The second section focused on capturing data related to the frequency of usage and effectiveness of the DTT utilized by the teachers. This section comprised 10 items each, answerable using the Likert scale. By quantifying the frequency of usage and rating the perceived effectiveness of each DTT, the researchers aimed to gauge the extent to which these tools contributed to the teaching and learning process.

In the final section of the questionnaire, three open-ended questions were included to provide respondents with an opportunity to provide qualitative insights into their experiences with DTT. These questions also served as interview prompts, allowing the researchers to delve deeper into themes or issues that emerged during the quantitative analysis.

To ensure the validity of the questionnaire, the researchers sought input from three experts in science teaching. The experts were asked to evaluate the questionnaire using a survey instrument validation rating scale adapted from Oducado (2020). Based on their feedback, the questionnaire was revised iteratively to address any identified issues or concerns. The revised version was then subjected to another round of validation to finalize the DTT Questionnaire for use in the study. Through this validation process, the researchers ensured that the questionnaire was well-designed and capable of effectively capturing the insights and perceptions of the respondents regarding the use of DTT in teaching.

To establish the reliability of the questionnaire, a pilot test was conducted with a representative sample of science teachers from different schools. Internal consistency was evaluated using Cronbach's alpha, with a value of 0.72, which is relatively higher than 0.7, indicating acceptable reliability. Additionally, test-

retest reliability was assessed by administering the questionnaire twice to the same participants at a two-week interval to check for consistency in their responses over time. Feedback from the pilot test was also incorporated to refine and improve the instrument before its final deployment.

3.4 Administration of the Digital Technology Tools (DTT) Questionnaire

Following ethical approval and ensuring participant data privacy, the DTT Questionnaire was distributed to 41 junior high school (JHS) science teachers. Administered via Google Forms, the questionnaire took approximately 10-15 minutes to complete. This method facilitated data collection while respecting participants' time constraints.

3.5 Instruments

3.5.1 *Digital Technology Tools (DTT) Questionnaire*

To gather data on their perceptions and experiences with digital technology tools (DTT), the researchers administered the Digital Technology Tools (DTT) Questionnaire to the participants. This questionnaire was a comprehensive tool for capturing the teachers' perspectives regarding using various DTT in their teaching practices. By soliciting feedback on the perceived effectiveness of DTT using a Likert scale, DTT usage frequency, and challenges encountered with each application, the questionnaire enabled a nuanced understanding of the role of DTT in education.

3.5.2 *Interview*

Semi-structured interviews were conducted to gain deeper insights into teachers' questionnaire responses, allowing for guided yet flexible discussions to explore specific answers. Using convenience sampling, teachers who completed the questionnaire were invited for in-person interviews, and four agreed to participate. This small group was chosen to strengthen qualitative findings by enabling a focused and detailed exploration of their perspectives. Their responses provided richer context and unique experiences and complemented the survey data with insights into using digital technology tools in science teaching.

3.6 Data Analysis

The quantitative data collected from the experts' validation of the DTT Questionnaire underwent analysis using the Statistical Package for the Social Sciences (SPSS) v.29. Fleiss' kappa and mean were obtained to assess the inter-rater reliability of the experts' validation process. Additionally, the frequency of usage and effectiveness ratings of DTT utilized by teachers were determined through quantitative analysis using SPSS v.29. Further, canonical correlations were used to analyze the relationship between the demographic profile of science teachers and the usage of DTT. Meanwhile, the qualitative data from the interview and open-ended questions were subjected to thematic analysis. This qualitative approach enabled the researchers to identify recurring patterns, themes, and insights within the qualitative data, providing a deeper understanding of teachers' experiences and perceptions regarding using DTT in teaching. By employing quantitative and qualitative analyses, the study explored the usage and perceived effectiveness of DTT in online and face-to-face teaching.

