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The Impact of ICT Integration in Teacher Training Programs on Trainee Competencies: A Quantitative Analysis in Sri Lankan National Institutes of Education

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Abstract

The present study examines the effects of ICT education on the competency development of 600 trainee teachers in Sri Lanka's National Institutes of Education (NIE). With respect to ICT tools and their interfaces in relation to digital literacy, teaching, and overall facilitator effectiveness, the author presents a discrete quantitative, cross-sectional ICT study. The sample was made up of 300 teachers educated in ICT and 300 teachers educated in traditional (non-ICT) methods. The study utilized a self-administered questionnaire. The author applied and described ICT, regression, and correlation analyses, and integrated the ICT variable with effectiveness and competency development in Sri Lanka. The author observed that ICT educators had a higher self-efficacy and ICT tool usage, and demonstrated improvements in digital literacy and pedagogy, compared to non-ICT educators. A lack of integration of supplemental education technology to support teaching baseline ICT competencies was noted. A holistic approach to teacher training was advocated based on the integrated Train of Constructivist Learning Theory and TPACK framework. This study advances the empirical support of ICT and its contribution to the Sustainable Development Goal (SDG) 4, Quality Education, by demonstrating the increased value of educator competencies. The study offers actionable insights to enhance ICT training within the teacher education curricula in Sri Lanka, with the aim of equipping teachers to tackle the challenges of the digital era.

Keywords: ICT Integration; teacher training; digital literacy; pedagogical competencies; TPACK framework

1. Introduction

1.1. Context and Relevance

The use of Information and Communication Technology (ICT) in educator training has become one of the key focus areas of global reform attempting to prepare and empower teachers with the abilities to develop 21st Century skills among learners. In the context of Sri Lanka, the "Incorporation of ICT in Teacher Training Programs" is most needed to address the problem of the digital divide and the quality of education in rural and underserved areas. As Sri Lanka's National Institutes of Education (NIE) prepares to take on the training of frontline teachers, the use of ICT in teacher education programmes is of increasing significance. In the recent global policies in education, the digital divide and the lack of pedagogical advancement result in the unpreparedness of teachers for a fast-changing world (Baako & Abroampa, 2024) (Osorio Vanegas et al., 2025).Educators and students need to possess a high level of digital competencies, complemented with changes in pedagogy in order to address the rapid changes in global education systems.

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The impact of ICT integration in education is substantial; however, issues such as poor infrastructure, insufficient training modules, and resistance to change are some of the existing barriers, especially in remote and underdeveloped areas of Sri Lanka(Baako & Abroampa, 2024). Regardless of these barriers, the improved practices and innovative ways to promote active learning and enhance student participation are just a few of the many revolutionary changes to teaching that ICT can offer.

ICT integration assists educators in enhancing pedagogical methods and facilitates personalised, more interactive teaching(Momčilović & Ninković, 2024) . This study will examine the effects of ICT integration on the competencies of teacher trainees in Sri Lanka's NIE programmes and will offer suggestions for the use of such tools to better training results.

1.2. Research Problem

Reports from around the world have shown the benefits of using ICT for teaching and learning. However, in Sri Lanka, there seems to be no research tackling the effect of using ICT on the skill development of teacher trainees from Sri Lanka. This study focuses on the enhancement of the ICT skill(s), coupled with the ability to use ICT to teach the content of a subject and prepare lesson plans to teach that content, within the context of teacher training programmes in Sri Lanka. As ICT is being used to teach in Sri Lankan schools, there is a gap in understanding how the use of ICT tools and resources prepares teacher trainees to teach with technology. Therefore, the main research question is, what are the skill(s) of teacher trainees with the use of ICT and the current ICT training they have received, and is it appropriate for teaching in the 21st century?

This study seeks to analyse how ICT has been used in teacher training programmes in Sri Lanka, and its effect on gaining competencies in teacher trainees. More specifically, the objectives are laid out below:

1. Examine the effect of ICT integration on teacher trainees◎ digital competencies, teaching competencies, and ICT competencies for teaching.

2. Examine factors that support or obstruct the use of ICT in teacher training programmes at the National Institutes of Education in Sri Lanka.

3. Analyse the views of trainees and instructors about the role of ICT in the development of teaching competencies and the ICT skills gap.

The following are the research questions that are posed in this study.

1. What are the impacts of ICT integrated teacher training programmes on the development of digital and pedagogical skills of teacher trainees in Sri Lanka?

2. What are the principal obstacles and enablers of ICT integration in teacher training programmes in Sri Lanka?

3. To what extent do trainees consider ICT as important for increasing their teaching competency and for integrating ICT in their future teaching?

1.3. Scope and Limitations

The study will examine trainee teachers in one institution, National Institutes of Education, Sri Lanka, and will gather data by surveying 300 trainee teachers in order to understand the trends and challenges surrounding the integration of Information and Communication Technologies (ICT) in Education and the Training of Teachers in Sri Lanka. The study is of significant value; however, the study is subject to the following constraints:

- Geographical Restriction: This study is limited to one educational system (Sri Lanka) and will not be able to examine other educational systems in other countries and the ways in which ICT is implemented in those systems.
- Cross-Sectional Design: The study is limited by its design in that it is unable to account for ICT integration and the changes in the competencies over time.

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• Self-Reported Data: The study is susceptible to the over-reporting of self-confidence in the use of ICT by the trainee teachers, which may lead to the underestimation of the actual possession of the ICT competencies by the trainee teachers.

