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Exploring the Challenges Faced by Primary School Teachers in Tobago in Using ICT to Teach Mathematics Problem-Solving

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Abstract: ***The study explored challenges experienced by primary school teachers in the Tobago Education District when integrating Information and Communication Technology (ICT) into mathematics problem-solving instruction. It examined the extent to which infrastructural and resource factors predicted teachers' ICT use, differences in student mathematics problem-solving performance between classes with high and low levels of teacher ICT integration, and the relationship between professional development and ICT use. A cross-sectional quantitative survey design was used. The population comprised approximately 400 teachers across 40 primary schools, from which nine schools and 78 teachers were selected using stratified random sampling. Data were collected using a structured questionnaire and analysed using descriptive statistics, multiple regression, an independent samples t-test, and Pearson correlation. Infrastructural and resource factors did not significantly predict teachers' ICT use, $F(5, 72) = 1.478$, $p > 0.05$, and explained 9.3% of the variance. Student mathematics problem-solving performance differed significantly between the high and low ICT integration groups, $t(57) = -2.515$, $p < 0.05$, with the high-integration group recording the higher mean score. Professional development was moderately and positively associated with ICT use, $r = 0.521$, $p < 0.01$. The findings indicate that professional development is an important correlate of ICT integration and that higher ICT integration is associated with better mathematics problem-solving performance. Sustained professional development, technical support, and continued access to appropriate ICT resources are recommended.***

Keywords: ICT integration, educational technology, primary school teachers, mathematics problem-solving

1. Introduction

Historically, in Trinidad and Tobago, obtaining a Bachelor of Education (BEd) degree certification, which was frequently funded by financial aid, required five CSEC passes, including English, Math, and Science (Grade 3 or higher), in addition to in-service experience. Primary School Teacher I appointments now require a BEd. [1]. Information and Communication Technology (ICT) training was, and still is an integral part of BEd. programmes offered by universities like the University of Trinidad and Tobago, University of the Southern Caribbean, and University of the West Indies. Notwithstanding this, classroom utilization, especially for instruction in Mathematics, is still inadequate, despite the Ministry's Teacher Education Performance and Professional Development Division overseeing digital-learning professional development. This is an indication of the greater difficulties in putting Information and Communication Technology (ICT) policy into practice in the regional context [2].

Though its efficacy in mathematical pedagogy is still underutilized, the integration of Information and Communication Technology (ICT) has been acknowledged as a transformative tool in education [3,4]. Specifically, poor performance in mathematics problem-solving persists in many educational systems at both the primary and secondary levels [5]. Although digital technologies are readily available to enhance instruction, there hasn't been much focus on using ICT to improve students' problem-solving skills [6]. According to research, instructional methods like the Concrete–Pictorial–Abstract (CPA) framework and bar modelling techniques greatly improve students' mathematical reasoning and conceptual understanding [7,8]. This gap, the underutilization of Information and Communication Technology (ICT) to assist teachers in problem-solving, although there is evidence that ICT can assist, could be mitigated. This can be done through the integration of ICT-based manipulatives and interactive online resources, which have been demonstrated to enrich mathematics learning experiences and foster deeper engagement [9].

Statement of the Problem

The persistent underperformance in mathematics problem-solving at Tobago primary schools points to shortcomings in current approaches to teaching Mathematics and to a failure to use ICT to address this problem effectively.

Purpose of the Study

This study aimed to explore the challenges Tobago primary school teachers faced in using ICT to enhance mathematics problem-solving and to recommend strategies for improving their readiness and professional development in ICT integration.

Significance of the Study

Valuable insights will be provided into the factors that influence Tobago primary school teachers to meaningfully infuse ICT in their pedagogical practice of mathematics problem-solving. This is done through the identification of essential infrastructural factors, pedagogical challenges, and examination of ICT-related professional development. This will help in providing clarity in understanding the conditions that support or hinder the effective infusion of ICT in the teaching of mathematics problem-solving. The results can inform targeted professional development initiatives and resource allocation strategies within the Tobago Education District by highlighting areas where teachers may require additional training, technical support, or access to digital tools. While the study does not seek to establish causal relationships, it will offer empirical evidence of associations among teachers' professional development, infrastructure availability, and ICT usage patterns. Ultimately, the study aims to guide practical, data-driven improvements in teacher preparation and school-level planning for ICT use, thereby supporting gradual enhancement of mathematics instruction and, over time, improved student engagement and problem-solving performance.