4. Results

4.1. Digital Technology Tools (DTT) Questionnaire Validation

Table 1 below shows the validity of the DTT Questionnaire using the adapted instrument of Oducado (2020). The overall mean and the Fleiss' kappa were 4.85 and 0.42, respectively, interpreted as highly accepted with raters' moderate agreement.

Table 1: Digital Technology Tools (DTT) Questionnaire Experts' Validation

Criteria	Mean
1. The items in the instrument are relevant to answer the objectives of the study. *(Content validity)*	5
2. The items in the instrument can obtain depth to the constructs being measured. *(Construct validity)*	5
3. The instrument has an appropriate sample of items for the construct being measured. *(Content validity)*	5
4. The items and their alternatives are neither too narrow nor limited in their content. *(Content validity)*	5
5. The items in the instrument are stated clearly. *(Face validity)*	5
6. The items on the instrument can elicit responses that are stable, definite, consistent, and not conflicting. *(Reliability)*	5
7. The terms adopted in the scale are culturally appropriate. *(Cultural validity)*	5
8. The layout or format of the instrument is technically sound. *(Face validity)*	4.33
9. The responses on the scale show a reasonable range of variation. *(Construct validity)*	5
10. The instrument is not too short or too long so that the participants will be able to answer it within a given time. *(Practical validity)*	4.33
11. The instrument is interesting so that participants will be induced to respond to it and complete it fully. *(Face validity)*	4.33
12. As a whole, the instrument could answer the basic purpose for which it is designed. *(Construct validity)*	5
13. The instrument is culturally acceptable when administered in the local setting. *(Cultural validity)*	5
Average	**4.85**
Fleiss' Kappa	**0.42**

4.2Digital Technology Tools (DTT) Questionnaire Results

4.2.1 DTT usage in terms of Basic Education Services

The usage of DTT in terms of basic education services was measured by 10 key result area objectives: in terms of content, knowledge, and pedagogy; (a) to ensure the positive use of ICT in facilitating the teaching and learning process; (b) in applying various teaching strategies to develop critical and creative thinking and higher-order thinking skills; (c) to establish a learner-centered culture; (d) to plan and deliver teaching strategies that are responsive to the special educational needs of learners in difficult circumstances; (e) in terms of providing timely, accurate, and constructive feedback to improve learner performance; (f) to select, develop, organize, and use appropriate teaching and learning resources to address learning goals; (g) to set achievable learning outcomes aligned with learning competencies; (h) to build relationships with parents/guardians and the wider school

community to facilitate involvement in the educative process; and (i) to participate in professional networks to share knowledge and enhance practice. Overall, Microsoft PowerPoint, Messenger, and Google Meet were the top three DTT used by the respondents in terms of basic education services (Figure 1).

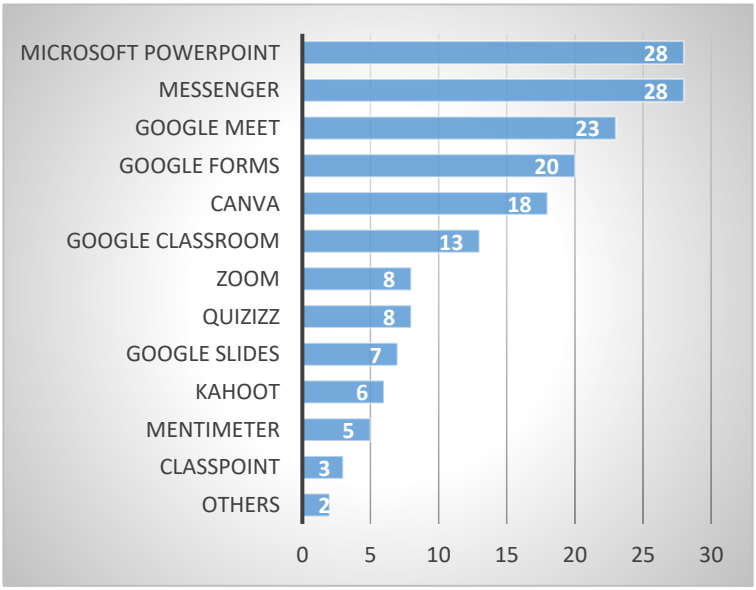

Figure 1: Overall Digital Technology Tools (DTT) Used by Science Teachers Based on Basic Education Services