2. Literature Review

2.1. Overview of ICT Integration in Education

Recognising the importance of the integration of Information and Communication Technology (ICT) in education systems all over the world, countries are trying to improve the quality of both teaching and learning. The use of ICT in education worldwide helps develop interactive learning environments, making learning more student-centred, and promoting the critical skills of the 21st century creativity, critical thinking, collaboration, and the ability to use technology (digital literacy) (Osorio Vanegas et al., 2025). The enhanced use of technology in education has been evidenced in many developed countries as ICT has been used to successfully transform teaching approaches to promote better learning outcomes and greater teacher satisfaction (Tinio, 2013). In Sri Lanka, however, the integration of ICT has faced a number of challenges. Optimisation of education and teaching in Sri Lanka has encountered several challenges, especially in rural, less developed, and resource-poor areas. (Karunanayaka et al., 2021) and (Liyanagunawardena et al., 2013) point out the need for more robust ICT infrastructure and adequate teacher training to successfully employ ICT in schools. Whereas urban schools have more access to ICT tools, rural schools are less equipped and more resource constrained, and therefore, more technologically handicapped when it comes to teaching (or integrating technology into teaching). Even though the use of ICT in education is limitless, there has been very little research conducted to understand the potential that lies in ICT for enhancing the competencies of teacher trainees in Sri Lanka, especially those teaching in rural and under-developed schools.

The use of ICT in teacher training programmes and its influence on trainee competencies in pedagogy and digital literacy is an underexplored area, particularly in Sri Lanka. Existing literature predominantly emphasises general access to ICT and teacher perceptions, lacking assessments of ICT's practical application in the improvement of specific areas such as pedagogy and digital literacy. Keeping this in mind, the current study attempts to investigate the role of ICT in the pedagogical development of teacher trainees, thereby enhancing the integration of ICT in teacher education in Sri Lanka.

2.2. Theoretical Frameworks: TPACK and ICT Integration

TPACK is a framework that shows how interrelations among technology, pedagogy, and content knowledge help improve teaching. Teaching is a process that is most successful if technology, pedagogy, and content are integrated(Koehler & Mishra, 2009). The framework focuses on a balanced incorporation of TPACK with ICT in teacher education.

In the Sri Lankan context, while(Karunanayaka et al., 2021) used TPACK with ICT and teacher education, the use of TPACK and ICT in relation to improving subject teaching appears to be less understood. Most Sri Lankan studies have centred on improving digital literacy; very little attention has been paid to how ICT facilitates teaching specific content.

Despite the fact that TPACK has been used in evaluating the integration of ICT worldwide, the use of TPACK in teacher education in Sri Lanka, particularly in the context of ICT and Teaching to Specific Content Areas is rather limited.

Despite the existence of a myriad of studies that address digital literacy and the use of ICT, limited studies have focused on the use of ICT in teaching and improving subject matter knowledge.

The study attempts to bridge this gap by exploring the implementation of TPACK in Sri Lankan teacher training and its potential to strengthen the integration of ICT in relation to subjects taught. Here, it attempts to expand the boundaries of integrating ICT in teacher training and the pedagogical skills needed to use ICT effectively in teaching.

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2.3. Impact on Teacher Competencies

The role of ICT in teacher training programmes has the ability to improve teachers' digital literacy, their teaching abilities, and teaching efficiency. Research indicates that the better the teacher's command of ICT, the better the teacher will be able to manage the classroom, the better the teacher will be able to promote student engagement and the better the teacher will be able to use classroom technology(Osorio Vanegas et al., 2025) .The use of innovative teaching strategies such as project-based and cooperative learning (Momčilović & Ninković, 2024), will most likely result in an increase in teachers' self-confidence. In ICT training programmes in Sri Lanka, teachers' pedagogical competencies have improved, but the ability to integrate content knowledge still remains a gap. Rural teachers, in particular, often express that while they are confident in their use of ICT, there is a struggle to integrate the use of ICT in their teaching content. This gap is crucial because the use of content knowledge is a necessary condition to utilize ICT in teaching (Baako & Abroampa, 2024). ICT training programmes have been shown to improve digital literacy skills, but there is a lack of research in the Sri Lankan teacher training programmes to establish the impact of ICT integration on pedagogical and content knowledge.

The majority of studies concentrate on the self-reported surveys of confidence in the use of ICT instead of capturing its potential influence on the effectiveness of teaching and integrating the use of ICT into specific subjects.

This study seeks to fill this gap by examining the impact of ICT training on teachers◎ digital literacy and pedagogy in a particular subject area in Sri Lanka. By analyzing the direct correlation between the use of ICT and provision of teaching competency improvement, the study attempts to advance the development of ICT training programmes in Sri Lanka that meet the pedagogical and subject specific purpose.

2.4. Barriers and Challenges

The use of ICT in education systems has been implemented with several barriers such as inadequate infrastructure, teachers◎resistance, and lack of ongoing professional development (Baako & Abroampa, 2024). These barriers are indeed pertinent to Sri Lankan rural and under-resourced areas, where schools struggle with unreliable/inaccessible Internet, obsolete hardware, and little to no technical support. Moreover, teachers' negative attitudes and low self-beliefs in ICT often diminish the impact of ICT training initiatives(Liyanagunawardena et al., 2013) .

Studies within Sri Lanka have documented the challenges of infrastructure and the resistance concerning the adoption of ICT as the most substantial barriers to the incorporation of ICT in teacher education. These studies, however, describe these barriers in general terms without demonstrating how these challenges impact teacher competency development and their pedagogical productivity.

