CJED
CARIBBEAN JOURNAL OF EDUCATION AND DEVELOPMENT

Preservice Teachers' Readiness to Integrate Technology at a Teachers' College in Jamaica

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Abstract

Education remains the most significant catalyst in any country's national development. The quality of teachers, influenced by the quality of the training received, directly impacts a country's education system. This mixed methods study assessed preservice teachers' readiness to integrate technology effectively based on self–efficacy, modelling of technology use, age, gender, specialization, year of study, and the training received. The analysis of quantitative data revealed a moderate positive correlation between techno–pedagogic knowledge and self–efficacy and modelling of technology use by teacher educators; and no statistically significant difference in preservice teachers' techno–pedagogic knowledge based on age, specialization, gender, and year of study. Qualitative data supported and further explained the quantitative findings, but indicated there was some hesitancy in using technology because of a lack of confidence in addressing challenges; and that although some teachers observed technology integration, their approach was still limited and traditional. Recommendations based on the findings include the need for more deliberate teaching, assessment, and feedback on technology integration; greater guidance and support for preservice teachers; and professional development for teacher educators.

Keywords: Jamaica, preservice teachers, TPACK, teacher education, teacher training, technology integration, techno–pedagogy

Background

Education remains the most significant catalyst in any country's national development, with teachers being the primary drivers of its education system. The quality of teachers, influenced by the quality of the training they receive, directly impacts a country's education system (Smith–Sherwood, 2017). While what should be included in teacher preparation programmes continues to be debated, it is widely accepted that observation of model teachers and opportunities for practice are essential elements of any teacher training programme (George et al., 2017; Smith–Sherwood, 2017). However, the 21st century approach to teaching has resulted in an additional component to teacher preparation — the integration of technology in teaching and learning (Tran et al., 2020).

Globally, the developments in information communication technologies (ICT), an integrated set of technological tools and resources employed for processing and communicating information, including electronic and digital devices such as computers, the internet, and various broadcasting technologies, have influenced educational reform, and technology training has become an important element of many teacher–training programmes, recognizing that technological skills are an essential part of 21st century capabilities (Drummond & Sweeney, 2017; Kaware & Sain, 2015). The most recent influence on education reform in Jamaica was a decade–long (2011–2020) National Education Strategic Plan (NESP). The National ICT in Education Policy and the National Curriculum Policy were established as products of the

Submitted 17 March 2025
Accepted 25 August 2025
Electronically published 3 March 2026

https://doi.org/10.46425/cjed402013686

Caribbean Journal of Education and Development,
Vol. 2 No. 1 2025
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The University of the West Indies, Mona • ISSN 0799-6977

NESP, which resulted in the development of ICT Integration Standards and the National Standards Curriculum (NSC) respectively (Mayne & Dixon, 2020). The NSC reflects the newly developed ICT Integration Standards and has been implemented in stages since 2016. How preservice teachers are prepared and substantial changes in instructional methods are areas of focus to address the "radically different" approach required by the NSC, which involves the infusion of "traditional academic curriculum with elements of technical and vocational education [to] nurture learners who are critical thinkers, problem solvers, and collaborative learners" (George et al., 2017, p. 125).

In Jamaica, over 25 institutions offer some form of teacher preparation programme, of which eight government–assisted teachers' colleges operate collectively under the aegis of the Teachers' Colleges of Jamaica (TCJ), offering a four–year baccalaureate degree in early childhood, primary, and secondary education (George et al., 2017). TCJ, through partnership with the colleges, seeks to prepare "teacher professionals of the highest standard [using a] common framework for teacher education to mitigate discrepancies and enhance efficacy" (Teachers Colleges of Jamaica, 2021, p. 1). It is expected that preservice teachers who complete a course of study at any of these eight institutions would know "how to use current instructional strategies" and can "utilize ICT in teaching" (Teachers Colleges of Jamaica, 2021, p. 2). However, the inability of teacher training to keep pace with the technology is a challenge noted by one education practitioner more than 20 years ago (Peart & Sheffield, 2001).

Problem Statement

Preservice teachers trained in institutions under the TCJ seem to possess insufficient student–centred pedagogy training in areas such as technology integration in teaching and learning. This is reflected in their techno–pedagogic knowledge, which has resulted in: (1) graduates who are under–prepared to engage 21st century learners effectively in the classroom and execute the technology–infused NSC (The Jamaica Education Transformation Commission, 2021), (2) students who are underserved resulting in underperformance, and (3) increased expenditure by the government to retrain in–service teachers (World Bank Group & UNICEF [United Nations Children's Fund], 2021). *Techno–pedagogic knowledge* refers to "the use of technological developments as educational tools and deals with [the integration of] content, pedagogical and technological knowledge" (Türkeli, 2022, p. 604). Research in Jamaica highlighted preservice teachers' recognition of the lack of training and support received in using technology for teaching and learning (Roofe & Miller, 2013). Mayne and Dixon (2020) reported that the implementation of the NSC has been inhibited by the deficit in "meeting the demands of the technological age [which involves the]…skills and competencies necessary for learning in the 21st century" (p. 37). If the problem of insufficient student–centred pedagogy training in technology integration continues unabated, this can potentially undermine the goal of the new curriculum, that of "teaching and learning representative of international standards and global trends", and the development of citizens with 21st century skills who are lifelong learners (Mayne & Dixon, 2020, p. 31). This explanatory sequential mixed methods study aimed to assess preservice teachers' readiness, as per their techno–pedagogic knowledge (TPACK), to integrate technology effectively based on self–efficacy, modelling of technology use, age, gender, specialization, year of study, and the training received at a teacher–training institution in Jamaica.

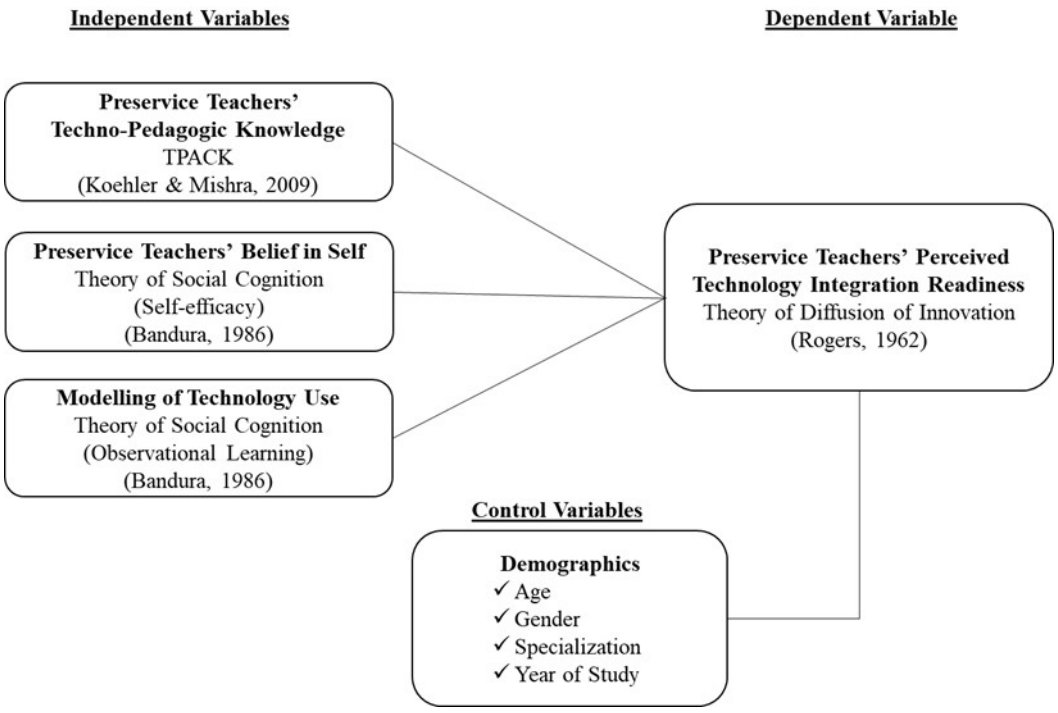
Literature Review

Conceptual Framework

The Theory of Diffusion of Innovation, proposed by Rogers in 1962, formed the theoretical underpinning of the construct examined. Independent variables in the study included preservice teachers' self–efficacy regarding technology and the modelling of technology use by teacher educators — both grounded in Bandura's 1986 Theory of Social Cognition, and preservice teachers' technological knowledge (as assessed by TPACK) purported by Koehler and Mishra in 2009. The control variables in the study were age, gender, specialization, and year of study. Figure 1 presents the conceptual framework showing the relationships assessed in the study.