4.2.2 *Digital Technology Tools Usage and Effectiveness in Online Class*

Tables 2 and 3 summarize the usage and effectiveness of DTT in online classes. The data reveal that Messenger, Microsoft PowerPoint, and Google Meet were the most frequently utilized DTT during online classes. Conversely, Microsoft PowerPoint, Messenger, and Canva emerged as the most effective DTT in facilitating online learning experiences. This shows the prevalence of communication tools such as Messenger, video conferencing platforms such as Google Meet in online educational settings, and presentation software such as Microsoft PowerPoint. Moreover, the effectiveness of Canva, known for its graphic design capabilities, shows the importance of visual aids and multimedia elements in enhancing online teaching and learning. Overall, the findings suggest what DTT fit to be used and effective for JHS science teachers, highlighting the role of these tools in shaping the digital classroom.

Table 2: Usage of DTT in Online Class

DTT	Mean	Usage Description
Messenger	4.63	Always
Microsoft PowerPoint	4.51	Always
Google Meet	4.00	Often
Google Forms	3.73	Often
Canva	3.41	Sometimes
Google Classroom	3.07	Sometimes
Google Slides	2.56	Sometimes
Quizizz	2.56	Sometimes

Zoom	2.54	Sometimes
KaHoot	2.34	Rarely
Mentimeter	2.29	Rarely
Classpoint	1.90	Rarely

Messenger, Microsoft PowerPoint, and Google Meet appeared to be most often used during online teaching.

Table 3: Effectiveness of DTT in Online Class

DTT	Mean	Usage Description
Microsoft PowerPoint	4.24	Effective
Messenger	4.02	Effective
Canva	3.00	Moderately Effective
Google Forms	2.49	Slightly Effective
Google Classroom	2.20	Moderately Effective
Google Meet	2.05	Very Effective
Quizizz	2.02	Rarely
Google Slides	1.90	Rarely
KaHoot	1.73	Rarely
Mentimeter	1.71	Rarely
Zoom	1.71	Rarely
Classpoint	1.54	Rarely

Microsoft PowerPoint, Messenger, and Canva appeared to be the most effective during online teaching.

4.2.3 *Usage and Perceived Effectiveness of Digital Technology Tools (DTT) in Face-to-Face Class*

Tables 4 and 5 summarize the usage and perceived effectiveness of DTT in face-to-face classes. The data indicate that Microsoft PowerPoint, Messenger, and Canva were the most frequently used DTT during face-to-face classes. Similarly, Microsoft PowerPoint, Messenger, and Canva were perceived as the most effective DTT, supporting face-to-face teaching and learning experiences. This underscores the continued importance of presentation software, such as Microsoft PowerPoint, alongside communication tools, such as Messenger, in traditional classroom settings. Additionally, the perceived effectiveness of Canva, known for its graphic design capabilities, shows the value of visual aids and multimedia elements in enhancing face-to-face instruction. Overall, these findings suggest a consistency between the frequency of DTT usage and their perceived effectiveness in face-to-face teaching contexts, emphasizing the enduring relevance of these applications in shaping classroom-based education.

Table 4: DTT Usage During Face-to-Face Class

DTT	Mean	Usage Description
Microsoft PowerPoint	4.07	Often
Messenger	3.90	Often
Canva	3.82	Often
Google Forms	3.74	Often
Google Meet	3.73	Often
Google Classroom	3.21	Sometimes

Quizizz	3.21	Sometimes
Zoom	3.00	Sometimes
Google Slides	2.97	Sometimes
KaHoot	2.89	Sometimes
Classpoint	2.78	Sometimes
Mentimeter	2.68	Sometimes

Microsoft PowerPoint, Messenger, and Canva were the most effective DTT during face-to-face classes.