Research Questions

This study considered the following research questions:

1) To what extent do infrastructural and resource factors (e.g., availability of devices, internet access, and digital tools) predict primary school teachers' use of ICT in mathematics problem-solving lessons in Tobago?
2) Is there a significant difference in student mathematics problem-solving performance between classes taught by teachers with high versus low levels of ICT integration?
3) What is the relationship between the level of teachers' professional development in ICT and the frequency or effectiveness of ICT use in mathematics problem-solving instruction?

Limitations

The research is limited to the Tobago Territory, so geography is the first limitation. Additionally, due to the limited time the researcher has to complete the study, the schools in the sample had to be carefully selected in order to meet the deadline

Definition of Terms

Information and Communication Technology (ICT): This is a collection of tools and systems - such as computers, tablets, projectors, internet connectivity, software, and online platforms - utilized by teachers during mathematics problem-solving lessons. Clarity on what is included in ICT is established to guide scope and operationalization [10].

Digital Competence: The confident, critical, and creative use of ICT in teaching and educational practice [11]. Expanded by the European Union [12] to include responsible use across learning, work, and societal participation, encompassing areas such as media literacy, safety, communication, and problem-solving.

ICT Infrastructure: Tondeur et al. [4] describe ICT infrastructure as the technological resources and supporting systems that enable the integration of digital technologies into teaching, learning, and educational administration.

Professional Development: The formal and informal training mechanisms - such as workshops, seminars, online courses, mentoring, and in-service sessions - are intended to build teachers' capacity to effectively integrate ICT into mathematics instruction [13].

Teachers' Readiness to Adopt ICT-Based Approaches: Teachers' readiness to adopt ICT-based approaches refers to the knowledge, skills, attitudes, confidence, and willingness required to effectively integrate digital technologies into teaching and learning processes [3].

Effectiveness of Professional Development: This is measured via teacher-rated outcomes—using tools such as Likert scales—covering perceived improvements in ICT integration, confidence, and instructional practice [10,13].

Mathematics problem-solving: Mathematics problem-solving is the process through which learners engage in cognitive and metacognitive activities to interpret, represent, and resolve unfamiliar or non-routine mathematical situations by applying prior knowledge, logical reasoning, and strategic thinking. It involves understanding the problem, devising a plan, executing that plan, and evaluating the solution process and outcome [14,15].

2. Literature Review

The patterns of computer use were studied at Belgian primary schools by Tondeur et al. [16]. These studies focused on how school policy, teacher attitude, and ICT resource availability influenced teachers' ICT integration. The researchers subsequently identified three categories of teachers' computer use, namely: the enhancement of traditional instruction, the fostering of students' information literacy, and the facilitation of creative learning strategies such as active engagement and collaboration [16]. Their findings revealed that a combination of ICT infrastructure and supportive ICT school policies greatly assists in transforming instruction. This therefore emphasizes the critical importance of combining ICT infrastructure and institutional support to drive teachers' willingness to use ICT in their mathematics problem-solving lessons.

Though the literature emphasized access to ICT infrastructure as the primary element that drives teachers' ICT integration in their pedagogy, further studies revealed that access alone cannot guarantee meaningful use of technology. Further, the research data for small Caribbean islands, Tobago in particular, is very limited, thereby creating a research gap.

Unwin [17] similarly identified infrastructural factors such as limited access to devices, unreliable internet, and an undependable electricity supply as hindrances to teachers successfully integrating ICT in their pedagogy. It is these hindrances that cause teachers to revert to "first principles", traditional teaching. This in itself hinders professional growth and thereby prevents them from exploring the use of ICT to teach mathematics problem-solving. The same is true for primary school teachers within the Tobago Education District, as primary school teachers encounter the same infrastructural challenges.