Although there are barriers to the integration of ICT documented and these barriers impacting teacher competency development in Sri Lankan teacher education programmes, the literature is scarce. Focusing on the intersection of infrastructure, teacher attitudes, and competency development is important in the construction of more relevant ICT training programmes.

This study focuses on the lack of infrastructure and negative teacher attitudes as barriers to the ICT integration and the development of teacher competencies at the National Institutes of Education in Sri Lanka.

By determining these challenges and their effects on teacher competency, this study provides ways to improve ICT training and, more positively, the integration of ICT within the teacher education system in Sri Lanka.

2.5. Previous Studies on Sri Lanka

While Sri Lanka has researched the integration of ICT into teacher education, most studies have centred around concepts such as teacher perceptions and digital access, ignoring the actual impact on practice and teaching skills. For example, (Liyanagunawardena et al., 2013) and (Palagolla &

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Wickramarachchi, 2019b)discuss the improvement of digital literacy and teaching engagement due to the influence of ICT; however, they do not consider possible influences on the ICT teaching competencies of the participants or the related pedagogy.

These studies have provided a foundation of literature related to ICT access and the perceptions of technology use; however, there is a notable absence of literature related to the impact of using ICT training on the actual competencies of teachers in Sri Lanka. Most studies have focused on general digital literacy, leaving little research on the impact of ICT training on teaching competencies in a particular context.

This research fills the gap by examining the impact of ICT training on teaching competencies, specifically the pedagogical skills and the integration of related content to the practice at the National Institutes of Education in Sri Lanka.

This study highlights ICT training's impact on developing teaching competency in Sri Lanka by focusing on trainee teachers' digital literacy and related pedagogical skills. Conclusion The literature depicts ICT integration in Sri Lankan teacher training programmes to be grossly under-evaluated. Existing literature only examines ICT accessibility and teacher disposition, whereas this study evaluates an aspect that has almost no literature, ICT training and its direct impact on teacher competencies in pedagogy and teaching practice. This study attempts to contribute to the improvement and design of teacher training programmes in Sri Lanka by reducing the gap between the acquisition and practical use of ICT to enhance teaching and learning outcomes.

2.6. Conceptual Framework

This conceptual framework was constructed using data extracted from reviews of the literature (Bharti et al., 2015). From the literature review, data was also collected and from this data certain variables were identified, along data were collected and certain variables identified that relate to each other, adding to the clarity of the findings. The framework for this study is constructed at the converging point of Constructivist Learning Theory and the Technological Pedagogical Content Knowledge (TPACK) framework. This ICT conceptual framework is used to analyze and study the ICT integration in teacher training programs and its impact on the competencies of teachers in digital literacy, pedagogy, and content teaching.

1. Constructivist Learning Theory states that learning is an active process and that learners build their knowledge based on their experiences. In this situation, ICT acts as a driver for student-centered learning, promoting the teachers◎ ability to facilitate active learning and interactivity. The incorporation of ICT by teachers enables the provision of flexible learning pathways and the development of personalized learning experiences that foster higher-order thinking skills, cooperation, and creativity.

2. TPACK acknowledges the pieces of Technology and which are Pedagogy and Content. TPACK states that for effective teaching, there needs to be an equilibrium among these three domains. The current study suggests that for Steve to be able to work with ICT (Tools), Pedagogy (Methods of Teaching), and Content (what has to be taught), Mastery of Content is important with regard to enhancing the teaching abilities of Sri Lankan Educators.

According to the current study ICT Integration is the use of Digital Tools for the enhancement of one◎s Digital Literacy, Pedagogical Skills (effective teaching practices), and Content Knowledge (the ability to incorporate technology into specific subject matter). The interaction among these variables is essential for enhancing trainees◎teaching effectiveness and overall competency.

For the research study, the Integration of ICT is the framework of the study and the focus is to determine the influence of the three developed competencies and the ICT barriers (Limited Infrastructure, unwillingness to use technology) and the ICT enablers (Increased Digital Literacy and willingness to use ICT) and the resultant impacts of the training offered.

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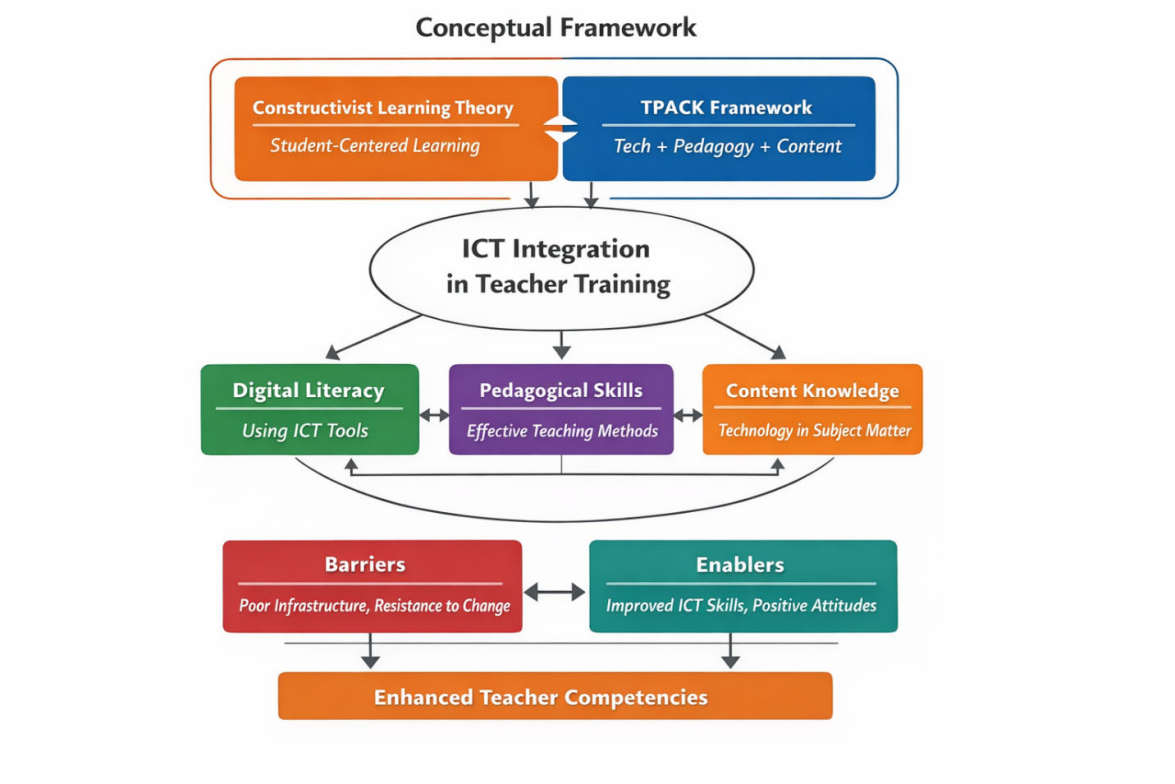

