EFFECTIVENESS OF TECHNO-PEDAGOGY CONTENT INTEGRATION (TPCI) PACKAGE ON DEVELOPMENT OF DIGITAL COMPETENCIES OF IN-SERVICE TEACHERS AT SECONDARY LEVEL

Research Report

March, 2024

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DECLARATION

I declare that this research entitled "**Effectiveness of Techno-Pedagogy Content Integration (TPCI) Package On Development of Digital Competencies of In-Service Teachers at Secondary Level**" has been taken up as a part of the **PAC 20.04** project.

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CHAPTER 1: INTRODUCTION

1.1 Introduction

In today's world, ICT has significantly shaped various aspects of our lives, and it is difficult to envision a world without ICT. Throughout our daily lives, we are constantly surrounded by the advantages of ICT. Due to the emergence of ICT, the field of education has also undergone a remarkable transformation. This has resulted in a fundamental change in the approach to teaching and learning (Prasad Chauhan, 2021). The field of ICT has become a significant catalyst in the worldwide shift towards digitizing education. From traditional chalk-and-board classrooms to dynamic digital learning environments, the integration of ICT has revolutionised teaching and learning methods. The evolution of ICT in education can be traced back to the advent of personal computers in the late 20th century. As a result of these technologies, educational content became digitized and multimedia learning resources gained popularity. These remarkable advancements in technology have led to the emergence of numerous digital devices, widespread availability of internet access, and the development of sophisticated educational software applications. These advancements have significantly broadened the possibilities for education and knowledge acquisition. In today's educational landscape, ICT plays a crucial role in various aspects, such as fostering innovation, enhancing student engagement, and enabling personalised learning experiences (Balayogi, 2022). Teachers utilize ICT tools to create captivating and interactive educational content, foster collaboration among students and provide timely feedback. Likewise, students also utilize digital resources to delve into a vast array of educational materials, engage in self-directed learning endeavours, and collaborate with peers both inside and outside the confines of the classroom. The influence of ICT extends beyond the boundaries of conventional classrooms, encompassing blended and online learning methods that overcome geographical limitations and time restrictions.

Through the integration of traditional classroom instruction and digital learning resources, educators can create adaptable and dynamic learning environments that cater to the diverse needs and preferences of students. In the field of education, online learning platforms offer a convenient way for students to participate in asynchronous learning. This enables individuals to easily access educational content at their own convenience, regardless of their location or the time. Research in this area has shown that teachers' digital competencies play a crucial role in effectively integrating ICT into education. These competencies cover the essential knowledge, skills, and attitudes required to effectively utilize technology for educational purposes. In today's ever-changing digital landscape, educators must possess a comprehensive grasp of both technology and teaching methods in order to successfully develop, implement, and assess learning experiences that integrate ICT. Professional development programmes and training initiatives are crucial for preparing teachers with the necessary skills to navigate digital environments, effectively utilize educational technology, and encourage student-centred learning approaches.

Digital skills are becoming increasingly important for teachers to properly integrate technology into their teaching techniques. For educators, these competencies include technical skills for

operating hardware and software, pedagogical skills for incorporating digital tools into teaching methods, information literacy for evaluating and utilizing digital information, and communication and collaboration skills for interacting with students and colleagues online. These competencies are critical for improving teaching and learning, preparing students for a technologically driven future, improving student learning outcomes, and supporting educators' professional development.

Technology is being incorporated into classrooms more and more, as seen by current developments in digital technology and education. Blended learning methods integrate traditional and digital technologies, whereas flipped classrooms use online resources to deliver knowledge outside of class, allowing for more engaging in-class activities. Artificial intelligence (AI) and machine learning are customizing learning experiences and automating processes, whilst virtual and augmented reality (VR/AR) produce immersive learning environments. There is also a greater emphasis on digital literacy, such as cybersecurity, online safety, and tackling digital equality, to ensure that all pupils have access to technology. Professional development for teachers is expanding with online and mixed training programs and collaborative learning communities, reflecting the constant need to equip educators with the skills required to effectively harness technology.

Despite their importance, an enormous number of in-service teachers encounter major challenges in acquiring these competencies, such as limited access to professional development opportunities, out-of-date materials, and insufficient assistance with technology integration. These difficulties limit the potential advantages of technology in the classroom and have an impact on the efficacy of instruction.