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Corroborating those aforementioned challenges faced by primary school teachers of Tobago is the UNESCO Global Education Monitoring Report [18]. They posit that digital inequalities persist between developed and developing countries because of limited ICT infrastructure, poor connectivity, and insufficient teacher support systems [18]. Overall, the report emphatically stated that meaningful ICT inclusion needs both physical access to the ICT resources and a school-based teacher support system. All the aforementioned studies revealed infrastructural deficiencies as a universal barrier to teachers implementing ICT in their pedagogy, and the same may even be true for a third-world island like the resource-deprived Tobago.

Contrary to the findings of previous researchers, Koehler and Mishra (2009) have deviated from attributing the physical ICT infrastructure as a barrier to infusing ICT in their pedagogy to teacher competence. Koehler and Mishra [19] postulated that teachers' digital competence is insufficient to engender meaningful integration of technology with the pedagogy of mathematics, hence the development of the Technological Pedagogical Content Knowledge (TPACK) framework. Koehler and Mishra [19] postulated that effective ICT integration requires teachers to effectively integrate four dimensions of the TPACK framework (where all four sets intersect). This study is in direct alignment with Alonso-García et al. [20], who postulate that purposeful integration of technology in primary school mathematics classrooms leads to improvement in student engagement and conceptual understanding. Notwithstanding this, the benefits of integration are also aligned with teachers' readiness and pedagogical application rather than solely infrastructural availability [20]. This contravenes earlier studies that identified infrastructure as the primary constraint [17,18].

With respect to integrating ICT into teachers' pedagogy, integration strategies such as TPACK [19] and Alonso-García et al.'s [20] postulations suggest that pedagogy supersedes technological access as it relates to ICT integration. This contradicts previous studies; however, there was a need to investigate whether a pedagogical framework such as TPACK will yield the same results within the Tobago space.

Quantifying the impact of ICT on student achievement was the position adopted by Ndlovu and Mji [21] and Skryabin et al. [22]. Both studies had some commonality, one of those being a positive correlation between ICT use and mathematics problem-solving performance. This correlation, however, is realized when ICT was thoroughly integrated and supported by sustained teacher training [21]. However, whenever ICT was used superficially or disconnected from instructional goals, the effects on students' performance were negligible [22]. Skryabin et al. [22] further posit that long-term benefits were derived from a systemic approach, socioeconomic factors, and the quality of teacher training. This exposes a gap in the literature: while students' performance was improved on the international front, there is little data relating to how these same factors impact Tobago, given its resource constraints.

Research that was done by Ndlovu and Mji [21] and Skryabin et al. [22] suggests that meaningful ICT integration in teachers' pedagogy can improve students' performance, especially when it is supported by adequate infrastructure, effective pedagogy and teacher readiness. Here is where the research gap lies, as it remains unclear whether the same will apply in the Tobago scenario, where limited research data on this issue exist.

With respect to teacher preparedness, Ertmer and Ottenbreit-Leftwich [3] posit that internal factors restrict teachers from creatively integrating ICT in their pedagogy. These factors include: teacher belief, confidence, and pedagogical mindset. This position was corroborated by Petko et al. [23] as they found that teachers' perception of ICT quality (reliability, relevance, usability) influenced their willingness to infuse ICT into their pedagogy. Petko et al. [23] contended that teachers' perceptions have a significant influence on them integrating ICT in their pedagogy even if they had access to ICT infrastructure. These perspectives add a new dimension to the barriers that restrict or prevent teachers from infusing ICT into their pedagogy, thereby placing teacher perception on the same tier as earlier literature suggested infrastructure being the primary barrier.

Research on teacher belief and teacher confidence is central to teachers' self-efficacy, which, according to Ertmer and Ottenbreit-Leftwich [3] and Petko et al. [23], is a prime determinant of teachers' use of ICT. However, research data that support this position are limited in the Tobago context, thereby creating a research gap.

Voogt and McKenney [24] further support the view of teacher confidence being a major barrier to ICT infusion. This determination was made through observation of pre-service teacher training that emphasized acquisition of technical skills but lacked components of pedagogical integration. Voogt and McKenney [24] posited that both pedagogical competence and confidence should be embedded in professional development programmes to enable teachers to align ICT with learning objectives. Similarly, Darling Hammond et al. [25] supported these findings by identifying active learning, collaboration, and extended-duration training as critical features of impactful professional development. These research findings collectively suggest that for professional development to be meaningful, it must be ongoing and contextually relevant. Both Voogt and McKenney [24] and Darling Hammond et al. [25] saw short-term technical workshops as being insufficient for fostering sustained ICT integration. Despite this, there is little to no research data outlining the frequency with which ICT-related professional development is conducted with primary school teachers in Tobago, and whenever it is being conducted, the measurement of its effectiveness.