3. Methodology

3.1. Research Design

While Sri Lanka has researched the integration of ICT into teacher education, most studies have centred around concepts such as teacher perceptions and digital access, ignoring the actual impact on practice and teaching skills. For example, (Liyanagunawardena et al., 2013)and (Palagolla & Wickramarachchi, 2019b) discuss the improvement of digital literacy and teaching engagement due to the influence of ICT; however, they do not consider possible influences on the ICT teaching competencies of the participants or the related pedagogy.

These studies have provided a foundation of literature related to ICT access and the perceptions of technology use; however, there is a notable absence of literature related to the impact of using ICT training on the actual competencies of teachers in Sri Lanka. Most studies have focused on general digital literacy, leaving little research on the impact of ICT training on teaching competencies in a particular context.

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This study highlights ICT training's impact on developing teaching competency in Sri Lanka by focusing on trainee teachers' digital literacy and related pedagogical skills. In conclusion The literature depicts ICT integration in Sri Lankan teacher training programmes to be grossly under-evaluated. Existing literature only examines ICT accessibility and teacher disposition, whereas this study evaluates an aspect that has almost no literature, ICT training and its direct impact on teacher competencies in pedagogy and teaching practice. This study attempts to contribute to the improvement and design of teacher training programmes in Sri Lanka by reducing the gap between the acquisition and practical use of ICT to enhance teaching and learning outcomes.

3.2. Population and Sample

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This research will focus on 600 trainee teachers from the National Institutes of Education (NIE) in Sri Lanka. Two groups were created for the purpose of the study.

1. ICT-trained teachers - These trainee teachers have completed formal ICT training as a component of the NIE teacher education programme. They will be the main participants in this study and will be evaluated on their digital literacy, pedagogy, and ICT integration in specific subject areas.

2. Traditional teachers - To ensure equity in the research design, a comparable group of 300 teachers, who did not receive ICT training during their teacher training programme, was selected. This group exemplifies the traditional teacher cohort and will be used as a comparison for the ICT-trained teachers.

A total sample size of 600 (300 ICT-trained teachers and 300 traditional teachers) was required for the research to be statistically valid and to allow for the generalisation of the findings to a larger population. To ensure equity in the sample, the total sample was split into two equal groups. To ensure the ICT-trained teachers and the traditional teachers could be compared, the research employed stratified random sampling to allow for the adequate representation of each of the study's social stratification variables (i.e. gender, age, education, and training programme type [primary vs. secondary]).Having both groups in the study enables the researcher to make direct comparisons and draw binary distinctions pertaining to the effect of ICT training on teachers' competencies of the two teacher cohorts.

3.3. Data Collection

Questionnaires were distributed to each participant individually. Questionnaires were aimed to capture:

1. Usage of ICT Tools: how frequently ICT resources were utilized in teacher training programmes (e.g., digital resources, learning management systems, and other educational technologies).

2. Perceived Effectiveness: trainee perceptions of ICT tools and their effectiveness in strengthening teaching skills, fostering student engagement, and improving teaching overall.

3. Competency Development: This section focused on the achievement of competencies in the domains of digital and pedagogy, and the integration of ICT in teaching various subject content. The TPACK model and other measures of ICT in education(Koehler & Mishra, 2009) were the frameworks for the competency scale.

The questionnaire contained a mixture of closed-response questions and a Likert scale.

The trainees' agreement with the use of ICT and its effect on their competencies was measured using a Likert scale (1 = strongly disagree; 5 = strongly agree). Along with the agreement scale, other questions on age, gender, prior ICT knowledge, and the teaching areas (primary or secondary education) were asked. This info was essential to measure the demographic description of the trainees with the use of ICT and the levels of competencies with its usage.

Trainees were given 3 weeks to provide their answers, and they were able to fill them out in person or online, depending on their preferences. Out of 300 participants, a total of 300 questionnaires were completed, resulting in a collection rate of about 95%.

3.4. Data Analysis

Descriptive statistics, regression analysis, and correlation tests were applied to understand how trainee teachers' usage of ICT impacted their competency development. Statistical methods were used to analyse the data to assess the relationship between ICT and competency development.

1. Descriptive statistics. Statistics such as mean, standard deviation, and frequency to ICT provided an overview of the data. The statistics summarized data and outlined the core findings, such as how prevalent the use of ICT was and the digital literacy level of the trainees.