1.2 ICT in Education

The incorporation of ICT in education has brought about a significant change, affecting different aspects of teaching and learning methods. This integration presents numerous possibilities for improving educational outcomes and equipping students with the skills needed to tackle the challenges of the modern era, including the demands of Industry 4.0. Developing ICT literacy skills has become increasingly important for educators. These skills empower teachers to foster critical thinking by teaching students how to conduct research, organize information, evaluate sources, and communicate effectively. A research report by Gazali and Pransisca (2020) highlights the significance of ICT literacy in this context. This foundation is crucial for developing individuals who can excel in a rapidly changing technological environment. ICT in education is centered around the creation, advancement, and assessment of the teaching and learning process, drawing from research on various styles of learning. The main objective is to promote effective learning by utilizing digital multimedia materials that cater to the individual needs of learners (Ángeles Villeda, 2018). The shift from traditional educational practices to those heavily reliant on Internet technology demonstrates the ever-changing role of technology in education. The significance of incorporating different learning applications to enrich the educational experience is highlighted by this transition (Idris, 2018). However, certain difficulties arise when incorporating ICT in education. Educators must have a strong command of modern ICT, which includes a diverse array of tools spanning from audiovisual to storage and presentation technologies. To effectively utilize ICT in education, it

is crucial to have a comprehensive understanding of the advantages and disadvantages of educational information. This includes being aware of the methods used to evaluate the quality of educational tools (Bidaybekov et al., 2014).

By integrating ICT in education, a wide range of components are involved, such as the essential digital infrastructure that allows access to educational technology tools and resources. It explores the application and integration of ICT in teaching methodologies, learning processes, and assessment practices, which are essential for fostering interactive and effective educational intelligence. Exploring cutting-edge technologies like artificial intelligence and virtual reality can revolutionize the field of education, offering exciting new opportunities for teaching and learning. Customized learning materials are essential in this ecosystem as they cater to the diverse needs and preferences of students. Incorporating these technologies in education requires educators to have a strong proficiency in ICT. Therefore, it is crucial to provide training programmes that focus on enhancing teachers' ICT competencies. These programmes will equip educators with the skills they need to effectively utilise technology and enhance the educational experience for students. This has resulted in an improved understanding of various skills, leading to an overall enhancement in the quality of education (Ngongo, Hidayat, & Wiyanto, 2019).

1.2.1 Digital Infrastructure

At the heart of integrating ICT in education lies the cornerstone of digital infrastructure, a pivotal element in unlocking access to an array of technological tools and resources. The impact and efficiency of ICT in education greatly depend on broad and fair access to internet connectivity, diverse devices, applications, tools, and services. This accessibility is crucial for leveraging technology's full potential in learning environments. Ensuring that every student, teacher, and educational institution has access to an essential suite of advanced technologies is crucial, as these components are integral to the functioning of modern, digitally-enabled educational ecosystems (Minea-Pic & Moreno-Monroy, 2023). This access empowers students and teachers alike to delve into information and gain insights well beyond the confines of traditional textbooks, fostering a culture of continuous learning and exploration.

The evolution of digital infrastructure in education from the simple use of radio and television to the incorporation of more sophisticated technologies demonstrates its transformative potential as a driver of educational advancement. By effectively harnessing this digital infrastructure, educators can expand access to education, thereby strengthening the ties between academic settings and the digitised professional landscape (Gupta, 2019). It lays the groundwork for elevating academic standards by making the educational journey more engaging, dynamic, and reflective of the complexities of the real world. It introduces innovative ways to develop and practice skills through activities such as audio and video recording, enabling the integration of these technologies into broader, more interactive learning experiences. This fusion facilitates the creation of multimedia content, cooperative projects, and virtual simulations, enhancing educational outcomes and equipping students with the skills needed for success in a technology-driven workplace (Gupta, 2019).

Section 3.1 of the OECD Education Working Paper No. 226, authored by Vlies (2020), underscores the pivotal role of ICT infrastructure as the cornerstone for digital innovation

within the educational sector. It articulates that a comprehensive digital infrastructure, characterized by high-speed internet connectivity and the widespread availability of digital devices such as computers and tablets, is indispensable for fostering digital advancements in education. It is noted that while a majority of students in OECD countries benefit from access to computers at school, there is a pressing need for enhancements in ICT to align with the rapid pace of innovation cycles and the escalated requirements for connectivity and digital device standards. Such infrastructure is heralded as the foundational pillar for a myriad of digital initiatives, playing a crucial role in facilitating the shift towards a more technologically integrated education system (Vlies, 2020).