Figure 1

Diagrammatic Representation of the Conceptual Framework



Theoretical Constructs

Social Cognitive Theory

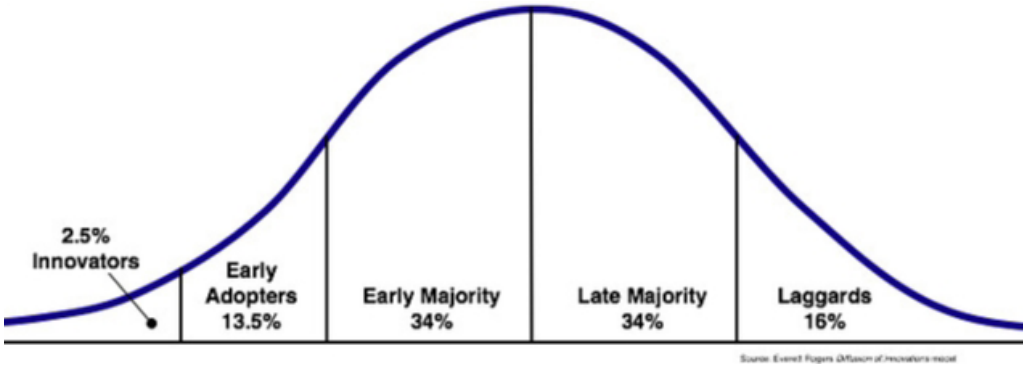
Unlike earlier theories, with a somewhat linear approach to behaviour being a product of the person and environment, Bandura suggested that behaviour, environmental, and personal factors all interact and are equal determinants of each other (reciprocal determinism) (M. Zhou & Brown, 2015). This theory is based on the belief that learning occurs in a social context through interactions with others and observation; people assimilate and reproduce these behaviours in unique ways, often based on positive experiences, which may include rewards related to the behaviour (Nabavi, 2012).

Theory of Diffusion of Innovation

The Theory of Diffusion of Innovation is based on the notion that the adoption of a new idea, even if it is advantageous, is often very challenging and requires a significant time before it is widely embraced (Rogers, 1983). Diffusion is a form of social change caused when new ideas (planned or spontaneous) are "invented, diffused, adopted or rejected" (Rogers, 1983, p. 6). The suggestion is that for diffusion to occur, the innovation has to be communicated to members of the social group, over time, through specific channels. Additionally, the adoption of innovation by individuals has been categorized by Rogers (1983) into five groups, with each group exhibiting unique characteristics, from being venturesome and eager to experiment with new ideas (Innovators) to being traditionalists, basing their decisions on past generations' experiences, often embracing an innovation at a point when another has surpassed it (Laggards). A normal distribution curve has been utilised to apply the adopter categorization to any "normally" distributed population (see Figure 2).

Figure 2

Theory of Diffusion of Innovation Curve



Note. Adaptation of Everett Rogers' diffusion of innovation curve. From "Diffusion of Innovation" by W. Fryer, 2007, Flickr (https://www.flickr.com/photos/wfryer/1342355056/). CC.

Given the focus of this study on preservice teachers' level of self–efficacy and teacher educators modelling the use of technology, the idea purported by the Social Cognitive theory about the social nature of learning (which occurs through observation) and the extent to which belief in one's self affects the ability to utilize technology, directly aligns to the current research. Furthermore, the application of the Theory of Diffusion of Innovation to current preservice teachers (assuming a normally distributed population) would suggest that most of them are Early and Late Majorities, delayed in their adoption of technology and skeptical about its use. This theory also presupposes that the teacher education programme exposes preservice teachers (including teacher educators) to technology over time in different ways, thus its use in undergirding this study.

Technological, Pedagogical Content Knowledge (TPACK)

More than 30 years ago, Shulam developed a concept that focused on teachers' pedagogical content knowledge, suggesting that pedagogy and content knowledge are inextricable (Drummond & Sweeney, 2017). However, the authors contend that, with the increase in technology use in education, recent revisions (e.g. Koehler & Mishra, 2009) now emphasize technological knowledge, positing a view that technology should not be seen as separate from teaching and learning, thus forming what is now referred to as the TPACK framework. According to Lee and Kim (2017), there are three distinct forms of teacher knowledge — content knowledge (CK), pedagogical knowledge (PK) and technological knowledge (TK). These forms of knowing overlap in sections to create additional components — pedagogy and content knowledge (PCK), technology content knowledge (TCK), and technological and pedagogical knowledge (TPK). The interplay of all these is collectively known as technological, pedagogical content knowledge (TPACK) (see Figure 3).

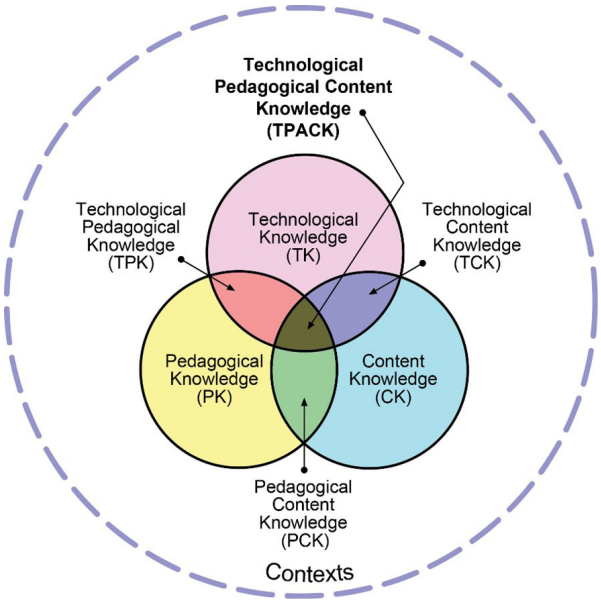
Technology and Teacher Education

In the past decade there have been more changes in the educational landscape than seen in 100 years, a response to the fourth industrial revolution spurred by the advancement of technology (Kolesnikova, 2020; Sakhapov & Absalyamova, 2018). As postulated by Kolesnikova (2020), evidence of this impact is manifested in part by the "rapid change of educational standards, uncertainty of the content of education, and transformation of the teacher professional position" (p. 94). This was

recently highlighted when the need to integrate technology in teaching and learning became more crucial in 2020 because of the global COVID–19 pandemic. According to Lyublinskaya and Kaplon–Schilis (2022), the abrupt switch to virtual learning environments emphasized many teachers' struggle to utilise technology. Modern technologies demand that teachers learn how to use them, thus increasing the need for training (Raja & Nagasubramani, 2018). Lyublinskaya and Kaplon–Schilis (2022) contended, "teacher education programs need to prepare preservice teachers to relearn, rethink, and reframe learning and teaching by taking advantage of the communication, collaboration, and inquiry technologies for 21st century instruction" (p. 1).

Figure 3

The TPACK Framework and Knowledge Components



Note. Adaptation of Matthew Koehler and Punya Mishra's TPACK. From "Using the TPACK Image" by M. Koehler, 2011, TPACK.ORG (https://tpack.org/wp-content/uploads/2024/07/TPACK.png). CC.

In Jamaica, the preparation of teachers appears to follow a process similar to teacher training globally — a 3–4–year programme marked by the completion of courses to develop content and pedagogy skills, and opportunities to engage in supervised field practice (Roofe & Miller, 2013). As suggested by the authors, the curriculum offered and the training product determine the quality of any teacher–training programme. However, they contend that current teacher preparation programmes do not adequately prepare students. According to Mirzajani et al. (2015), lack of access to resources, lack of training and limited experience with technology use, and unknown advantages in educational settings are "hindrances in full integration of ICT" (p. 25). The study by Roofe and Miller (2013) appeared to echo similar sentiments, as participants had high expectations of teacher educators, but their inability to deliver content effectively led to them feeling underserved and underprepared to become teachers.

Preservice Teachers' Technology Integration

The current shift in the use of technology in education, from an "add–on" to being embedded in the curriculum, requires teachers at all levels to be adequately prepared to integrate it effectively. This integration is often referred to as educational technology, or instructional technology, and is "the study and ethical practice of facilitating learning and improving performance by creating, using and managing appropriate technological processes and resources" (Kaware & Sain, 2015, p.25). Preservice teachers represent the next generation of teachers and are expected to adequately utilise educational technology in teaching and learning.

Self–Efficacy and Technology Integration

Preservice teachers enter teacher education programmes having prior experiences with technology integration based on their exposure in pre–tertiary education, through the use either by teachers or for their own academic purposes (Ebersole, 2019). As a result, different levels of technological exposure and competencies exist, which may manifest in the self–efficacy exhibited. Studies have found that perceived competence in technology was a statistically significant predictor of technology integration (Aslan & Zhu, 2017); there is a high positive correlation between techno–pedagogical education competency and technology integration self–efficacy beliefs (Birisci & Kul, 2019); and that perception of digital competency was positively

related to self–efficacy (Elstad & Christophersen, 2017). These studies highlighted that "increasing the technology integration self–efficacy beliefs of preservice teachers is vital in shaping their educational levels" (Birisci and Kul 2019, p. 78).

Modelling of Technology Integration by Teacher Educators

Many preservice teachers adopt a teaching style and approach to the classroom based on their experiences in teacher education programmes (Tiba & Condy, 2021). One key determinant is the interaction that preservice teachers have with their teacher educators, who serve as models of expectations, directly and indirectly (Özüdoğru & Çakir, 2020). According to Uerz et al. (2018), "teacher educators are not just teachers", as they have a unique group of students who will one day become teachers and managers of classroom spaces (p. 13). Hence, in addition to being teachers, teacher educators are expected to "serve as role models for their students in teaching with technology", strengthening the efficacy beliefs of preservice teachers (Uerz et al., 2018, p. 13). Recent studies suggested a link between teacher educators modelling the use of technology and preservice teachers' attitude towards technology (Tiba & Condy, 2021); competency in (Roulston et al., 2019); and subsequent adoption of technology in teaching and learning (Özüdoğru & Çakir, 2020).