In summary, the literature reviewed in this paper supports the idea that there are many factors that influence effective ICT integration. These factors include but are not limited to: the interrelationship among infrastructure, teacher competence, teacher self-efficacy, and sustained professional development. Notwithstanding this, earlier research suggested that emphasis should be placed on infrastructure as a barrier to ICT integration; however, later studies gave more precedence to other factors, such as teacher agency, pedagogical capability, and continuous learning. However, this global perspective accentuates the research gap, especially because there is insufficient research data to establish any alignment of these international findings to the Tobago scenario.

3. Methodology

3.1 Research Design

The researcher used a cross-sectional quantitative survey design to reveal some of the barriers that challenge Tobago primary school teachers from infusing ICT in their mathematics problem-solving pedagogy. The design was considered suitable for this type of research, since the data were collected at a single point to enable the researcher to effectively examine whether relationships exist among infrastructural factors, professional development, ICT integration, and students' mathematics problem-solving, using statistical analyses. Quantitative data were gathered using a structured questionnaire. Questions contained in the questionnaire related to:

- Teachers’ access to ICT infrastructure and resources
- Teachers’ professional development in ICT
- Frequency and effectiveness of ICT use in mathematics problem-solving instruction
- Student mathematics problem-solving performance

The quantitative design was considered appropriate because it enabled the researcher to analyse patterns, relationships, and differences among variables using statistical procedures.

The Participants

The teaching population at the primary schools in the Tobago Education District is about 400. These teachers are spread across 40 primary schools. All the teachers who participated in the study were qualified and willingly provided information about their ICT practices and their students’ mathematics problem-solving performance. To obtain an appropriate representation of the primary school teaching population, stratified random sampling was done by randomly selecting three schools within the district’s three fraternities. This totaled nine schools, and from the schools, there was a total of 78 respondents. According to calculator.net [26], this sample size was considered appropriate to achieve a 95% confidence level with a 10% margin of error.

Data Collection and Data Analysis

Data were collected using a structured questionnaire consisting primarily of closed-ended items. The questionnaire was divided into sections designed to measure the major variables of the study: Demographic information; ICT infrastructural and resource availability; Teachers' ICT use in mathematics problem-solving instruction; Teachers' professional development in ICT; and Student mathematics problem-solving performance. Likert-scale items ranging from Strongly Disagree (1) to Strongly Agree (5) were used to measure participants' perceptions and practices. Frequency scales were also used to assess levels of ICT integration. To improve validity, the instrument was reviewed by individuals with expertise in mathematics education and ICT integration. A pilot test involving 10 teachers was conducted to assess clarity and reliability before the full administration of the questionnaire.

The researcher requested permission to conduct the study from the relevant educational authorities, which included the principals of all participating schools. Subsequently, respondents were recruited from participating schools, and they were informed of the purpose of the research and the benefits that it can bring before their participation. Respondents were able to access the questionnaire both digitally and through a paper-based medium. Before their participation, respondents were also given the assurance of confidentiality and anonymity. Data collection was conducted over two weeks: Completed paper questionnaires were collected by the researcher, while digital responses were automatically recorded using a secure online platform.

The study examined the key variables, independent and dependent variables. The independent variables included:

- ICT infrastructural and resource factors which focused on Availability of ICT resources, Reliable internet access, Access to digital tools, Availability of technical support, and ICT resource limitations
- Teachers’ professional development in ICT

On the other hand, the dependent variables comprised Teachers’ ICT use in mathematics problem-solving instruction and Student mathematics problem-solving performance. Composite variables were created in SPSS by calculating mean scores for related questionnaire items.

The data emanating from student performance were obtained from the class mean reported by the teacher, which resulted from assessments that were constructed and administered by the teacher after implementing specific mathematics problem-solving topics. The assessment was not standardized, and teachers used their usual way of administering their assessments; this included ICT-based assessments, pen-and-paper-based assessments, or a combination of both.