Table 5: Effectiveness of DTT During Face-to-Face Class

DTT	Mean	Usage Description
Microsoft PowerPoint	3.93	Very Effective
Messenger	3.58	Very Effective
Canva	3.50	Very Effective
Google Forms	2.74	Moderately Effective
Google Slides	2.56	Moderately Effective
Google Classroom	2.55	Moderately Effective
Google Meet	2.52	Moderately Effective
Quizizz	2.43	Slightly Effective
KaHoot	2.42	Slightly Effective
Mentimeter	2.32	Slightly Effective
Zoom	2.25	Slightly Effective
Classpoint	2.24	Slightly Effective

Microsoft PowerPoint, Messenger, and Canva appeared to be the most effective during face-to-face classes

4.2.4 JHS Science Teachers' Demographic Profile and DTT Usage: Canonical Correlation Analysis

Canonical correlation analysis (CCA) was conducted to explore the relationship between two sets of variables. Set 1 included the independent variables, which were demographic and teaching background variables such as age, educational background, grade level currently taught, and number of years teaching experience. Set 2 included usage levels of various DTT, such as PowerPoint, Canva, Google Meet, Messenger, and others. The goal of the analysis was to determine the extent to which the linear combinations of variables in one set were associated with the linear combinations of variables in the other set. In Table 6 below, four canonical functions were extracted, corresponding to the number of variables in the smaller set. The canonical correlations for the four extracted functions were 0.732, 0.565, 0.553, and 0.305, respectively. Though 0.732 (0.6-0.79 range) is a strong correlation, the Wilks' Lambda tests indicated that none of the canonical functions were statistically significant ($\lambda = 0.199$, $p = 0.386$ for the first function; $\lambda = 0.429$, $p = 0.784$ for the second function, and so on). This suggests that the linear combinations of variables from the demographic profile and usage of DTT did not have significant relationships.

Table 6: Canonical Correlations

	Correlation	Eigenvalue	Wilks Statistic	Sig.
1	.732	1.155	.199	.386
2	.565	.469	.429	.784
3	.553	.440	.630	.806
4	.305	.103	.907	.962

In Table 7, the variable Number of Years of Teaching experience had the largest positive weight (1.875) in Canonical Function 1, suggesting its direct relationship to the usage of DTT, which may mean that as the length of teaching experience increases, the usage of DTT is more observable. However, Age has the largest negative weight (-1.608), suggesting an inverse relationship with the usage of DTT, which means that as the teacher grows older, the usage of DTT decreases. However, going back to Table 6, though there is a 0.784 correlation, the p-value is 0.386>0.05, which means there is a non-significant relationship among these variables.

Table 7: Set 1 Standardized Canonical Correlation Coefficients

Variable (Demographics)	1	2	3	4
Age	-1.608	.357	1.604	-1.010
Educational Background	-.823	-.033	-.431	.796
Current Grade Level Taught	.075	.347	-.395	-1.150
No. of Years Teaching Experience	1.875	.746	-1.376	.579

In Table 8, among Set 2 (DTT) variables, Messenger usage had the largest positive weight (0.970) in Canonical Function 1, indicating it plays the most significant role in constructing the DTT canonical variate. Other tools, such as KaHoot (1.038) and Zoom (1.083), also contribute positively to Function 1, while some, such as Canva (-0.775), contribute negatively.