Demographics

Demographic variables such as age, gender, specialization, and year of study have varying impacts on technology integration. According to Albion et al. (2011), there is a myth about a generational gap related to ICT; however, the rapid development of technology has resulted in the use of one's age and generation as markers to suggest technological competence, with terms such as "digital immigrants", "digital natives" and "digital learners" denoting distinct groups (Creighton, 2018). With more than four generational groups alive today, current teachers (some of whom are learning about and trying to adopt new technology) are educating students born into a digital world (Prensky, 2001). Studies have suggested that age influences technology adoption and use, with some indicating that while there is a significant variation in participants' knowledge and use of ICT based on age, this did not affect the inclusion of technology in teaching and learning (Gómez–Trigueros et al., 2019; Redmond & Peled, 2019; Šabić et al., 2021).

The *digital gender gap* refers to the difference in basic computer skills, access, and use of technology by males and females (Gómez-Trigueros & Yáñez de Aldecoa, 2021). Several studies have suggested that there is a significant difference between male and female preservice teachers' use of technology (e.g. Çebi & Reisoğlu, 2020; Gómez–Trigueros & Yáñez de Aldecoa, 2021; Grande–de–Prado et al., 2020); while others (e.g. Caner & Aydin, 2021; Keser et al., 2015; Yusop et al., 2021) have reported no difference. In the Jamaican context, Martin (2019), using a mixed methods approach involving 30 preservice teachers explored the influence of gender on preservice teachers' perceptions regarding their ability to integrate ICT. The results were statistically significant, with the difference between male and female perceptions of preparedness being -0.498.

Teacher education programmes prepare individuals to teach at various levels of the education system through training focused on areas such as early childhood, primary, and secondary education. Secondary training involves focused preparation in a specific discipline, for example, Mathematics or Science. According to Kale and Akcaoglu (2018), there exist fundamental differences in how preservice teachers are prepared for the elementary classroom compared to the secondary classroom, with elementary-trained teachers favouring a more student-centred approach with greater emphasis on instructional methods.

Regarding subject specialization, Aslan and Zhu (2017) analyzed data collected from 599 preservice teachers across science, elementary mathematics, social sciences and Turkish teaching disciplines, revealing that science teachers' average integration index was higher than the other groups. In another study conducted by Yusop et al. (2021) involving 1,133 preservice teachers enrolled in three universities in Indonesia, the results of the ANOVA test revealed a significant difference between majors, with science education producing the highest mean and preschool and primary education the lowest.

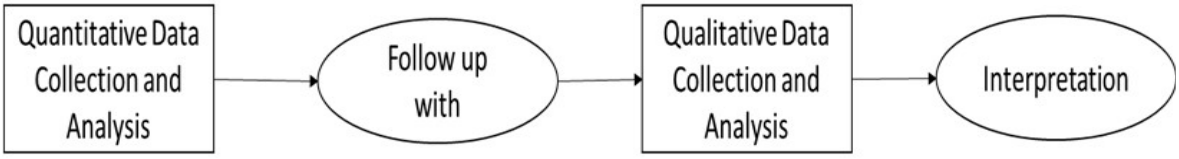
Finally, teacher education programmes vary in duration; however, it is expected that as preservice teachers progress through their programme, there will be an improvement in content, pedagogical, and technological skills. Some studies have revealed a difference in technological skills based on the year of study. Gill et al. (2015) tracked the development of ICT competence of 11 preservice primary teachers in New South Wales over the 3 years of their teacher education programme. The data revealed that in their first year of teacher training, preservice teachers were "uncritical and accepting", but by their final year, they began to reflect on experiences, critically analysing circumstances when ICT is used and the appropriateness of its use (Gill et al., 2015, p. 49).

Methodology

The research employed a mixed methods explanatory sequential design (see Figure 4) to capture the perspectives of a larger sample, while also providing deeper insight which neither a quantitative nor a qualitative approach could offer separately.

Figure 4

Explanatory Sequential Design



Note. Adapted from Creswell (2012).

Ethics and Recruitment

Following research ethics committee approval, the details of this study were shared with the institution's administration and permission obtained. A video providing an overview of the purpose, procedures, and methods of confidentiality, along with informed consent, and the questionnaire were sent to the target population by the system administrator, with all participants included in the study indicating consent. Additionally, approval was sought and received from the developers of two pre-established instruments, Dr. Coleen Moore-Hayes and Professor Isil Kabakci Yurdakul, for the modification and use of the Teacher-Efficacy Scale and TPACK-Deep Survey instruments, respectively.

Population and Sample

The target population was full–time preservice teachers in their final 2 years of study at a Jamaican teachers' college, because, based on their programme spread, these students would have completed the two core technology– related courses (Introduction to ICT and Educational Technology) and practicum experience (135 hours for students in their third year and 405 hours for students in their fourth year). The course, Introduction to ICT, would have provided all students with the fundamental principles related to computer hardware and software, while Educational Technology introduced them to the application and integration of technology, grounded in educational theories. Practicum experiences provided the opportunity for supervised practice. Total population sampling was first applied to collect quantitative data, as the target population was already limited to only Year 3 and 4 students (see Table 1). Table 2 indicates that 86% of respondents were 18–25 years old; 80.9% were female and 17% male; 67% were in their penultimate year and 33% were in their final year; and based on specialization, 5.3% were in Early Childhood, 24.5% in Primary, and 70.2% in Secondary.

The sample for the qualitative aspect of the study involved a small subset of the individuals who participated in the initial quantitative phase. Participants were selected using criterion sampling, based on the completion of the questionnaire in the first phase; specialization; year of study; and indication of a willingness to engage in the focus group. Four Year 3 and 3 Year 4 preservice teachers indicated a desire to participate in the focus group. Given the limited response, all were included (see Table 3).

Data Collection

Data was collected in two phases, beginning with the collection of quantitative data. In Phase 1, a self–assessment questionnaire was used — this was a combination of two previously developed scales — the Teacher–Efficacy scale (Moore–Hayes, 2011), and the Techno–pedagogical Competencies Scale (TPACK–deep) (Kabakci Yurdakul et al., 2012). Four other items related to the participant's assessment of the extent to which faculty modelled technology integration were included, three of which were developed based on items in a study by Schmidt et al. (2009). Feedback from the pilot testing resulted in items being adjusted to reduce ambiguity, utilize simpler and more familiar terminologies, and include more relatable examples to explain the concept being assessed. The final instrument had three sections (Self–Efficacy, TPACK, and Faculty) consisting of 42 items, in addition to demographic data related to age, gender, year of study, and specialization.

To ensure the highest possible response rate, participants had three ways to access the questionnaire: clicking on a link sent via email, scanning a quick response (QR) code, or reading the physical document. A disclaimer for informed consent (See Figure 5) was provided in both versions of the questionnaire. The initial analysis of the data from the questionnaire provided the framework for the development of the questions used in the semi–structured focus group (See Table 4). Participants who completed the second[1] informed consent document were collated and vetted for selection, resulting in two focus group sessions, one for each year of study.

Table 1

Distribution Based on Specialization and Year of Study

Specialization	Year 3	Year 4	Total
Early Childhood	7	5	12
Primary	21	7	28
Secondary	48	50	98
Total	**76**	**62**	**138**

Table 2

Demographic Characteristics of Participants

Characteristics	n	%
Age		
18 – 21	44	46.8
22 – 25	37	39.4
26 – 29	2	2.1
30 – 34	9	9.6
35 or older	2	2.1
Gender		
Male	16	17.0
Female	76	80.9
Missing	2	2.1
Year of Study		
Three	63	67.0
Four	31	33.0
Specialization		
Early Childhood	5	5.3
Primary	23	24.5
Secondary	66	70.2

Table 3

Distribution of Focus Group Participants

Focus Group	Specialization	N
1: Year 3	Early Childhood	0
	Primary	2
	Secondary	2
2: Year 4	Early Childhood	0
	Primary	0
	Secondary	3

1 The first informed consent was for the collection of data using an anonymous questionnaire. The second informed consent was in relation to the focus group and indicated how the sensitive data would be secured and handled, i.e. saving the audio recording on a password-protected device, use of pseudonyms to protect the identity of those named, and the subsequent destruction of all files.