However, the journey to fully harness the educational benefits of digital infrastructure is complex and multifaceted. The global experience of integrating various digital technologies in educational settings has shed light on the challenges and intricacies involved in realising their full academic potential. As digital technology becomes more prevalent across global societies, its infusion into educational systems and higher learning institutions signifies a pivotal shift towards a more digital-centric approach to learning. This evolution underlines the increasing importance of digital infrastructure as the foundation for a future where education is more accessible, interactive, and closely aligned with the evolving demands of the digital age.

1.2.2 Digital Content

As more homes have gained access to the Internet, the amount of digital content has grown. The increased access has resulted in the creation of more digital content in the form of ebooks, blog posts and social media posts. Digital content can be referred to as any information existing as digital data and stored in digital format. It encompasses various forms including text, images, audio, video, animations, and interactive features. Digital content serves many purposes such as entertainment, education, communication, marketing etc. Digital data can be broadcast, streamed or saved. Some examples of digital content are e-books, blogs, articles, newsletters, audiobooks, videos, live streams, websites, social media posts etc. In the context of education, it refers to any educational materials or resources that are distributed and used using digital technology. This encompasses a wide range of platforms, formats, and material types meant to enhance learning and elevate educational encounters. In contrast to traditional educational materials like printed worksheets, digital content uses technology and digital media to provide dynamic, interactive, and multimedia-rich learning experiences. It merely substitutes technological options for conventional teaching methods, with the expectation that these new ones will be more effective, user-friendly, scalable, and environmentally friendly.

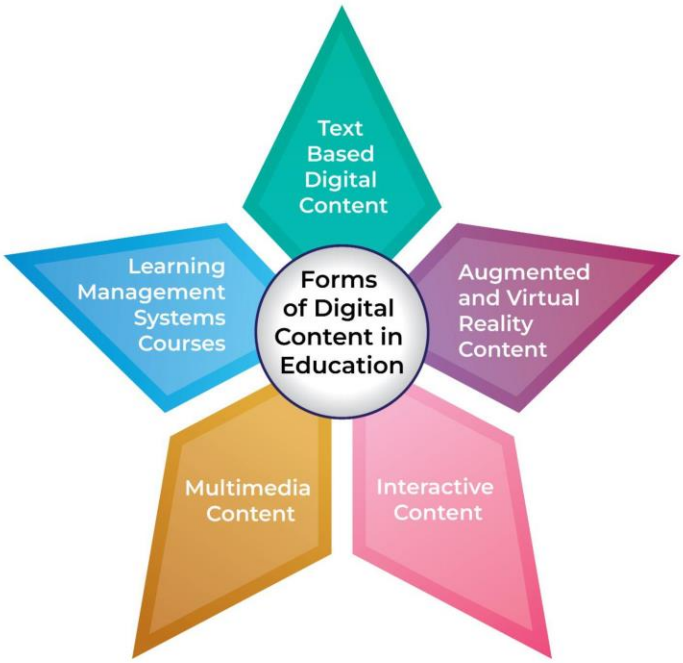


Fig.1.2: Forms of Digital Content in Education

Text-based digital content consists of items such as ebooks, articles, blogs and online publications. Multimedia elements such as infographics, videos, audio files, images, and animations can all be incorporated into digital content. These visual aids help in explaining the concepts, accommodating different learning styles, and providing real-world examples. Along with this, interaction is a crucial element of digital content. Interactive digital content allows the students to participate actively via interactive activities, games, tests, and simulations. These experiences provide kids the chance to apply what they've learned, investigate ideas, and receive immediate feedback. Virtual reality and augmented reality (VR and AR) technologies offer immersive and captivating learning experiences by projecting digital content onto the real world. These tools enable students to conduct experiments, look into complex concepts, and take part in hands-on learning activities. These Learning management systems come in various forms such as websites, web apps, mobile applications, etc. These can also be operated on all kinds of devices such as interactive smartboards, tablets, mobile phones, computers, laptops, etc. Through this interactive and personalized learning experiences are created. As digital content continues to evolve, it promises to further enhance educational experiences, making learning more accessible, engaging, and aligned with the demands of the digital age.