Table 8: Set 2 Standardized Canonical Coefficients

Variable (DTT)	1	2	3	4
PowerPoint	-.229	-.611	-.176	.759
Canva	-.775	-.145	-.248	-.448
Google Meet	.157	-.226	.779	.451
Messenger	.970	.268	-.414	-.005
Classpoint	-.329	.092	.283	.085
Google Classroom	-.341	.278	-.689	-.013
Google Forms	-.721	.190	-.275	-.343
Google Slides	-.029	.741	-.011	-.374
KaHoot	1.038	-1.260	.248	-.800
Mentimeter	-.739	.219	-.065	-.300

Quizizz	.040	.561	-.410	.028
Zoom	1.083	.121	-.004	.544

In Table 9, Canonical Function 1 explains 13.9% of the variance in Set 1 and 4.5% in Set 2. This indicates that the demographic variables have a stronger representation in the first function than the DTT usage variables. The remaining functions explain progressively smaller proportions of variance, suggesting diminishing relationships between the two sets.

Table 9: Proportion of Variance Explained

Canonical Variables	Set 1 by Self	Set 1 by Set 2	Set 2 by Self	Set 2 by Set 1
1	.139	.075	.045	.024
2	.467	.149	.053	.017
3	.244	.075	.201	.061
4	.151	.014	.133	.012

The results indicate weak relationships between the two sets of variables – Set 1 (demographic profile) and Set 2 (usage of DTT) No canonical functions showed statistically significant correlations, as indicated by high p-values for Wilks' Lambda tests. These findings suggest that demographic and teaching background variables in Set 1 are not strongly associated with the usage of digital tools in Set 2.

Although the CCA does not identify statistically significant relationships, the variable weights suggest areas for further investigation, such as educators' years of teaching experience might influence their preferences for specific DTT tools such as Messenger or Zoom. The low shared variance among the sets underscores the complexity of the relationship between demographics and DTT usage, suggesting that additional factors not included in this analysis might be at play.

4.2.5 Continuity of the Use of Digital Technology Tools (DTT)

Teachers were asked whether they still at least any of DTT in face-to-face classes. The analysis revealed continuity in using DTT in science teaching, though it is not without limitations. Many teachers reported partial integration of DTT in their face-to-face instruction, primarily due to limited Internet connectivity and the lack of student access to the necessary gadgets. Statements such as “Not all since it needs (Internet) connection” and “Sometimes, not all have gadgets” illustrate these barriers. However, several respondents acknowledged the usefulness of DTT in facilitating lesson delivery and improving student learning. Responses such as “Yes, because it is very helpful to the students to better understand the lessons” and “It makes the lesson presentation convenient” highlight the perceived benefits of these tools.

Additionally, teachers preferred specific tools, with PowerPoint, Canva, and Messenger emerging as the most widely used DTT. These tools were valued for their ability to support lesson planning, presentation, and communication.

Teachers also emphasized the importance of creativity and adaptability in incorporating DTT to maintain student engagement. Statements such as "Creativity in using these digital tools makes a fun and lively classroom interaction" reflect efforts to sustain dynamic and interactive learning environments. While some teachers noted challenges such as limited time and resources, others expressed optimism about the role of DTT in enhancing science teaching in the current educational setup.

5. Discussion

The study aimed to answer which digital technology tools (DTT) are used by junior high school (JHS) science teachers during both online and face-to-face teaching modalities. Among the DTT in teaching, respondents often use Messenger, Google Meet, Google Classroom, Microsoft PowerPoint, and Google Forms during online teaching (Hodges et al., 2020), and they still use Messenger, Google Classroom, and Google Forms in Face-to-Face classes. Most respondents use Google Meet, Messenger, and Google Forms to communicate with the stakeholders. Overall, the most used DTT are Microsoft PowerPoint, Messenger, and Google Meet. Respondents often use Messenger, Microsoft PowerPoint, and Google Meet during online classes. The teachers mostly used PowerPoint (Ahmad et al., 2023; Rosyiddin et al., 2023) since it can be used online or offline. Students and teachers can also access Messenger even without using data. Given that they are in a public school setting, PowerPoint and Messenger remained the most used DTT in online or face-to-face classes. Canva, which can be used as a presentation tool, took the third spot in face-to-face classes since Google Meet lost its relevance.