Table 4

Interview Protocol

Before recording starts	The researcher will ensure all participants have used pseudonyms and where this was not done, they will be asked to rename themselves. They will also be asked to remove any display images which may be used to identify them.
Opening Statement	Thank you for availing yourself for this aspect of the study. This focus group session is being conducted virtually on _____(date) as a second phase in the data collection process for the study investigating *Preservice teachers' readiness to integrate technology at a teachers' college in Jamaica.* The focus group involves _____ (number of participants) _____ (year of study) preservice teachers. The session is intended to last for approximately one hour and will be recorded. The recording will be stored on a password–protected device and will not be shared in any way. All participants were required to complete an electronic informed consent document and provide pseudonyms for the interview process. Participation in this process is voluntary and you are free to refuse to answer any questions posed. You may use the raise hand feature to indicate or open your mic at an opportune time and respond. Whatever is shared in this session is to remain here and you are being asked not to discuss or share the responses of your colleagues with anyone. Are there any questions? If there are no (more) questions, I will ask each of you to introduce yourself using your pseudonym and state your area of specialization and your most memorable experience as a student here at the College.
Interview Guide	The following are pre–developed questions that were asked in the interview, based on the quantitative data related to research questions 1–3, and aligned to the qualitative question 'What are preservice teachers' perceptions about their readiness to integrate technology based on the teacher education programme?': Research Question 1: What is the level of techno–pedagogic knowledge of preservice teachers at a teachers' college in Jamaica? i. Given that technology appears to be a part of every aspect of our lives (communication, banking, entertainment, etc.), what are your feelings towards it? ii. What are your thoughts on the use of technology in education? iii. If you were to rate your technological ability generally, low, average or high, what rating would you give yourself and why? iv. Have you used technology in teaching a lesson and what was that experience like? Research Question 2: What is the relationship between preservice teachers' readiness to integrate technology in teaching and learning and self–efficacy at a teachers' college in Jamaica? i. What are some ways you have used technology? ii. As a teacher in training, how prepared do you feel to use educational technology in the teaching and learning process? And what has contributed to that feeling? iii. Is there any specific experience during your training that you believe has helped or hindered your preparedness? iv. What more do you believe can be done in the teacher–training programme to help you feel more prepared to integrate technology in teaching and learning? Research Question 3: What is the relationship between preservice teachers' readiness to integrate technology in teaching and learning and teacher educators modelling the use of technology at a teachers' college in Jamaica? i. If you have observed your facilitators using technology, describe what that experience was like.
Closing Statements	I would like to thank each of you for sharing so openly. Let me also take the opportunity to remind you that your responses are being held with the strictest confidence and you are being implored not to share or discuss what was mentioned here with anyone. Over the next few days, I will be analyzing the conversation and I will share with you my interpretation, to solicit any clarification and to ensure I have accurately captured what was said. Are there any questions? If there are no (more) questions, again, thank you and have a good rest of your day.

Data Analysis

Of the 138 questionnaires, 98 were returned, resulting in a response rate of approximately 71%. An initial review of the returned questionnaires revealed that 17 were missing data, and each was then further analysed, with the intention of preserving as much of the dataset as possible, without compromising validity or reliability. Three were missing responses to 11–19 items and were removed from the data set, using listwise deletion. Six were missing data on one or two items and data imputation was applied, in which a neutral response on the Likert scale was added. Where this resulted in a change in the ranking of the TPACK score (low, average, high), the case was deleted. The remaining eight questionnaires with missing data were missing responses for gender and items associated with the perception of faculty. Pairwise deletion was applied in the final analysis. After the entire process, 94 questionnaires remained for analysis. Descriptive and inferential analyses were used to analyse the quantitative data. The potential for Type 1 errors was reduced by: (1) employing the mixed methods approach, where the qualitative data was used to further explain the quantitative data; (2) using total population sampling; (3) addressing issues of missing data; and (4) using a confidence interval of 95% and the corresponding level of significance of 5%.

Figure 5

Instrument used for Quantitative Data Collection

Technology Integration Readiness Survey

This survey instrument is designed to collect data on three dimensions: self-efficacy, technological, pedagogical and content knowledge (TPACK) and faculty modeling. By completing the survey, you agree that the information provided maybe used in a research study being conducted by [redacted]
Further details are available at https://bit.ly [redacted]

Please read the instructions associated with each section and tick the appropriate response.

1. Age (years): ☐18 – 21 ☐22 – 25 ☐26 – 29 ☐30 – 34 ☐35 or older
2. Gender: ☐Male ☐Female
3. Specialization: ☐Early Childhood ☐Primary ☐Mathematics ☐Science ☐Human Ecology ☐Geography/History/Social Studies ☐Modern Languages ☐Language Arts/Literacy/Literature
4. Year Group: ☐Year 3 ☐Year 4

Section 1: Self-Efficacy

The purpose of this section is to gather information about your belief in your ability to use technology in the teaching and learning process. For each item, tick only one option that best describes you.

1 – Not at all *2 – Very little* *3 – Somewhat*
4 – Quite a bit *5 – A great deal*

	1	2	3	4	5
1. How competent do you perceive yourself to select and use various media to support teaching and learning?					
2. How well prepared are you to evaluate software to support teaching and learning?					
3. To what extent can you integrate technology across the curriculum?					
4. How capable are you of determining why, when, and how to use technology in education?					
5. To what extent do you feel prepared to select and utilize assistive technologies? (e.g. text-to-speech/speech-to-text or simulation software)					

Figure 5 (continued)

Instrument used for Quantitative Data Collection

Section 2: Technological, Pedagogical and Content Knowledge (TPACK)

The purpose of this section is to gather information about combining technology, pedagogy and content knowledge in the teaching and learning process. For each item, tick only one option that best describes you.

1 – Strongly Disagree *2 – Disagree* *3 – Neither Agree or Disagree*
4 – Agree *5 – Strongly Agree*

	1	2	3	4	5
1. I can update instructional material (paper-based, electronic or multimedia materials, etc.) based on the needs (students, environment, duration, etc.) by using technology.					
2. I can use technology to determine students' needs related to a content area in during the reinforcement/teaching of prerequisite/prior knowledge.					
3. I can use technology to develop activities based on student needs to enrich the teaching and learning process.					
4. I can plan the teaching and learning process according to available technological resources.					
5. I can conduct a needs analysis for technologies to be used in the teaching and learning process to increase the quality of teaching.					
6. I can optimize the duration of the lesson by using technologies (educational software, virtual labs, etc.).					
7. I can develop appropriate assessment tools by using technology.					
8. I can combine appropriate methods, techniques and technologies by evaluating their attributes in order to present the content effectively.					
9. I can use technology to appropriately design materials to the needs of students for an effective teaching and learning process.					
10. I can organize the educational environment in an appropriate way to use technology.					
11. I can implement effective classroom management in the teaching and learning process in which technology is used.					
12. I can assess whether students have the appropriate content knowledge by using technology.					
13. I can apply instructional approaches and methods appropriate to individual differences with the help of technology.					
14. I can use technology for implementing educational activities such as homework, projects, etc.					
15. I can use technology-based communications tools (blogs, forum, chat, email, etc.) in the teaching process.					
16. I can use technology for evaluating students' achievement in related content areas.					
17. I can be an appropriate model for the students in following codes of ethics for the use of technology in my teaching.					
18. I can guide students in the process of designing technology-based products (presentations, games, films, etc.)					
19. I can use innovative technologies (blogs, podcasting, Facebook, Twitter, Snapchat, TikTok etc.) to support the teaching and learning process.					
20. I can use technology to update my knowledge and skills in the area that I will teach.					
21. I can update my technological knowledge for the teaching process.					
22. I can use technology to keep my content knowledge updated.					
23. I can provide each student equal access to technology.					
24. I can behave ethically in acquiring and using special/private information – which will be used in teaching a subject area – via technology (audio records, video records, documents etc.)					
25. I can use technology in every phase of the teaching and learning process by considering the copyright issues (e.g. license)					
26. I can follow the teaching profession's codes of ethics in online educational environments such as Moodle, Schoology, Google Classroom etc.					
27. I can provide guidance to students by leading them to valid and reliable digital sources.					
28. I can behave ethically regarding the appropriate use of technology in educational environments.					
29. I can troubleshoot problems that could be encountered with online educational environments such as Moodle, Schoology, Google Classroom, etc.					
30. I can troubleshoot any kind of problem that may occur while using technology in any phase of the teaching-learning process.					
31. I can use technology to find solutions to problems (structuring, updating and relating the content to real life, etc.).					
32. I can become a leader in spreading the use of technological innovations in my future teaching community.					
33. I can cooperate with other disciplines regarding the use of technology to solve problems encountered in the process of presenting content.					

Figure 5 (continued)

Instrument used for Quantitative Data Collection

Section 3: Faculty

The purpose of this section is to gather information about your perception of your lecturers/course facilitators demonstrating (modeling) the use of technology in teaching and learning. For each item, choose the option that best describes your thoughts.

1 – Strongly Disagree *2 – Disagree* *3 – Neither Agree or Disagree*
4 – Agree *5 – Strongly Agree*

	1	2	3	4	5
1. Lecturers/Course Facilitators **in my area of specialization** appropriately model (demonstrate) combining content, technologies and teaching approaches in their teaching.					
2. Lecturers/Course Facilitators **for technology courses** appropriately model (demonstrate) combining content, technologies and teaching approaches in their teaching.					
3. Lecturers/Course Facilitators **for all other non-specialist courses** appropriately model (demonstrate) combining content, technologies and teaching approaches in their teaching.					