Raw assessment scores were converted to percentages, and the teacher calculated and reported the class’s mean score as individual scores were not used. Typically, primary school students in the Tobago District score below 35% in problem-solving, so any average that exceeds this is regarded as good.

The data analyses were completed using the statistical software called Statistical Package for Social Sciences (SPSS). This software provided both descriptive and inferential analyses to answer the research questions. Some of the descriptive statistics generated by SPSS, which were used to summarize demographic information, included: frequencies, percentages, means, and standard deviation. Major variables of the study included:

- ICT infrastructure and resource availability
- Teachers’ professional development levels
- ICT use in mathematics problem-solving instruction
- Student mathematics performance

To determine the internal consistency of the questionnaire scales, a reliability analysis was conducted using Cronbach's alpha.

To answer Research Question 1, multiple linear regression analysis was conducted. The dependent variable was the composite score of ICT use in mathematics problem-solving instruction. The independent variables included: Availability of ICT resources; Reliable internet access; Access to digital tools; Availability of technical support; and ICT resource limitation item (reverse coded). Composite scores were first created in SPSS by calculating the mean scores of the relevant questionnaire items. Regression analysis was then performed to determine the extent to which infrastructural variables predicted teachers' ICT use. However, to answer Research Question 2, an independent samples t-test was conducted. Teachers were grouped into two categories based on their ICT use scores: Low ICT integration and High ICT integration. The high integration group was the teachers who frequently integrated ICT into their mathematics instruction (at least twice per week), and the low integration group consisted of teachers who had ICT integration at most once per week and relied primarily on traditional teaching. This was reflected in the response to the question "How frequently do you use ICT tools in your mathematics lessons?" The classification of teachers according to their level of ICT integration was based on their responses to the question: "How frequently do you use ICT tools in your mathematics lessons?" Response options included Daily, 2–3 times per week, Once per week, Rarely, and Never. Teachers who reported using ICT at least twice per week (daily or 2–3 times per week) were classified as having high ICT integration, while those who reported using ICT once per week, rarely, or never were classified as having low ICT integration. Student mathematics problem-solving performance served as the dependent variable. Mean scores and standard deviations for both groups were first examined using descriptive statistics. Of the 78 teachers surveyed, 19 did not respond to the item asking for their class's mean problem-solving score. These cases were excluded via listwise deletion, leaving a final analytic sample of 59 teachers ($N = 59$). The independent samples t-test was then used to determine whether a statistically significant difference existed between the performance of students taught by teachers with high ICT integration and those taught by teachers with low ICT integration. Additionally, Levene's Test for Equality of Variances and the significance value (p-value) were used to determine statistical significance at the 0.05 level. On the other hand, to answer Research Question 3, Pearson product-moment correlation analysis was conducted. Composite scores were created for: Teachers' professional development in ICT and ICT use in mathematics problem-solving instruction. Pearson's correlation coefficient (r) was used to determine the strength and direction of the relationship between the two variables. Statistical significance was determined using the p-value at the .05 level.

The following assumptions were considered before conducting the inferential analyses:

- The data were assumed to be approximately normally distributed.
- Responses were assumed to be independent.
- Linear relationships between variables were assumed for regression and correlation analyses.
- Homogeneity of variance was considered for the independent samples t-test using Levene's Test.

Ethical Consideration

Before the study was conducted, the researcher had to seek permission to undertake the research from the university's ethics committee. This is a body of individuals who rigorously ensure that the research meets the highest ethical standards, thereby providing a layer of protection for the researcher, respondents, and the university. Subsequently, approval was obtained to research once the ethical standards were met. Upon receiving approval from the ethics committee, permission was sought and obtained from the Division of Education and all participating school principals before the final level of permission was sought from the respondents, the participating teachers. Following this, participants were assured that their participation in the study was strictly voluntary and were allowed to withdraw at any time without penalty. Furthermore, Written and verbal assurances of confidentiality and anonymity were provided. Additionally, no identifying information was collected through the questionnaire, and all data were securely stored in password-protected files accessible only to the researcher. The findings were reported honestly and accurately to avoid any form of misrepresentation or bias.