1.2.3 Emerging Technologies

A significant transformation in teaching learning has occurred after the introduction of digital technologies in education. This shift has gained significant momentum after the pandemic. The educational landscape has been changed through groundbreaking advancements such as smart devices, the Internet of Things, artificial intelligence, augmented and virtual reality. Both teachers and students have adopted digital tools for teaching and learning leading to the improvement of educational methodologies. This widespread integration of digital resources in education helps educators and students to be proficient in digital literacy. In the context of

education, emerging technologies are those that have the potential to change the current state of affairs in education. Change is the essence of emerging technologies and the use of educational technology plays a big role in its impact on educational outcomes. In education, this change is related to the change in the learning experiences of students. This shift is occurring due to the rising nonequilibrium between student knowledge and real-life problems. Emerging technologies have the potential to bring change in educational settings. One example of an upcoming technology that will undoubtedly bring about change is artificial intelligence applications in education.

Recently educational research is moving towards experimental research designs to generate meaningful integration of technology. This shift aims to rigorously assess the impact of various technological interventions on learning outcomes and identify best practices for their implementation in educational settings. Furthermore, novel approaches to assessing the efficacy of emerging technologies are being investigated. These approaches include data analytics to offer more profound insights into student engagement and achievement, qualitative assessments to comprehend user experiences, and longitudinal studies to monitor long-term effects. A more sophisticated understanding of how technology can best support and enrich the educational process is ensured by this all-encompassing approach.

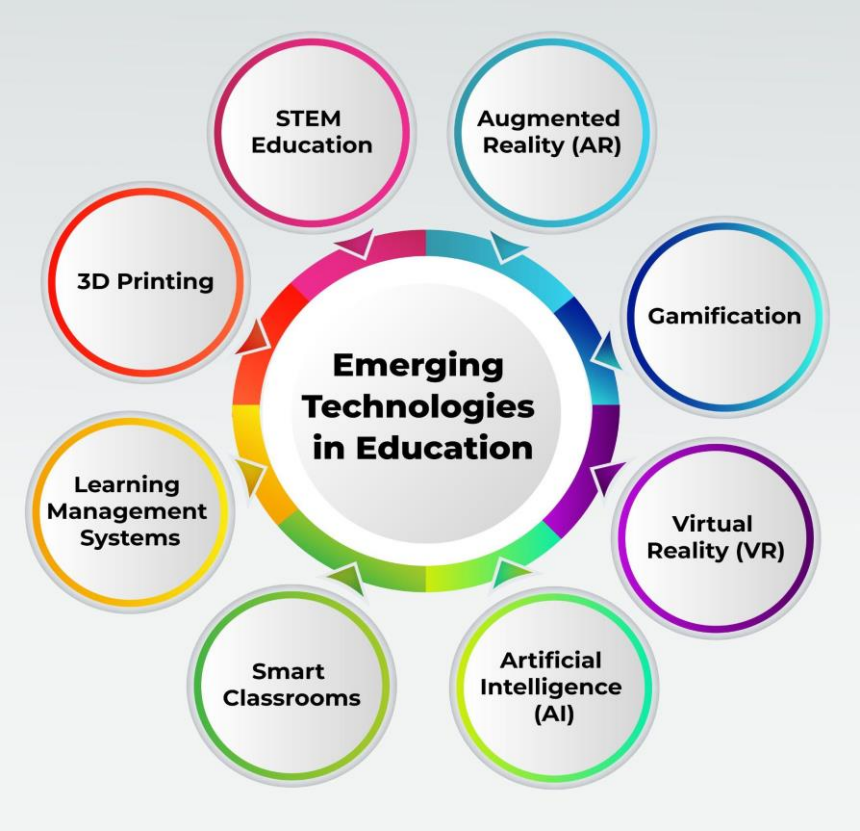


Fig.1.1: Emerging Technologies in Education

1.2.4 ICT in teaching, learning and assessment

The integration of Information and Communication Technology (ICT) in education has revolutionized the traditional approaches to teaching, learning, and assessment. The use and integration of ICT in teaching, learning and assessment have been widely studied and are