4. **In general**, approximately what percentage of your lecturers/course facilitators have effectively modeled combining content, technologies and teaching approaches in their teaching?

☐25% or less (None to only a few of them) ☐26% - 50% (Some of them)
☐51% - 75% (Most of them) ☐76% - 100% (Almost all to all of them)

Thank you for your participation and contribution to educational research.

The qualitative data was analysed using thematic analysis. The audio recording of each session was uploaded to web–based transcription software, Otter AI. The accuracy of the information was checked by playing the recording while reading the transcript. The names of the persons involved in the focus group were replaced by pseudonyms, representing the respondent's year of study, specialization, and gender. For example, 3SM1 would be a third–year, secondary specialist, male. The transcripts were then shared with the respective participants of the focus groups for respondent validation and subsequently uploaded to NVivo 14.23.0 for further analysis. Codes were established first by deductive coding, utilizing codes based on the literature reviewed. A codebook was developed, and the transcript was read and coded. The inductive coding approach was applied in a secondary analysis of the transcript and in vivo coding used. The similarity of some of the codes resulted in mergers and the development of four themes: perceived techno–pedagogic ability, application of techno–pedagogic skills, training in techno–pedagogy, and observed techno–pedagogy (See Figure 6).

Results of Quantitative Data Analysis

Research Question 1: What is the level of techno–pedagogic knowledge of preservice teachers at a teachers' college in Jamaica?

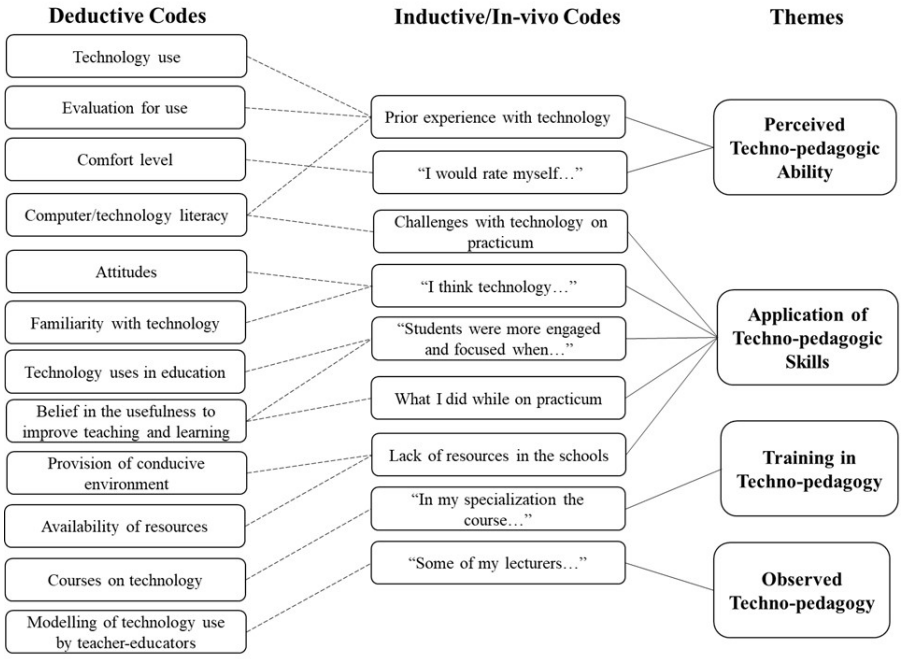
Responses to this question were analysed using descriptive statistics. Based on the instrument used, respondents with a score less than or equal to 95 were considered to have low–level readiness to integrate technology; a score of 96–130 was considered average; and a score of 131 or greater was considered high (Kabakci Yurdakul et al., 2012). The results indicated that approximately 47% of the respondents had either low–level (5.3%) or average (41.5%) techno–pedagogic knowledge; with the remainder, 53%, considered high–level (See Table 5).

Inferential analysis using a 95% confidence level was used to assess the hypotheses related to Research Questions 2–7 as follows:

Research Question 2: What is the relationship between preservice teachers' readiness to integrate

Figure 6

Deductive and Inductive Codes and Generated Themes



technology in teaching and learning and self–efficacy at a teachers' college in Jamaica?

H_{01}: There is no relationship between preservice readiness to integrate technology in teaching and learning and self–efficacy.

The null hypothesis was tested using Pearson's Product–Moment Correlation analysis, and the results indicated $r = 0.553$ and $p < 0.01$ (See Table 6). This suggested a statistically significant, moderate positive correlation between preservice teachers' readiness to integrate technology in teaching and learning and self–efficacy, hence the null hypothesis was rejected.

Research Question 3: What is the relationship between preservice teachers' readiness to integrate technology in teaching and learning and teacher educators modelling the use of technology at a teachers' college in Jamaica?

H_{02}: There is no relationship between preservice teachers' readiness to integrate technology in teaching and learning and instructors' modelling of technology use.

The null hypothesis was tested using Pearson's Product–Moment Correlation analysis, and the results indicated $r = 0.449$ and $p < 0.01$ (See Table 7). This suggested a statistically significant, moderate positive correlation between preservice teachers' readiness to integrate technology in teaching and learning and the modelling of technology use by faculty.

Table 5

Techno–pedagogic Knowledge of Participants

TPACK Level	n	%
Low	5	5.3
Average	39	41.5
High	50	53.2

Table 6

Correlation Between TPACK and Self–Efficacy Scores

		Self–Efficacy Score	TPACK Score
Self–Efficacy Score	Pearson Correlation	1	0.553**
	Sig. (2–tailed)	94	0.000
	N		94
TPACK Score	Pearson Correlation	0.553**	1
	Sig. (2–tailed)	0.000	94
	N	94	

** Correlation is significant at the 0.01 level (2–tailed)

Table 7

Correlation Between TPACK Score and Faculty Modelling Technology

		Faculty Model	TPACK Score
Faculty Model	Pearson Correlation	1	0.449**
	Sig. (2–tailed)	93	0.000
	N		93
TPACK Score	Pearson Correlation	0.449**	1
	Sig. (2–tailed)	0.000	93
	N	93	

** Correlation is significant at the 0.01 level (2–tailed)

Research Question 4: To what extent does preservice teachers' readiness to integrate technology in teaching and learning differ based on age at a teachers' college in Jamaica?

H_{03}: There is no difference in preservice teachers' readiness to integrate technology in teaching and learning based on age.

In the test of homogeneity of variance, the Levene statistic produced a result of 1.139, suggesting equal variance and that the ANOVA test can be considered robust. Results from the ANOVA showed no significant difference in preservice teachers' readiness to integrate technology in teaching and learning based on the age of the respondents ($F_{(4,89)}$ = 1.953, p = 0.109). Based on the results, and given that the observed p–value was greater than 0.05, the null hypothesis was accepted, as no statistically significant difference existed between preservice teachers' techno–pedagogic readiness and their age using a 95% confidence interval.

Research Question 5: What is the difference in preservice teachers' readiness to integrate technology in teaching and learning based on specialization at a teachers' college in Jamaica?

H_{04}: There is no difference in preservice teachers' readiness to integrate technology in teaching and learning based on specialization.

The results showed differences in the means: Primary = 125.13, Secondary = 127.80, and Early Childhood = 134.20. The standard deviation was highest for Primary (SD = 23.352), while Early Childhood had the least spread (SD = 9.935). In the test of homogeneity of variance, the Levene statistic produced a result of 1.536, suggesting equal variance and that the ANOVA test can be considered robust. The ANOVA results showed no significant difference in the TPACK scores obtained based on the specialization of the respondents ($F_{(2,91)}$ = 0.455, p = 0.636). Based on the results and given that the observed p–value was greater

than 0.05, the null hypothesis was accepted, suggesting that no statistically significant difference existed between preservice teachers' readiness to integrate technology based on specialization using a 95% confidence interval.

Research Question 6: What is the difference in preservice teachers' readiness to integrate technology in teaching and learning based on gender at a teachers' college in Jamaica?

H_{05}: There is no difference in preservice teachers' readiness to integrate technology in teaching and learning based on gender.

Results of the independent samples t–test showed similar mean scores for males ($\bar{x}$ = 127.13) and females ($\bar{x}$= 127.82), but the males had a greater spread, as evidenced by the standard deviation, SD = 26.470; compared to the females, SD = 16.949. The observed p-value (p(obs)=0.129) of Levene's Test of Equality of Variance, a statistical measure of the spread in data across different groups, was greater than the expected p-value of 0.05, indicating that the variance between the mean TPACK score for males and females was not significantly different — hence equal variance was assumed. The results produced a t–value of -0.133, a significance value of 0.894, and a degree of freedom of 90 ($t_{(1,90)}$ = -0.133, p = 0.894). Given that the observed p–value was higher than the expected p–value of 0.05, there was no statistically significant difference in preservice teachers' readiness to integrate technology based on gender; thus, the null hypothesis was accepted.

Research Question 7: What is the difference in preservice teachers' readiness to integrate technology in teaching and learning based on year of study (third and final year) at a teachers' college in Jamaica?