4. Results

These findings were guided by the aforementioned research questions.

1) Participants Profile

A total of seventy-eight (78) primary school teachers from selected schools within the Tobago Education District participated in the study. The findings revealed that the majority of respondents were female teachers (71%), while male teachers accounted for 28% of the sample. One respondent (1%) preferred not to disclose gender (Table 1).

Table 1. Primary school teachers' profile

Profile		Frequency	Percentage (%)
Gender	Male	22	28
	Female	55	71
	Prefer not to say	1	1
Age Range	20–29 years	16	21
	30–39 years	13	17
	40–49 years	27	34
	50 years and over	22	28
Teaching Experience	0–5 years	17	22
	6–10 years	11	14
	11–15 years	13	17
	16 years and over	37	47
Class Teaching Levels	Infant Department	20	25
	Standard 1–3	27	35
	Standard 4–5	31	40
Highest Qualification	Bachelor's Degree	56	72
	Master's Degree	21	27
	Currently Pursuing Bachelor's Degree	1	1

There were more teachers in the 40-49 age group in the study as compared with other age groups. This is illustrated in Table 1. This is because the schools that were sampled have a relatively large middle-aged population. Almost half of the respondents (47%) possessed more than 16 years of teaching experience. Additionally, teachers with 0–5 years of experience accounted for 22% of the sample, while 17% of the respondents had between 11–15 years of experience and 14 % of the respondents had between 6–10 years of experience.

The majority of respondents (40%) taught at the Standard 4–5 level, followed by 35% who taught Standards 1–3. Teachers from the Infant Department accounted for 25% of the sample (Table 1). The majority of respondents (72%) possessed a Bachelor's Degree, while 27% held a Master's Degree. One respondent (1%) indicated that they were currently pursuing a Bachelor's Degree. These findings suggest that the respondents were generally experienced and professionally qualified teachers, thereby providing credibility to the responses gathered regarding ICT integration in mathematics problem-solving instruction.

2) Results Based on Research Question 1

To what extent do infrastructural and resource factors predict primary school teachers' use of ICT in mathematics problem-solving lessons in Tobago?

This question was answered using multiple regression analysis, where five independent variables, namely: sufficient ICT school resources, internet reliability, digital tool access, the availability of technical support, and ICT resource limitations, were collectively regarded as "infrastructural resources". The infrastructural resources were then used to predict the respondents' ICT use.

3) Predicting ICT Use from Infrastructural Factors

Looking at the individual variables that comprised the "infrastructural factors", the term ICT school resources referred to whether the school had sufficient computers, tablets, projectors, smartboards, and other technological devices to serve both students and teaching staff. The second variable, the reliability of the internet connection, addressed the efficiency (stability and accessibility) with which internet access is provided. The third variable, technical support, refers to the on-site IT support the respondents have to enable troubleshooting whenever they encounter ICT challenges. Fourthly, ICT Resource limitation refers to the incompatibility of the ICT resource, especially as it relates to meeting the teacher's pedagogical needs. Table 2 illustrates that this combined set of infrastructural factors is weakly associated with teachers' use of ICT. Furthermore, only 9.3% of the variation of this usage is explained by the infrastructural factors, indicating that other factors not captured in this model may account for the 90% variation.

Table 2. Model Summary for Infrastructural Factors Predicting ICT Use

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.305	0.093	0.030	0.67223

4) Variables in the Regression Model

Among the infrastructural variables, availability of technical support demonstrated the strongest positive relationship with ICT use ($\beta = 0.186$, $p > 0.05$), although the predictor remained statistically insignificant (Table 3).

Table 3: Regression Coefficients for Infrastructural Predictors

Predictor Variable	B Unstandardized Coefficients	Beta (β) Standardized Coefficients	t	Sig.
School Has Sufficient Resources	-0.067	-0.087	-0.655	0.514
Reliable Internet Connections	0.073	0.115	0.925	0.358
Access to Digital Tools	0.035	0.073	0.581	0.563
Availability of Technical Support	0.145	0.186	1.573	0.120
Reverse-coded ICT Resource Limitation	-0.105	-0.191	-1.644	0.105

5) Results Based on Research Question 2

Is there a significant difference in student mathematics problem-solving performance between classes taught by teachers with high versus low levels of ICT integration?