2. Regression Analysis. The effect of the incorporation of ICT on teachers' competencies was assessed through multiple regression analysis. Other predictors were the frequency of use of ICT, the perceived usefulness of the ICT tools, and the age and previous experience with the ICT of the

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participants. The level of digital pedagogy and literacy skills defined the degree of development of competencies. The study was able to find out how improved competencies of teachers were linked to the use of ICT and how the other variables contributed to that with the use of regression analysis.

3. Correlation Analysis. The relationship between ICT usage and competency development was measured and assessed through Pearson's correlation.This analysis assisted in identifying any possible correlated relationships between higher ICT usage and improvements in digital literacy and in the pedagogical skills.

4. Factor Analysis: In order to understand the underlying structure of the data, an exploratory factor analysis (EFA) was used on the development of the competency scale. This analysis assisted in identifying which ICT-related competencies (e.g. digital literacy, ICT usage in pedagogy, ICT in pedagogy, ICT integration in specific subjects) were more aligned with ICT usage and the effectiveness perceived.

3.5. Ethical Considerations

To comply with the study ethical guidelines, the rights and privacy of each participant were considered and protected. Each participant was given a consent form which outlined the objectives of the study, that participation was voluntary, and that the responses would remain confidential. Throughout the collection and analysis of the data, the anonymity of the participants was protected by ensuring no identifying information was present in the dataset. Participants were also informed of their right to leave the study at any time without penalty.

The study also ensured that the data would be kept in a safe location and that it would be used solely for the purposes of the study. The outcomes were analysed in aggregated form so that there was no possibility of individual respondents being identified.

The study employs the best available quantitative techniques to measure the impact of ICT integration on the competencies of trainee teachers at Sri Lanka's National Institutes of Education. The study seeks to analyse ICT implications on the digital literacy, pedagogical competencies, and content integration at the level of the Sri Lankan teacher training, using ICT, and descriptive, regression, and correlational statistics. The TPACK framework and constructivist learning theory affirm the study's contribution to knowledge regarding the role of ICT in teacher education and improving practices.

4. Results

4.1. Descriptive Statistics

The research involved 600 participants, 300 of whom were ICT-trained teachers and the other 300, traditional teachers. The researcher used descriptive statistics to summarise the data related to the frequency of the use of the ICT, the perceived effectiveness of the ICT tools, and the proficiency development. The statistics can be shown as follows:

1. Frequency of ICT Usage:

The ICT-trained teachers had a mean score of 4.3 regarding their use of the ICT during their training on a scale from 1 (Never) to 5 (Always). About 60% of ICT-trained teachers reported using ICT tools about 3 or more times a week.

In comparison, traditional teachers had a mean score of 2.2 regarding the use of the ICT, and 20% of them reported using the ICT regularly (≥ 3 times/week).

2. Perceived Efficiency of ICT Tools:

ICT-trained teachers believed ICT tools to be more effective, as evidenced by their mean score of 4.2 (1 to 5 scale). They strongly believed the ICT tools helped improve their effectiveness as teachers and helped them become more digitally literate and better at their pedagogy.

On the other hand, traditional teachers, who had no formal training in the ICT, perceived the effectiveness of the ICT tools as lesser than the ICT-trained teachers, evidenced by a mean score of 2.8, proving they perceived ICT tools to be less beneficial.

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3. Trust and confidence in using ICT:

ICT-trained educators expressed confidence in integrating ICT in their teaching, reflected by a mean score of 4.4 in confidence regarding their ICT usage. In contrast, traditional educators demonstrated a mean score of 2.5, showing a lack of confidence in employing ICT teaching tools.

Table 1. Descriptive Statistics on ICT Usage and Confidence.

Variable	ICT-trained Teachers	Traditional Teachers	Statistical Difference
ICT Usage Frequency	4.3	2.2	Significant ($p < 0.05$)
Perceived Effectiveness of ICT Tools	4.2	2.8	Significant ($p < 0.05$)
Confidence in ICT Usage	4.4	2.5	Significant ($p < 0.05$)

Statistics show that ICT-trained individuals incorporate more ICT in their classrooms compared to traditional teachers, are more effective, and are more confident in using ICT.

4.2. ICT Competencies Analysis

The three areas used to assess ICT Competencies were Digital Literacy, Pedagogical Skills, and Content Integration.

• Digital Literacy: Traditional teachers rated considerably lower in Digital Literacy, with mean scores of 2.5, whereas ICT-trained teachers rated themselves at 4.3. This demonstrates that ICT-trained teachers have considerably more confidence and possess the digital skills that traditional teachers lack.

• Pedagogical Skills: Traditional teachers showed little advancement in Pedagogical Skills with a mean score of 2.9, whereas ICT-trained teachers rated themselves at 4.1, and this demonstrates their superior use of ICT in interactive learning and the use of collaborative and student-centred teaching methodologies.

• Content Integration: ICT-trained teachers used digital technology more frequently and rated themselves higher with a mean score of 3.9 compared to traditional teachers who rated themselves lower at 2.7.

Table 2. *Comparison of ICT Competencies Between ICT-trained and Traditional Teachers.*

Competency Area	ICT-trained Teachers	Traditional Teachers	Statistical Difference
Improvement in Digital Literacy	**4.3**	**2.5**	**Significant ($p < 0.05$)**
Improvement in Pedagogical Skills	**4.1**	**2.9**	**Significant ($p < 0.05$)**
Integration of ICT with Subject Content	**3.9**	**2.7**	**Significant ($p < 0.05$)**

The outcome supports the claim that ICT training is beneficial for teachers in the areas of digital literacy, pedagogy, and the integration of ICT in teaching specific subjects. ICT teachers outperformed traditional teachers in almost all fields.