H_{06}: There is no difference in preservice teachers' readiness to integrate technology in teaching and learning based on the year of study.

Data was analyzed using an Independent Samples t–test. The null hypothesis postulated that there was no difference in preservice teachers' readiness to integrate technology in teaching and learning based on the year of study. The mean TPACK score for the third–year students ($\bar{x}$ = 125.71) was approximately six points less than that of the fourth–year students ($\bar{x}$= 131.10). The spread, as indicated by the standard deviation, was 19.275 for third–year preservice teachers and 0.542 for fourth–year preservice teachers. The observed p–value ($p_{(obs)}$ = 0.544) of Levene's Test of Equality of Variance was greater than the expected p–value of 0.05, indicating that the variance between the mean TPACK score for Year 3 and Year 4 students was not significantly different, hence equal variance was assumed. The results produced a t–value of -1.246, and a significance value of 0.216 with a degree of freedom of 92 ($t_{(1,92)}$ = -1.246, p = 0.216). Given that the observed p–value was higher than the expected p–value of 0.05, there was no statistically significant difference in preservice teachers' readiness to integrate technology according to the year of study; thus, the null hypothesis was accepted.

Results of Qualitative Data Analysis

The qualitative arm of the study was guided by the research question: What are preservice teachers' perceptions about their readiness to integrate technology based on the teacher education programme? The results of the data analysis are presented based on the themes derived.

Perceived Techno–pedagogic Ability

Participants were asked to rate themselves on their technological ability and readiness to use technology in teaching and learning based on their recent practicum experience in the classroom. All rated themselves as average or high with 4SF1 and 4SF2, indicating that they were somewhere between average and high. Two of the male participants, 3SM1 and 4SM2, confidently stated that they were high in technological competence, not only related to teaching and learning, but with technology

in general. 3SF1, in rating herself as average, shared that she was not "necessarily always sure how to, or what specific technology to utilize when dealing with the Math [content]". 3PM1, claiming to be average, indicated that with technology, "every day has something new for you, so today we know how to do work a particular way and by tomorrow there's a different way to do it".

Application of Techno–pedagogic Skills

When initially asked to describe their feelings towards technology, the respondents in both focus groups expressed an appreciation for technology in everyday life and its use in education. "Excited" was a commonly used word, with 3SF1 saying, "I'm really excited as I am open to change, and I like that it allows us greater access to many things". 3PM1 noted, however, that technology can be both good and bad, "good in the sense that everything is just right on your fingertips; but for the bad part, social media can be used to do so many things and can make somebody's life miserable". There were mixed responses, however, to the use of technology in education while on practicum. 3PF1 avoided its use, utilizing traditional methods, for fear of mishaps while being assessed by the practicum supervisor. Attempting to use it but experiencing challenges with equipment and lack of resources were other reasons expressed by 3PM1 and 4SF2, while 4SF1 reported using technology every day. Interactive PowerPoint and Kahoot! were the two most commonly mentioned tools in technology use, with reports of greater student engagement when they were used. However, several participants contended that while they felt adequately prepared and would want to use technology in teaching and learning, they did not believe that the schools were ready for them, lamenting "Are the schools prepared for us, as in we having this knowledge to use? I'm not sure".

Training in Techno–pedagogy

With the seeming interest in the use of technology in teaching and learning, and with some teachers showing frustration with the education system's lack of resources to support their interest, the researcher inquired about the training that participants received. All the participants reported some form of training, mentioning the Educational Technology course done in the second year of teacher training. 3PF1 said that in this course she learned to create a website and "find a lot of online resources to use in our classrooms, in our lessons. So being exposed to all that content really helped, [giving] me the knowledge I needed". While not referencing a specific course, 3SM1 mentioned a 90–minute session led by a lecturer in his department in preparation for practicum serving as a "refresher because it was tied to the Ed Tech course, but she delved into other platforms we can use outside of Kahoot! and Google Classroom, and in terms of Canva, etc."

Observed Techno–pedagogy

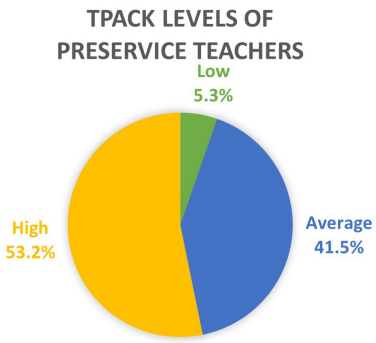
Participants were asked about the extent to which they believed their lecturers/facilitators were effectively demonstrating the use of technology in teaching and learning. 3SF1 reported that in her specialization the lecturers "demonstrated or modelled the use of technology very well". She added, "I think they have utilized most of the manipulatives. I think they've exhausted them to be very honest." 4SM1 expressed similar sentiments, "from year one we were introduced to different virtual manipulatives … we were even encouraged to download them for ourselves and try them out". He further stated that in a specific course, Introduction to ICT, "our lecturer like for every class, after a lesson would have a game and we will just play and then she will teach us about it". On the contrary, 3PF1 stated, "98% have not", claiming that facilitators mostly used PowerPoint, doing "the bare minimum". 3PM1 added that even when assistance is offered, the lecturers would say, "I'm the lecturer here, I know what to do". 4SF2 reiterated a similar point saying, "they're at the age where, you know, they're not really adept, and they don't really know certain things about technology. Sometimes we don't even have classes because [they] don't understand really how to manipulate the technology".

Integration of Quantitative and Qualitative Results using Joint Display Analysis

The integration and meta–inferences of the quantitative and qualitative data for Research Question 1 show that most preservice teachers had an average to high level of techno–pedagogic knowledge, with the qualitative data showing that preservice teachers in the focus groups rated themselves as average, high, or somewhere in between (See Table 8). The integration and meta–inferences of data related to Research Question 2 show the moderate positive significant correlation between preservice teachers' readiness to integrate technology and self–efficacy being supported by focus group participants' indication that the exposure to training in various courses contributed to their ability and level of comfort in using the technology (See Table 9). Finally, integration and meta–inferences for Research Question 3 indicated that the moderate significant positive correlation between preservice teachers' readiness to integrate technology and the modelling of technology by teacher educators is further explained by focus group respondents' contention that their facilitators demonstrated its use (See Table 10).

Table 8:

Joint Display of Results Related to Techno–pedagogic Knowledge

Quantitative: Techno–pedagogic knowledge of preservice teachers (N=94)	**Qualitative: Themes and sample quotes related to techno–pedagogic knowledge**
	**<u>Perceived Techno–pedagogic Ability</u>** 3SF1: "I think I am average". 3PM1: "I would say am average too". 3SM1: "I would rate myself highly". 3PF1: "I would say I am somewhere between average and maybe a little bit above average". 4SF2: "I don't think I am advanced in the use of technology, I am getting there. So I'm somewhere above average". **<u>Training in Techno–pedagogy</u>** 3PM1: "ICT, Special Education Methodology, and Ed Tech — those are the courses that would have prepared me for the technology world now". 3SF1: "I guess the only course that really prepared me with the use of technology that I could remember was Teaching Secondary School Mathematics (TSSM)". 4SF2: "Educational Technology and also through my individual research, because I do work with technology outside of school".

Meta–Inferences

The quantitative data results indicated that most preservice teachers had either an average (41.5%) or high (53.2%) level of techno–pedagogic knowledge. These results represent the competence of approximately 95% of the sample. The participants corroborated these results during the focus groups when asked how they would rate their techno–pedagogic knowledge. Two of the 7 participants said they were average, 3 indicated average bordering on high, and 2 said they were high; thus, all were average or high. The qualitative findings gave further insights into what contributed to this level of competency. Participants indicated that this was attributed to the exposure, in some instances, to courses covered in the teacher–training programme and other activities outside of school. The results, therefore, suggest that preservice teachers possess the requisite skill involved in synthesizing content, pedagogy, and technology; thus demonstrating average to high levels of techno–pedagogic knowledge, in part because of training received and because of involvement in technology–related activities in other aspects of their lives. The results obtained were similar to other studies that utilized the same instrument to measure TPACK. Giles and Kent's (2016) study of preservice teachers in the United States found that most of the participants had average to high techno–pedagogic knowledge. Similarly, Saglam–Kaya (2019) reported that 97% of the Turkish preservice teachers in the study had average or higher techno–pedagogic knowledge. Mourlam et al. (2021) claimed, however, that TPACK is just one measure of a preservice teacher's capacity to teach effectively using technology.

Table 9

Joint Display of Results Related to Techno–pedagogic Knowledge and Self–Efficacy

Quantitative: Techno–pedagogic knowledge of preservice teachers and self–efficacy (N=94)	**Qualitative: Theme and sample quotes related to self–efficacy in technology use**

Correlations

		SE_Score	TPACK_Score
SE_Score	Pearson Correlation	1	.553**
	Sig. (2-tailed)		.000
	N	94	94
TPACK_Score	Pearson Correlation	.553**	1
	Sig. (2-tailed)	.000	
	N	94	94

**. Correlation is significant at the 0.01 level (2-tailed).

Application of techno–pedagogic skills

3SF1: "Initially, I wasn't quite sure about the manipulative itself, because I was also new to it, so I had to learn how to use it".