6) Group Statistics

The results indicated that students taught by teachers with high levels of ICT integration obtained higher mean scores ($M = 50.46$) than students taught by teachers with low ICT integration ($M = 38.76$) (Table 4).

Table 4: Group Statistics for Student Mathematics Performance

ICT Integration Group	N	Mean	Std. Deviation
Low ICT Integration	34	38.76	14.279
High ICT Integration	25	50.46	21.427

Additionally, there was a statistically significant difference in student mathematics problem-solving performance between the two groups, $t(57) = -2.515$, $p < 0.05$. Therefore, the null hypothesis (there is no significant difference in students' performance at mathematical problem-solving between those taught by teachers with high ICT integration and those with low ICT integration) was rejected (Table 5).

Table 5: Independent Samples t-Test for Student Mathematics Performance

t	df	Sig. (2-tailed)
-2.515	57	0.015

7) Results Based on Research Question 3

What is the relationship between the level of teachers' professional development in ICT and the frequency or effectiveness of ICT use in mathematics problem-solving instruction?

The correlational analysis revealed that there was a moderately positive and statistically significant relationship between teachers' professional development and ICT use in mathematics problem-solving instruction, $r = 0.521$, $p < 0.01$ (Table 6). This result indicates that teachers who received higher levels of ICT-related professional development were more likely to integrate ICT frequently and effectively into mathematics problem-solving instruction. This also means that the converse is likewise true: the lower the levels of ICT-related professional development, the less likely teachers will be willing to integrate ICT into their mathematics instruction.

Table 6: Pearson Correlation Between Professional Development and ICT Use

Variables	r	Sig. (2-tailed)	N
Professional Development and ICT Use	0.521	0.000	78

5. Further Discussions

The study served to investigate three things, namely: the extent to which infrastructural and resource factors influence teachers' use of ICT in mathematics problem-solving instruction, determine whether differences exist in student mathematics performance based on levels of ICT integration, and investigate the relationship between teachers' professional development and ICT use in mathematics instruction.

In the first instance, the research revealed that infrastructural factors did not significantly predict teachers' use of ICT in mathematics problem-solving instruction. This means that teachers' use of ICT to teach mathematics problem-solving had no bearing on whether or not the schools were equipped with an adequate supply of any of the aforementioned ICT infrastructural factors. This was substantiated by the regression analysis, which revealed that the infrastructural variables explained only 9.3% of the variance in ICT use ($R^2 = 0.093$), and the overall model was not statistically significant, $F(5, 72) = 1.478$, $p > 0.05$. Additionally, none of the individual factors which comprised the "infrastructural factors" showed a significantly positive relationship with ICT use. This implies that in the Tobago Education District, the predictability of teachers' ICT use to teach mathematics problem-solving may be influenced by other factors besides infrastructural factors.

These findings contravene work done by Tondeur et al. [16], which concluded that both a robust schoolwide ICT policy, coupled with adequate ICT infrastructure, can significantly influence teachers' ICT integration. Similarly, Tim Unwin [17] also contrasted the research findings as he used the contrapositive to argue that inadequate access to devices, internet connectivity, and technical support often limit meaningful ICT integration. Conversely, the findings were supported by Ertmer and Ottenbreit-Leftwich [3], who proposed that adequate infrastructure alone cannot influence teachers' use of ICT. Rather, they posited that teachers' self-efficacy, pedagogical confidence, and professional readiness have a greater influence on teachers' ICT use. This was also corroborated in Koehler and Mishra [19] findings, which proposed a Technological Pedagogical Content Knowledge (TPACK) Framework. This framework can be considered as intersecting sets: Technological Pedagogy Content (TPC), Pedagogical Content Knowledge (PCK), Technological Pedagogical Content Knowledge, etc. The intersection of all four sets (TPACK) suggests that it takes more than the technology (infrastructure) to influence the use of ICT to teach mathematics problem-solving. They suggest that pedagogical knowledge and content knowledge also play a critical role in the effective use of ICT to teach mathematics problem-solving.