The study also wanted to identify the most effective DTT used by JHS science teachers in online and face-to-face settings. Microsoft PowerPoint, Messenger, and Canva were the top 3 DTTs rated very effective in online and face-to-face classes. Microsoft PowerPoint was the most effective DTT used in the return of the full implementation of face-to-face classes. Google Classroom, Google Forms, and Messenger would also be effective face-to-face classes. These are just a few DTT that enhance the quality of teaching and learning. (Chugh et al., 2023; Stošić, 2015; Tuma, 2021).

The study also tried to determine whether there is a significant relationship between the teachers' demographic profile (age, educational background, number of years in teaching, and current grade level handled) and their use of DTT. Canonical correlation analysis did not reveal significant relationships between demographic/teaching background variables and digital tool usage. These findings suggest that demographic and teaching background variables were not strongly associated with the teachers' usage of DTT, as Aljuzayri and Pleasant (2022) did not find any significant relationship between all possible demographic factors about self-efficacy and professional development and the use of technology tools in the classroom, The absence of significant results may be attributed to several factors, including a small sample size, potential multicollinearity among variables, or insufficient variability in the data. Moreover, the high positive weights for variables like Messenger Usage suggest

that certain tools may still hold importance, even if their broader relationships are not statistically significant.

Finally, the continuity of usage of these DTT in face-to-face classes was also examined. DTT usage in face-to-face science teaching reflects a growing emphasis on blended pedagogical approaches. Despite transitioning back to traditional classroom settings, teachers continue to incorporate digital tools to enhance instruction, as also found in the work of Oguguo et al. (2023). Frequently mentioned tools like PowerPoint and Messenger are lauded for their practicality and versatility in supporting synchronous and asynchronous teaching processes. The effectiveness of DTT differs between online and face-to-face classes based on their purpose and environment. During online learning, Messenger facilitated communication through instant messaging, ensuring timely feedback and interaction. PowerPoint enhanced structured, visually rich lessons, improving comprehension of complex topics, while Google Meet supported synchronous discussions and collaborative learning by enabling virtual interactions. In face-to-face settings, the tools are adapted to different roles. Messenger remained valuable for updates and assignment reminders outside the classroom. PowerPoint enhanced lesson delivery with dynamic visuals, making lectures more engaging. Canva gained importance by allowing teachers to create visually appealing instructional materials, such as posters and handouts, enriching in-person lessons.

Strategic use of these tools can maximize their impact. Messenger is ideal for real-time communication in online settings and post-class engagement in face-to-face scenarios. PowerPoint suits pre-recorded or live online presentations and serves as a visual aid in physical classrooms. Google Meet is crucial for synchronous online sessions but less relevant in face-to-face classes. Canva excels in creating engaging materials for both digital and printed formats. As Haleem et al. (2022) noted, digital technologies are essential for fostering inclusivity and equitable quality education.

6. Conclusion

Abrupt transformation in the teaching and learning process due to the COVID-19 pandemic has forced teachers to upgrade their skills in technology use to keep moving forward. It was noticeable from the data that most science teachers learn to adapt to integrating DTT in the classroom. This presents an awareness of the preferences and experiences of teachers through a thorough analysis of the usage patterns and effectiveness of various DTT.

This study features the transformative role of DTT in science education, underscoring its effectiveness in both online and face-to-face settings. The findings have broader implications for the education system, particularly in the Philippines as a developing country, where integration of DTT can address challenges in lesson delivery and engagement. Tools such as Microsoft PowerPoint, Messenger, and Canva emerged as the most effective, reflecting their adaptability across modalities and accessibility in resource-constrained contexts. These insights suggest the need for policy reforms that promote teacher training,

infrastructure development, and equitable access to digital tools to support the seamless adoption of DTT in schools. This study contributes to the growing literature on technology-enhanced learning in developing countries. The findings demonstrate how tools such as PowerPoint and Messenger remain popular owing to their practicality, while Canva offers value in creating engaging materials. These tools are now essential even in traditional classroom setups, indicating a shift toward blended pedagogical approaches.