3PF1: "Yes, you're there to get the experience and to be in the classroom with the children and everything, but risking my grade of being there, and something failing, and then you have an assessor there and, you know, it's a risk, that I was not willing to take. For the future when I go into the classroom, and I won't have the stress of worrying about my supervisor…I think I'm prepared to bring technology into the classroom."

Meta–Inferences

The results of the quantitative data analysis indicated a moderate positive significant correlation between preservice teachers' readiness to integrate technology in teaching and learning (techno–pedagogic knowledge) and self–efficacy. The results suggest that an increase in one variable results in an increase in the other. In other words, as techno–pedagogic knowledge increases, an increase in self–efficacy is likely. The qualitative analysis further supports the quantitative findings, as participants in the focus groups indicated that the exposure to training in various courses contributed to their ability and level of comfort in using the technology. However, one participant, although self–rated as average, indicated that she avoided using technology while on practicum for fear that challenges with its use would impact how her supervisor assessed her, but she would be more open to its use when she became a trained teacher. This may be one reason for the moderate correlation seen, as although preservice teachers believed they possessed the requisite knowledge, they doubted their ability to address challenges that may arise when technology was included in the lesson. This suggests that other factors may influence techno–pedagogic knowledge and self–efficacy. The literature suggests, for example, that prior experience with technology (Ebersole, 2019); attitude toward technology (Aslan & Zhu, 2017); and false sense of competency (Akcaoglu & Akcaoglu, 2022) are possible factors.

Table 10

Joint Display of Results Related to Techno–pedagogic Knowledge and Modelling of Technology Use

Quantitative: Correlation between techno–pedagogic knowledge of preservice teachers and modelling of technology use by faculty

Correlations

		TPACK_Score	Faculty_Model
TPACK_Score	Pearson Correlation	1	.449**
	Sig. (2-tailed)		.000
	N	94	93
Faculty_Model	Pearson Correlation	.449**	1
	Sig. (2-tailed)	.000	
	N	93	93

**. Correlation is significant at the 0.01 level (2-tailed).

Qualitative: Theme and sample quotes related to modelling of technology use

Observed Techno–pedagogy

3PF1: "98% have not. They mostly use Power-Points. When I'm on Instagram or whatever, I'm always looking at what other teachers in the US, for example, how they integrate technology."

3PM1: "So even like the PowerPoint, you know, how to put the picture behind the word. They don't know how to do those things, so we have to be teaching them."

4SM1: "For me on a scale of 1–10, I would say 8 because I mean, what I see at college, is that what is being taught is actually being done, to give us a blueprint of what is expected."

Meta–Inferences

The quantitative results indicated a moderate significant positive correlation between preservice teachers' readiness to integrate technology and the modelling of technology by teacher educators. The qualitative analysis further explained how preservice teachers' readiness to integrate technology in teaching and learning was directly related to how their facilitators demonstrated its use; as participants in the focus groups indicated observing their facilitators' use of the technology and expressing a desire to attempt to use it in the same way. However, some participants mentioned minimal use by teacher educators, lamenting the less–than–desirous ways demonstrated and their refusal to accept student assistance. Another participant mentioned watching videos online that demonstrated creative approaches to technology integration, as most of her facilitators did not effectively use technology. These results suggest that while preservice teachers look to their facilitators as models for technology use, their techno–pedagogic knowledge is not entirely related to this. The literature highlights other reasons that may explain the moderate association. These include access to technological resources and available peer support (Voithofer et al., 2019) that can supplement the lack of modelling demonstrated by faculty.

Discussion of Research Question 1

The rapid expansion in modern technology requires current and future teachers to be aware of educational technology and proficient in integrating it into teaching and learning (Raja & Nagasubramani, 2018). The results obtained are not unusual as several studies investigating preservice teachers' techno–pedagogic competence in Turkey and Germany (Atar et al., 2019), and the United States of America (Giles & Kent, 2016) found that most of the participants had an average to high level. Other studies employing the same instrument indicated similar results. For example, Saglam–Kaya (2019) reported that in a study involving 155 secondary pre–service teachers in Turkey, approximately half (50.3%) had average techno–pedagogic knowledge and 47.1% were high, indicating that more than 97% were average to high, a value similar to the over 94% in the current study. Self–rating results, according to Atar et al. (2019), could be attributed to "preservice teachers usually viewing themselves as competent in TPACK components" (p. 796). In addition, knowledge of technology and the capacity to integrate technology are distinct and may have been assumed by the participants. On the other hand, having engaged in two years of teacher training through emergency remote teaching and at least one practicum experience using the virtual platforms available, the preservice teachers in this study may have possessed the techno–pedagogic skills indicated by the survey instrument and described in the focus groups. According to Kwaah et al. (2022), the COVID-19 pandemic increased the use of digital technology

and individuals without the requisite digital skills had to "either catch up quickly or risk being left behind" (p. 3). The resilience and persistence of the preservice teachers to complete their course of study, despite the challenges posed by the disruptive nature of the COVID-19 pandemic, may have forced the development of adaptive expertise, essential for being an effective teacher (Xiang et al., 2022). This notion is supported by the results of a study involving Australian preservice teachers who indicated that the pandemic influenced, to some extent, pedagogies utilised and the ability to differentiate instruction (Aizenberg, 2022).

Discussion of Research Question 2

Türkeli· (2022) posited, "teacher self–efficacy appears to be an important variable for effective teaching and the integration of technology" (p. 605). The positive correlation noted in this and other studies could be explained based on the training that preservice teachers received. Mourlam et al. (2021) posited that there are often courses in educational technology offered in the preservice teacher education programme to develop TPACK. According to Birisci and Kul (2019), experiences in these courses "may be shown as one of the causes of high technology integration self-efficacy beliefs" (p. 83). Participants in the focus groups of the present study mentioned a particular course, Educational Technology, done in their second year of teacher training, that exposed them to a multiplicity of technological tools used to make lessons more interesting. The high self–efficacy and its positive correlation to techno–pedagogic knowledge could also be explained based on the sample's propensity to use technology. More than 85% of the participants were 18–25 years old. This generational group is "seen as innately or inherently tech–savvy as opposed to older generations" and is "confident in the knowledge they have in their use of technologies" (Gallardo–Echenique et al., 2015, p. 166). Preservice teachers enter teacher education programmes with prior technology integration experiences and different levels of technological exposure and competencies, which may manifest in the self–efficacy exhibited (Ebersole, 2019). Furthermore, the correlation between techno–pedagogic knowledge and self–efficacy could also be explained by the preservice teachers' sense of mastery, having successfully used technology on one or more occasions; or because of vicarious experiences, having observed someone else effortlessly using technology. This could have created a false sense of competency — a notion supported by Akcaoglu and Akcaoglu (2022). Finally, the study's sample represented preservice teachers who completed two years of teacher training online during the COVID–19 pandemic. The novelty of online learning required the participants in the study to learn to navigate the virtual space and technological devices. Students had to become more self–directed, thus increasing self–knowledge and self–confidence (Adefuye et al., 2021) — elements possibly contributing to their self–efficacy and techno–pedagogic knowledge.

Discussion of Research Question 3

Tiba and Condy (2021) postulated, "teachers teach the way they were taught", representing the most significant explanation for a positive correlation between techno–pedagogic knowledge and the modelling of technology by teacher educators (p. 157). Vicarious experiences contribute to self–efficacy, which in turn contributes to the readiness of an individual to perform a certain task. Bandura's Social Learning Theory emphasizes the importance of observational learning, noting that the decision to perform a behaviour depends on one's assessment, having watched the action being done, usually by another individual referred to as a model (Bandura, 1989). Teacher educators act as models for preservice teachers in content, pedagogic, and techno–pedagogic knowledge (Tiba & Condy, 2021). However, the extent to which teacher educators are suitably motivating role models has long been considered, as it is believed they often do not use technology effectively (Uerz et al., 2018). Thus if teacher educators do not demonstrate creative and appropriate uses of technology in teaching and learning, preservice teachers may be unable to do so when required in practice.

Discussion of Research Question 4

Descriptive statistics indicated that the 30 – 34 age group showed the lowest techno-pedagogic competency mean, while the 18 – 21 had the highest mean. While there was a noticeable difference in the mean for these two age groups, analysis of the data for all categories was done using One-way ANOVA and showed no statistically significant difference between preservice teachers' technopedagogic readiness and their age. The lack of difference among the age groups could be attributed to the exposure of all participants to the Educational Technology course in the teacher education programme, which equips students with the requisite knowledge to integrate technology in teaching and learning. However, previous studies. However, previous studies in Australia (Albion et al., 2011) and in Spain (Gómez–Trigueros et al., 2019) found that age influences technology adoption and use. Although the results of this study contradict that of previous studies, the results are similar to that obtained in a study conducted with 209 preservice teachers in Australia and Israel (Redmond & Peled, 2019) which revealed no differences among the age groups within or between the two countries.