Findings relating to Research Question 2 revealed that students who were taught by teachers who had high levels of ICT integration performed significantly higher, with a mean ($M=50.46$), as opposed to those who were taught by teachers with low levels of ICT integration ($M = 38.76$). This suggests that students who are taught by teachers with high levels of ICT integration generally outperform those who are taught by teachers with low levels of ICT integration in mathematics problem-solving, $t(57) = -2.515$, $p < 0.05$. This finding was also corroborated by Alonso-García et. al. [20], who assert that reasoning skills, student engagement, and conceptual understanding are significantly enhanced with meaningful ICT integration. These findings were also supported by Ndlovu and Mji [21], as they posit that when students are exposed to meaningful ICT-based mathematics instruction they performed significantly better at problem-solving activities. Similarly, Skryabin et. al. [22] support this position as they found that students' mathematics achievement is significantly improved over time when exposed to an interactive ICT-supported learning environment.

One possible explanation for the findings relating to Research Question 2 is that many ICT tools foster conceptual understanding through visualization of the concept taught using virtual manipulatives, students' interaction with software, their collaboration in pairs, and the immediate feedback for formative assessment. Additionally, many of the contemporary software allows for gamification, which increases students' engagement

The findings of Research Question 3 revealed a statistically significant and moderately positive correlation between teachers' professional development and ICT use in mathematics problem-solving ($r = 0.521$, $p < 0.01$). This suggests that the more ICT professional development that teachers receive, the more likely they are to use ICT in their mathematics pedagogy, and the converse is likewise true. Again, Koehler and Mishra [19] support this position as they posited that teachers who meaningfully combine technology, pedagogy, and content are more effective. Additionally, Voogt and McKenney [24] also supported these findings as they posited that professional development that is concentrated in ICT pedagogy improves teachers' confidence significantly and hence the ability to deliver the mathematics curriculum using ICT. Further, the research finding was also supported by Darling-Hammond et.al. [25], who posited that teachers' instructional practices had a greater impact when professional development is sustained over a longer period of time as opposed to workshops or short training sessions. From this, it can be inferred that the way professional development is being conducted in Tobago may be the single most efficacious tool that can propel teachers to integrate ICT in the teaching of mathematics problem-solving. ICT-focused professional development, therefore, that is sustained increases teachers' self-efficacy.

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6. Conclusion

The findings indicate that infrastructural and resource factors alone did not significantly predict teachers' ICT use in mathematics problem-solving instruction in the sampled Tobago primary schools. Nevertheless, adequate infrastructure remains important for enabling technology-supported teaching. Students in classes taught by teachers with higher levels of ICT integration recorded significantly higher mathematics problem-solving scores than those in the lower-integration group, although the cross-sectional design does not establish a causal effect. Professional development was moderately and positively associated with teachers' ICT use, indicating the importance of sustained opportunities to develop technological and pedagogical competence. Overall, effective ICT integration in Tobago primary schools appears to depend on a combination of appropriate resources, teacher preparedness, pedagogical competence, technical support, and continuing professional development.

7. Recommendations

Based on the findings of the study, the following recommendations are proposed:

1) The Division of Education should provide sustained and targeted professional development programmes focused on ICT integration in mathematics problem-solving instruction.
2) When designing professional development programmes, emphasis must be placed on using software that can meaningfully assist in conceptual development, student engagement and student interaction. This will make the teachers' ICT competency relevant to the mathematics classroom, especially when teaching problem-solving.
3) The Division of Education should strive to employ sufficient ICT personnel whose competency goes beyond hardware. These personnel must be on-site and ready to provide meaningful assistance to teachers even as they navigate their ICT mathematics problem-solving lessons.
4) The Division of Education can initiate the formulation of a community of learners who can collaborate in the ICT mathematics problem-solving delivery. This can be catalysed by the Mathematics Curriculum Officer (the author of this research) in order to share best practices and lend pedagogical support to teachers who may not be so efficacious.
5) Notwithstanding the findings of this research with respect to ICT infrastructure being an insignificant predictor of ICT use, it is still critical that schools be equipped with the necessary infrastructure to facilitate on-site ICT mathematics problem-solving pedagogy. This means that schools should be equipped with modern ICT devices, a stable internet, and sufficient devices to service both teachers and students.

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