The demographic profile of teachers, such as age, educational background, current grade level handled, and number of years in teaching, found no significant relationship to DTT usage. Teachers can view this in a positive light. Since age, years of teaching experience, educational background, and grade level taught do not directly affect the usage of DTT, whether old or young, teachers may explore the use of DTT in classroom instruction. The qualitative data underlines that while technological applications offer potential in online teaching, their effectiveness is hindered by systemic issues such as poor Internet infrastructure, lack of adequate devices, and digital literacy gaps. To mitigate these challenges, institutions could improve Internet access and affordability, provide devices or subsidies for students and teachers, offer training sessions to enhance digital literacy, and design online teaching strategies less dependent on high-speed Internet or advanced devices. Such efforts could enhance the inclusivity and effectiveness of online teaching environments.

Future research should explore the use of DTT in other subjects and in schools with limited access to technology, addressing gaps in implementation. Additionally, this study acknowledges limitations, such as its small sample size and challenges in data collection, which may have influenced the findings. Greater transparency about these constraints enhances the reliability of the research and paves the way for more comprehensive studies that can further validate and expand upon these results.

7. Recommendation

Various DTT are significant in online and face-to-face teaching contexts. However, challenges, such as poor Internet connectivity, persist across both instruction modalities. To address these issues and further enhance the effectiveness of DTT in teaching, the following research recommendation is projected.

Given the widespread use and perceived effectiveness of Microsoft PowerPoint, Messenger, Google Meet, Google Classroom, and Google Forms in teaching, future research should investigate strategies to mitigate the impact of poor Internet connectivity on integrating these DTT into teaching practices. This could involve exploring alternative communication methods or technological solutions that rely less on stable Internet connections, particularly in regions or contexts where Internet access is limited and unreliable. Also, considering the importance of student interest, engagement, and skills in adapting to and exploring DTT, future research could explore the factors influencing students' proficiency and comfort levels with these DTT. This could involve conducting qualitative studies

to explore students' perceptions, experiences, and preferences regarding using specific DTT in their learning environments. Additionally, while the effectiveness of Microsoft PowerPoint, Messenger, Google Classroom, Google Forms, and other DTT has been highlighted, further research could investigate the specific pedagogical approaches and teaching strategies that maximize the benefits of these tools in both online and face-to-face teaching settings. This may involve conducting comparative studies to evaluate the impact of different teaching methods or DTT on student learning outcomes and engagement.

In associating the demographic profile of teachers with the usage of DTT, future research may include additional variables, such as teacher attitudes toward technology, access to resources, or institutional support, to capture the factors influencing DTT usage. A larger and more diverse sample may enhance statistical power and improve the robustness of the findings. Multivariate approaches, such as structural equation modeling or factor analysis, may provide deeper insights into the relationships among variables. These may yield more actionable insights into the chemistry of demographic factors and technology use in educational settings.

Overall, by addressing these research recommendations, educators and policymakers can better harness the potential of DTT to enhance the quality of teaching and learning experiences while also addressing the challenges associated with their implementation, particularly in contexts where Internet connectivity is a limiting factor.

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Appendix 1

Digital Technology Tools Questionnaire

The **Digital Technology Tools Questionnaire** seeks to gather insights from science teachers on their use, perceptions, and the effectiveness of digital tools in teaching. It aims to evaluate how these tools support innovative strategies and improve educational outcomes in basic education.