Discussion of Research Question 5

The results showed that there was no statistically significant difference between technopedagogic readiness scores and specialization, although respondents from the Early Childhood specialization had a noticeably higher mean ($x = 134.20$), compared to the Primary ($\bar{x} = 125.13$) and Secondary ($\bar{x} = 127.80$) specializations. This difference in mean could be explained by the preparation that early childhood specialists receive, with Kale and Akcaoglu (2018) suggesting greater emphasis on student–centred approaches and instructional methods at the elementary level. The differences, the authors suggested, could determine the regularity and success of technology integration. However, while some studies have found significant differences based on specialization (e.g. Aslan & Zhu, 2017; Yusop et al., 2021), the results obtained are not unusual. Redmond and Peled (2019) also found no difference due to specialization in their study involving 209 preservice teachers in the disciplines of Mathematics and Sciences, Humanities and Social Studies, and Health and Physical Education in Australia and Israel.

Discussion of Research Question 6

TResults showed similar mean scores for techno-pedagogic knowledge for both genders, but females had a lower standard deviation. However, further analysis indicated that there is no difference in preservice teachers' readiness to integrate technology based on gender. This could be attributed to all preservice teachers completing courses in the use of information technology in teaching and learning. Other studies (e.g. Caner & Aydin, 2021; Keser et al., 2015; Yusop et al., 2021) have reported similar findings. However, several studies have suggested that there is a significant difference between male and female preservice teachers' use of technology (e.g. Çebi & Reisoğlu, 2020; Gómez-Trigueros & Yáñez de Aldecoa, 2021; Grande-de-Prado et al., 2020), suggesting that females exhibited higher negative perceptions of technology, their ability to use it, and the technological training received.

Discussion of Research Question 7

In this study, the mean techno–pedagogic knowledge (TPACK) score for the fourth–year students was higher than for their third–year counterparts. Keser et al. (2015) reported similar findings in a study involving 713 preservice teachers in Turkey in which the mean competency level score for first–year students ($\bar{x} = 127.11$) was lower than that of the seniors ($\bar{x} = 136.99$). However, unlike the Keser et al. (2015) study, where a statistically significant difference between the groups was reported, the Independent Samples t–test revealed that the difference was not statistically significant in the current study. Nevertheless, the difference in mean could be explained by the opportunity that fourth–year preservice teachers had to use the technology in instructional delivery, having engaged in more hours of field experience during their final practicum. The lack of significant difference between the two could also be because

of how close the two groups were based on how much training they would have received in their teacher education programme, having completed all the technology–related courses.

Theoretical Implications

The concepts of self–efficacy and observational learning, as espoused by Bandura (1989) in his Social Cognitive Theory, rely on an observer–model interaction, where the extent to which an observer assimilates a behaviour is dependent on the attention given to it; the influence of the model; the reinforcement of the behaviour; and the belief that an individual has about their ability to master a particular task. The moderate positive correlation results in this study between techno–pedagogic knowledge and self–efficacy and techno–pedagogic knowledge and modelling by faculty partly support this theory. The results suggest a link between perceived competence and belief in self and perceived competence based on observation. Based on this study, however, there are elements of self–efficacy that seem to be unexplained by the observation of a model, reinforcement of a behaviour, or the belief in one's ability. Preservice teachers self–rated as having average or high techno–pedagogic skills, even though they reported limited use of technology by teacher educators and limited access to technological resources to demonstrate the requisite skills. External demands such as the public's perception that current teachers are to be technologically aware or generational expectations that those of a certain age must know how to use technology, could be reasons contributing to the perceived self–efficacy reported by the preservice teachers.

The Theory of Diffusion of Innovation (Rogers, 1983), used as the theoretical underpinning for integrating technology in teaching and learning, was also supported by this study's results. Innovation is described in this theory as the novelty of an idea or practice to the individual and not necessarily the newness of it. As some focus group participants indicated, they were introduced to technological resources by their facilitators or, as in the case of one participant, by online videos. These technological innovations mentioned by the participants (for example, Kahoot!) had been present in education for many years, but were just being introduced to them. The study further supported the theory's categorization of how innovation is adopted. One participant described using a technological tool that she was unfamiliar with, learning along with her students as she taught — a feature characteristic of Innovators. Another participant indicated that she avoided using technology while on practicum, sticking to traditional methods of student engagement, characteristic of Laggards. The other participants in the focus group could be placed in the other categories named by Rogers (1983) (Early Adopters, Early Majority, and Late Majority), utilizing the technology and serving as role models; deliberating at times but ultimately adopting an innovation; or sceptical and delayed in adoption.

Practical Implications

Three implications for professional practice emerged from this study. The results of the techno–pedagogic knowledge of preservice teachers showed varying levels of competency. While most ranked average or high, this was based on self–rating, which the literature has suggested could be flawed (Atar et al., 2019). Furthermore, studies have found that TPACK knowledge and how it is enacted may be incongruent (Mourlam et al., 2021), therefore continued in–service teacher development is needed when preservice teachers enter the formal education system where the application of the training they receive is tested. Lipton and Wellman (2018), as cited in Schwan et al. (2020) postulated, "beginning teachers that are supported early in their careers have increased effectiveness in their classrooms, higher satisfaction, and greater commitment than those who do not experience these supports" (p. 191).

The moderate positive correlation between techno–pedagogic knowledge and self–efficacy highlights the need for teacher–training institutions to provide opportunities

for preservice teachers to learn about and use technology in authentic, supportive environments. This requires teachers' colleges to be equipped with the current technological and human resources to support effective teacher training. Consequently, schools at the early childhood, primary and secondary levels also need to be sufficiently resourced for preservice teachers to utilise the knowledge and skills acquired in teaching and learning.

As Tiba and Condy (2021) proffered, "teachers teach the way they were taught", and the positive moderate correlation between techno–pedagogic knowledge and modelling by teacher educators in this study is an indication that the empowerment of faculty is paramount (p. 157). Additionally, focus group participants indicated that many of their teacher educators failed to model technology–enhanced pedagogy. Tiba and Condy (2021) contended, "if teacher–educators cannot teach creatively with technology, pre–service may not be able to do so during professional practice", thus professional development for teacher educators is needed for them to "blend technology, pedagogy and content knowledge when they teach" (p. 157). Professional development opportunities are offered by the Ministry of Education through the Jamaica Teaching Council, but engagement with these are optional (Jamaica Teaching Council, 2023) and continued in–service certification is not mandatory. Özüdoğru and Çakir (2020) found that, teacher–training institutions where there are high levels of technology integration provide increased opportunities for their students to replicate technology–enhanced pedagogy in their teaching. Thus, the establishment of new roles and systems of accountability for teacher educators are needed if preservice teachers are to be provided with "equitable, high–quality experiences" in courses and during supervision while on practicum (Foulger et al., 2017, p. 417).

Recommendations

Four recommendations are made that will impact preservice teachers and faculty.

Recommendations for Preservice Teachers

1. Both technology courses, Introduction to Information and Communication Technology, and Educational Technology, are taught and assessed in isolation, focusing more on the use of technology, rather than on its integration in teaching and learning. Hence, the teaching of technology integration needs to be more deliberate, with assessment focused on technology integration and greater feedback provided to increase the level of correlation between techno–pedagogic knowledge and self–efficacy.
2. Provision of increased support for and guidance to preservice teachers, utilizing technology in authentic teaching and learning settings to increase techno–pedagogic knowledge and self–efficacy through a modified practicum. This recommendation can only be achieved if preservice teachers are willing to risk technology integration, teacher educators (practicum supervisors) provide the requisite guidance, and the practicum evaluation instrument explicitly reflects appraisal of technology integration.

Recommendations for Faculty

1. Provision of adequate technological infrastructure and a system for empowering and appraising faculty's use of technology in teaching and learning can be achieved through: (1) structured monthly sessions, where best practices are shared and demonstrated; (2) established mentorship programmes where faculty with average or advanced techno–pedagogic skills collaborate and guide their less proficient colleagues; and, (3) the development of ways to systematically and consistently monitor the use of computer labs and technological devices for lesson design and instruction by teacher educators.

2. The Ministry of Education should make mandatory the enrolment and attendance of in–service teachers (including teacher–educators) in the professional development courses offered annually by the Jamaica Teaching Council. Additionally, the provision of incentives (proficiency certification, link to teacher licensure, and compensation) would provide greater motivation for teacher educators to enrol in such courses and continuously hone their skills.

Limitations

The limitations of this study included generalizability, sample size, and representation in the focus group. While all eight institutions of TCJ utilise the same programme guide and standardized assessments, available resources and experiences of students may differ significantly among colleges and potentially influence the techno–pedagogical knowledge of the preservice teachers. Hence, generalizations based on findings are cautioned as the sample was taken from only one institution. Additionally, since the sample was restricted to full–time undergraduate students, the results may not be generalised to all students completing teacher training in the various programmes at the research site. Another limitation was that neither focus group had representatives from the early childhood specialization; the focus group with the fourth–year students also had no representation from the primary specialization. Despite these limitations, this study provided robust results to assess the problem related to preservice teachers' readiness to integrate technology at a teachers' college in Jamaica and provides focussed recommendations for future improvements.

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