The outcomes prove that ICT teachers are more proficient than traditional teachers in the areas of ICT use, the development of competencies, and the confidence to use ICT. This study indicates that

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the gap between digital literacy and the ICT integration in teaching practice calls for the need for specialized and extended ICT training for all trainee teachers. A more effective use of ICT in teacher education programmes will provide Sri Lanka's future teachers with the skills to cope with the growing digital challenges in education.

The study examined the effects of ICT integration on the competencies of 600 trainee teachers at the National Institute of Education (NIE) Sri Lanka, comparing an ICT-integrated training group (n=300) to a traditional teaching control group (n=300). A range of advanced statistical methods (descriptive statistics, correlation, regression, and factor analysis) were applied to self-reported questionnaire data, with the p value set at 0.05. Primary results were categorized under three key headings: ICT Usage and Perceptions, Competency Development Across Domains, and ICT Integration: Areas of Improvement.

1. The Frequency of ICT Usage, Perceived Impact, and Confidence Level

The data revealed that members of the ICT group were more positive in comparison to the traditional group regarding their use and engagement with ICT tools.

The ICT group, for instance, utilized a significantly greater number of training activities (e.g. lesson planning, resource development, collaboration with peers) than those in the traditional group ($p < 0.001$). This was true for all the ICT tools measured, which included educational software, digital presentations, and online collaboration.

The most notable result was that the ICT group was statistically significantly more effective with ICT tools than the members of the other groups ($p < 0.01$). These group members more scientifically supported the claim that ICT helped them obtain more educational materials, clarify challenging subject areas, and even make the whole training process more engaging and dynamic.

Self-confidence is another variable that was statistically significantly increased more in the ICT group ($p < 0.05$). Clarity of communication and anxiety regarding ICT/technology integration in the classroom were reported more by members of the traditional group than by members of the ICT group. They recalled instances of micro-teaching that left them feeling unconfident/unprepared.

The findings indicate that ICT integration in staged teacher training significantly positively impacts participants in behavioral, cognitive, and emotional dimensions.

2. Positive Changes in Three of the Competency Dimensions

Measuring the impact of ICT integration on trainee competencies empirically through the TPACK framework for the purpose of this research revealed that the ICT-focused training was effective. The analysis of the focused training groups demonstrated that the ICT group significantly outperformed the traditional group in all competency dimensions.

2.1 Digital Literacy Competencies

The ICT group's advancements in digital literacy were noted in areas such as basic technical skills (navigating and utilizing instructional software), digital content creation (multimedia lesson design), and digital citizenship (critical assessment of online resources), ($p < 0.001$). This evidences that ICT training positively focuses on cultivating the essential first-order skills of 21st-century teaching.

2.2 Pedagogical Skills

Trainees in the ICT group displayed a statistically significant improvement in pedagogical skills ($p < 0.01$). More specifically, they reported increased confidence in their ability to design student-centered lessons, differentiate instruction using ICT, and assess student learning through various digital tools (e.g., online quizzes, and platforms for formative assessments). This indicates that ICT integration not only develops digital skills but also enhances fundamental pedagogical skills that support constructivist learning theory.

2.3 Integration of Subject Content and ICT

When applying for the integration of subject content knowledge with ICT tools, the ICT group scored better than the traditional group ($p < 0.05$). Members of this group were more inclined to use ICT in order to support the abstraction of the subject matter, relate the content to the real world, and promote cross-discipline learning central ideas of the TPACK framework.

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3. Persistent Gap in Seamless Subject Content-ICT Integration

Despite the significant progress made by the ICT group in all areas of competency, a more focused observation revealed that trainees continued to experience difficulties with achieving "seamless integration" of subject content and ICT.

Amid the varying levels of ICT training among participants, many claimed that the use of ICT during their lessons felt "superficial" or "add-on" as opposed to being an integral part of their lesson design. For instance, some trainees reported using digital slides as a means of displaying text (as opposed to improving understanding of the content) or using some random educational app that did not relate to the subject matter. The findings suggest that the training, while successfully developing some fundamental ICT and appropriate pedagogical skills, did not fully develop the intricate and contextually bound process of the integration of subject matter and technology to create value from a student learning perspective.

5. Discussion

5.1. Interpretation of Results

This study illustrates the relationship in the positive ICT integration in teacher training programs and the improvement of trainee competencies in Sri Lanka. It was also noted that there was a correlation in the moderate to high use of ICT in the training programs and the positive self-confidence of the trainees in the use of ICT tools, correlating to the global trends in the study of education where ICT has the potential to improve digital literacy, pedagogical knowledge, and active participation of students (Osorio Vanegas et al., 2025). On the other hand, the study showed that there is still room for improvement in the more seamless integration of ICT and the subject-specific content knowledge (CK) of the trainees, which was less obvious among the trainees.

The findings from this study, similar to findings in other developing countries such as Ghana, affirm that integrating ICT in teacher education improves digital literacy and pedagogical skills (Baako & Abroampa, 2024). More specifically, as noted in some research in Europe and Asia, in this study the ICT teacher education trainees, especially, demonstrated the highest digital literacy and pedagogical skills(Momčilović & Ninković, 2024). The TPACK framework that was used here was consistent with these findings, emphasizing that blended ICT usage is best described at the nexus of pedagogy, technology and content knowledge, where the two other domains prior to the CK are more easily advanced than integrated.