The survey covers:

1. **Usage of Digital Tools –** Identifying tools used for fostering higher-order thinking, learner-centered strategies, and addressing diverse student needs.
2. **Perceptions and Effectiveness –** Assessing the frequency and effectiveness of these tools in online and face-to-face teaching.
3. **Open-ended questions –** Exploring challenges faced, reasons for tool usage, and their impact on teaching practices. Your input is valuable for improving the integration of technology in education. Thank you for your participation!

Your participation in completing this questionnaire is valuable and greatly appreciated.

Science Teachers' Perceptions on the Usage and Effectiveness of Digital Technology Tools in Teaching
Questionnaire

Name: _____ Age: _____ Position: _____

Educational Background *Number of years of teaching* _____

Bachelor's Degree: _____ Grade Level you are teaching: _____

Specialization: _____

Master's Degree: _____ Doctoral: _____

I. Usage of Digital Technology Tools in Basic Education Services

Direction: Put a check on digital technology tool/s (used in face-to-face teaching) that correspond to your answer in each item. Please choose all that apply.

Key Result Area	Digital Technology Tools												
	Canva	Class-point	G Class-room	G Forms	G Meet	G Slides	Kahoot	Menti-meter	Messen-ger	Microsoft Powerpoint	Quizizz	Zoom	Others. Specify
1. Which of these applications do you use to apply knowledge of content within and across curriculum teaching areas?													
2. Which of these applications do you use to ensure the positive use of ICT in facilitating the teaching and learning process?													
3. Which of these applications do you use to apply a range of teaching strategies to develop critical and creative thinking, as well as other higher-order thinking skills?													
4. Which of these applications do you use to establish a learner-centered culture (by using teaching strategies that respond to their linguistic, cultural, socioeconomic and religious backgrounds)?													
5. Which of these applications do you use to plan and deliver teaching strategies that are responsive to the special educational needs of learners in difficult circumstances?													

6. Which of these applications do you use for providing timely, accurate and constructive feedback to improve learner performance?													
7. Which of these applications do you use to select, develop, organize, and use appropriate teaching and learning resources to address learning goals?													
8. Which of these applications do you use to set achievable learning outcomes that are aligned with learning competencies?													
9. Which of these applications do you use to build relationships with parents/guardians and the wider school community to facilitate involvement in the educative process?													
10. Which of these applications do you use to participate in professional networks to share knowledge and to enhance practice?													

II. **Perceptions of Usage and Effectiveness of Digital Technology Tools**

A. Direction: Put a check that corresponds to your response in the questions below.

Technological Application	1. How often did you use these applications in your online class.					2. How often do you use these applications in your face-to-face class?				
	Never 1	Rarely 2	Some-times 3	Often 4	Always 5	Never 1	Rarely 2	Some-times 3	Often 4	Always 5
Canva										
Classpoint										
Google Classroom										
Google Forms										
Google Slides										
Kahoot										
Mentimeter										
Messenger										
Microsoft Powerpoint										
Quizzizz										
Zoom										
Others (Specify) _____										

B. Direction: Put a check corresponding to your rating of each technological application.

Technological Application	1. How effective were the following applications in your online classes?						2. How effective are the following applications in your face-to-face classes?					
	Not Applicable 0	Not at all effective 1	Slightly Effective 2	Moderately Effective 3	Very Effective 4	Extremely Effective 5	Not Applicable 0	Not at all effective 1	Slightly Effective 2	Moderately Effective 3	Very Effective 4	Extremely Effective 5
Canva												
Classpoint												
Google Classroom												
Google Forms												
Google Slides												
Kahoot												
Mentimeter												
Messenger												
Microsoft Powerpoint												
Quizzizz												
Zoom												
Others. Specify _____												

IV. Direction: Please answer these questions briefly.

1. What were the challenges you encountered in using these Digital Technology Tools in online teaching?
2. Do you still use Digital Technology Tools during this face-to-face teaching? Why or why not?
3. What are the challenges you encountered in using Digital Technology Tools during this face-to-face teaching?