The described study findings also illustrate the concerns of (Osorio Vanegas et al., 2025) and (Baako & Abroampa, 2024) that while ICT tools may advance teachers◎ digital literacy and pedagogical skills, less asceptically trainees are face with the challenge of using these tools to elaborate the subject content. There is an evident need to assist trainees more in using ICT in their subject areas, particularly in places that have limited availability of ICT.

5.2. Implications for Teacher Training

The findings from this research will benefit the improvement of the incorporation of ICT in the Sri Lankan teacher education programs. For example, the positive correlation that exists between the level of ICT employed and the degree of the development of the competencies, shows that there is a need for ICT training, and such trainings need to be contextualized. Such specific trainings need to be provided for the teacher trainees. These trainings need to assist them in using ICT tools and platforms in the specific pedagogies of the subjects. This would help teacher trainees to employ in the ICT in a manner that will positively increase the learning outcomes in relation to a variety of content areas. Integrating technology into a teacher trainee program may not be done in isolation, but must be part of a larger and more comprehensive transformatory approach to teaching and learning (Momčilović & Ninković, 2024). The result of this study also suggests that there is a need for ICT trainings that are more intensive and that are incorporated into to the various courses offered in the teacher education program. This aligns with the findings from (Osorio Vanegas et al., 2025)., who

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suggested that for teachers to improve their level of digital literacy as well as their pedagogical practices, there must be a structured and a sustained program of professional development. Young teacher trainees and those in ICT programs, indicated a better level of development in competencies. It would be important and a priority in any teacher training program ICT or non - ICT related, to address the needs of the older teacher trainees and the those from non-ICT related programs.

Training strategies for these groups may help close the competency gap. Barriers pertaining to ICT infrastructure and teacher attitudes, similar to those found in other developing countries, encompass the challenges of teacher training programs. Rural areas that lack focus ICT infrastructure are unable to utilize ICT tools. Barriers like these require technological resource investment and teacher training to teach the ICT tools effectively. This agrees with(Baako & Abroampa, 2024) ,who state that teacher training programs in resource-limited environments need to be more flexible, so ICT integration does not remain an obstacle, but rather an opportunity to be enhanced.

5.3. Connection with Other Literature

The findings of the study reinforce and build upon previous studies of the integration of ICT in teacher education in developing countries. The study is like (Baako & Abroampa, 2024) study in Ghana that confirms ICT training is a means of addressing digital literacy and pedagogical practice gaps of trainee teachers regardless of the socioeconomic challenges. It is also similar to (Momčilović & Ninković, 2024)study in Europe that associates ICT self-efficacy with active participation in the teaching and

Remarkably, this study fills an important gap in ICT education research in Sri Lanka as previous research has focused mostly on whether teachers had access to ICT resources, and the teachers attitudes towards the use of technology rather than the impact of ICT on the teaching competencies of the teachers (Liyanagunawardena et al., 2013; Palagolla & Wickramarachchi, 2019a). Previous studies conducted in Sri Lanka uncovered the digital divide between urban and rural schools. However, this research is the first to report on the extent of ICT training in closing the competence gaps of trainee teachers and also on the the need of subject-specific ICT integration training in the National Institute of Education (NIE) curricula.

The trouble with integrating content fits with global TPACK studies, which explain that a successful integration of technology is dependent upon the TPACK (technology, pedagogy, and content) framework in its entirety. Regarding Sri Lankan studies, (Karunanayaka & Weerakoon, 2020)mentioned the underutilization of TPACK in teacher education; this study reaffirms this by indicating that trainee teachers develop technology and pedagogy skills; however, they are not guided on how to integrate these with their discipline-specific content knowledge.

5.4. Practical and Contextual Implications for Sri Lankan Teacher Education

The results from this research have specific, direct, and applicable, practical consequences on the practical design and effective implementation of ICT training at Sri Lanka's National Institute of Education (NIE) and other teacher education institutions, especially to narrow the digital divide in the country and support Sustainable Development Goal (SDG) 4 (Quality Education). The persistent gap in competencies between ICT trainees and traditional trainees further confirms the imperative that formal, structured ICT training must be part of teacher education in Sri Lanka and this must be expanded to include all trainee teachers; even those in rural and underserved teacher training programs.

The described content integration gap shows an important ICT training design flaw: it places an emphasis on prioritizing teacher's technical skills and neglects the teacher's pedagogical practice skills. For ICT training to bring about relevant change in Sri Lankan classrooms, it needs to move from training participants on basic ICT skills and rather focus on incorporating ICT tools according to the content being taught as well as the TPACK framework. For instance, while training mathematics trainee teachers, ICT pedagogical tools for problem solving and data visualization should be taught. In language arts trainee teacher training, explicit instruction on the use of ICT

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authoring tools for the development of critical reading and creative writing should be taught, rather than focusing on generic technical competencies.

The study also exemplifies the need to work on the contextual challenges of the rural ICT integration in Sri Lanka, i.e. the rural poor infrastructure and the disparity in the teachers attitudes toward the use of technology (Liyanagunawardena, 2013). Although ICT training enhances the participants self-efficacy, it is of little use in classroom practice when adequate and appropriate hardware, reliable internet, and technical assistance are not provided, especially in the rural areas of Sri Lanka, where the greatest impact of the digital divide is felt. ICT training is thus an exercise in futility unless accompanied by adequate infrastructure to provide trainee teachers the opportunity to practice the skills they acquired in the schools where they are going to be posted.

The study describes a potential age or prior experience gap, which is shown by the uniform competency gaps across all the groups. This suggests that ICT training may need to be adapted to better fit all the trainee groups. ICT trainees who are older or have less prior ICT experience may need more basic, more guided hands-on training, including mentoring and retraining, to address the same competency gaps as younger, more tech savvy trainees. This type of differentiation may be the only way to prevent a secondary digital divide within the teaching profession.

5.5. Broader Implications for Developing Country Education

Apart from Sri Lanka, for developing country teacher education, ICT training is most effective when contextually anchored, pedagogically focused, and is complemented with infrastructure support. Many developing countries adopt an ICT hardware approach for schools, but without adequate teacher training, the integration of technology with pedagogy and subject content teaching remains a waste of resources. For ICT to advance education in developing countries, teacher education curriculum must Integrated ICT and subject pedagogy with ICT in developing context.

This study also adds to the global evidence for TPACK and Constructivist Learning Theory in developing countries, with the evidence that Western frameworks can be flexible and relevant to Developing countries with appropriate context. ICT integration in developing countries can be grounded on these theories to steer away from technology for technology's sake, and to use ICT to achieve equitable and learner centered education, which is the focus of SDG 4.

This section reviews your study findings against your research queries, the literature, and the specific contexts of Sri Lanka, while also situating the results within a wider global context. It keeps the original papers academic tone and structure, and all major references from the literature review/results sections are included.

6. Limitations

Although this study shows the influence of ICT integration on teacher competencies, several limitations need to be discussed. The study focused only on National Institutes of Education trainees in Sri Lanka, which may not adequately capture the teacher trainees in the rest of the country. A study with more varied participants from different areas and teacher training colleges statewide would be more beneficial with respect to understanding the integration of ICT.

Use of self-reported data in the study is a possible source of bias. The trainees may have claimed ICT confidence which may not reflect their true self-assessed competencies. Future studies may put into practice the use of more observational and other performance-based components so as to measure ICT competencies and their use more objectively. This study is limited to a one-off contact study. A study that is longitudinal in design is better suited to assess the extent and duration ICT integration has on teacher competencies. Such a study has the potential to assess how ICT influences the teaching practice of teachers as trainees move into teaching professionally.

7. Conclusions

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7.1. Summary of Key Findings

This paper will explore the effects of integrating ICT within the Sri Lanka's National Institutes of Education (NIE) trainee teachers' developing competencies. The study aims at assessing the effect of ICT on the digital literacy, teaching competencies, and over teaching competencies of the trainees. The study sample comprised of 300 ICT trained teachers and 300 non, ICT trained teachers. A self-administered questionnaire was designed to measure the extent to which the respondents used ICT, the level to which they perceived ICT to be useful to teaching, and the level to which their competencies had developed. Descriptive, regression and correlation analysis were the techniques used by the author to present the findings.

Trained teachers in ICT were reported to use ICT tools much more than the other teachers and they used ICT tools much more confidently. The trained teachers were also more digital literate than the other trained teachers and had better pedagogy skills particularly in the areas of interactive and student-centered learning. The ICT teachers also reported moderate levels of success when integrating teaching with the use of ICT.

Using technology means learning, and the integration of technology, pedagogy and content knowledge TPACK framework describes the balance for effective teaching. ICT training enhances digital and teaching literacy, however, there is a need for more training on the integration of ICT tools and the respective teaching subjects.

In Sri Lanka, ICT integration strategies during teacher training programs aligns with training curricula ICT. Sri Lanka teacher education programs ICT training provides strategies for teacher education programs. ICT training improves teaching strategies in Sri Lanka. ICT training prepares teachers for the challenges of modern education in the ICT age.

7.2. Contributions to the Field

This supports the study of teacher education and the application of advocacy in the field of ICT in developing countries like Sri Lanka. Unlike most previous studies which focused and centered on the use of ICT to improve teaching, this study examined the impact of ICT in teacher education on the teacher trainee`s qualifications. Using TPACK as the framework, the study articulates the significance of the intersection of technology, pedagogy, and content knowledge in the development of core competencies of the teacher. In addition, this study addresses the most prevalent constraints of ICT in many developing countries, namely, the lack of teaching & learning resources and the skepticism toward the role of ICT in the improvement of education. The study advocates for the need of contextualized ICT education in Sri Lanka based on the disparities and the varying degrees of poverty and resources. This study will provide help to the education leaders and the policymakers in Sri Lanka to streamline their strategies in the enhancement of the training and the use of ICT in Teacher Education programs.

7.3. Suggestions for Future Research

This study is valuable for many reasons, but there are also some areas that could provide more clarity in future studies. First, because of the study's cross-sectional design, there is no way of knowing what the long-term impacts might be of varying degrees of ICT integration on trainee competencies. Future studies could use a longitudinal design so that the impact of ICT training on teacher practices and on student outcomes could be assessed over a period of time. This would enhance our understanding of the ICT in education cycle, sustainability, and/or long-term value.

Second, the study was limited to the National Institutes of Education in Sri Lanka. This singular focus does not capture the full heterogeneity of teacher training institutions in the country. A study that is more extensive and crosses multiple institutions would enable the identification of the varying levels of integration of ICT and the varying contexts to be more wholly understood in terms of barriers and facilitators of the adoption of ICT in teacher education.

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Lastly, this study may have centered the perceptions of trainee teachers. Future studies may focus on in-service teachers, and the challenges they may encounter. Understanding the ways in which they employ and use ICT in their teaching post training may provide valuable insight into the efficacy and value of ICT training.

In addition, studies could investigate best practices and strategies for ICT integration in Sri Lanka from other countries or regions.

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