recognized for their potential to cultivate engaging and effective learning experiences. The use of ICT in the classroom teaching-learning is very important as it provides opportunities for teachers and students to operate, store, manipulate, and retrieve information. By embedding digital tools and resources into educational practices, ICT enhances the educational experience and outcomes for both teachers and students. ICT in teaching allows the use of multimedia presentations, simulations and interactive whiteboards to make lessons more engaging. It also offers a chance for collaborative projects and discussions. The availability of various educational software and applications supports diverse teaching strategies. Online libraries and educational platforms provide an opportunity to teach by using new resources and materials. ICT in education also helps in catering to the individual needs of students by tailoring a personalized lesson plan. Technology-based teaching and learning offers various interesting ways which include mind-mapping, guided discovery, brainstorming, audio, video, and animation to make the learning process more fulfilling and meaningful. Furthermore, it also helps in the professional development of the teachers.

ICT has been found to create productive learning environments, improve learning engagement, and enhance the teaching-learning process through gamified and interactive learning experiences. It also offers learning opportunities thus leading to improved performance, participatory skills and self-responsibility for learning among students. Along with this, it also provides access to a vast range of online forums, educational software, online media platforms to improve peer collaboration and communication. It is particularly evident in the context of language learning, where ICT tools such as digital storytelling, online forums, and language learning applications have been found to significantly enhance vocabulary, improve reading and speaking skills, and require educators to adopt dual roles as both facilitators and instructors. ICT has improved teaching and learning by providing quick access to information, online registration, digital study material, and feedback (Paterl and Jadeja, 2018). Moreover, ICT develops digital literacy, critical thinking skills and opportunities for students to work on real-world problems.

Traditionally, the assessment of learners is confined to the use of paper and pencil tests. However, the introduction of Learning Management Systems (LMS), virtual environments, and online assessment tools has offered online quizzes and tests to assess the performance of students. The online assessment process can be available at any time to match the needs of students and to enhance the traditional methods of evaluation. Online tools such as Edmodo, Kahoot, and HotPotatoes are quite useful in assessing students by using both objective and subjective types of questions. Along with these, e-portfolios are beneficial for the comprehensive assessment of a student's work and progress. They present a range of techniques for carrying out an assessment and hence must be implemented effectively in the process of evaluation. ICT in evaluation helps provide immediate feedback to the students, tracking ongoing student understanding, and providing timely interventions. The integration of ICT in teaching, learning and assessment transforms the educational practices making them more effective, engaging and inclusive.

1.2.5 ICT Competencies of Teachers

Competency is the ability to act effectively in specific situations based on their skill and previous experiences. In the context of ICT, the competencies are focused on the appropriate use of computer technology in the classroom. The ICT competencies are knowledge, skills and attitudes that teachers need to effectively integrate ICT into their teaching practices. There are six aspects of ICT competencies: a) understanding the role of ICT in education, b) curriculum assessment, c) pedagogical practices based on ICT, d) use of digital skills, e) organization and administration and f) teacher professional learning (UNESCO, 2018). These competencies help analyze curriculum standards, identifying functions of hardware, integrating ICT in various subjects, blending various digital tools, and using technology for their own professional development. These competencies are the driving force that results in better teaching practice, student engagement, access to resources, collaboration and professional development.

Fostering competencies in ICT is crucial for teachers to enhance ICT-enabled classrooms. They must understand the concept and use pedagogically appropriate methods to properly integrate computer-related technology for teaching-learning. One effective strategy that can be adopted to promote ICT in education is to equip teachers with these competencies. Modern educators of the 21st century should possess the technological, pedagogical, social and ethical competencies to shape the personality of pupils. Moreover, teachers must develop knowledge and skills for using ICT in an ethical, legal and safe manner (Husain, N. 2010). This involves understanding copyright laws, student privacy, online etiquette and cybersecurity practices. These competencies help the teachers not only enhance their instructional practices but also contribute to creating inclusive and safe digital classrooms. Therefore, teachers must have technical, pedagogical and ethical competencies for successful integration of ICT in instruction. These skills empower educators to create captivating and dynamic classes, adapt teaching methods to cater to the varying requirements of students and foster collaboration and communication among students. In addition, ICT competencies enable instructors to effectively access and utilize a diverse array of educational resources that are accessible online, hence improving the quality and pertinence of their teaching materials. By incorporating ICT skills into their teaching, educators can establish dynamic and inventive learning settings that promote critical thinking, creativity and digital literacy in students. However, technology alone is not enough to enhance the teaching material but a teacher's competency also matters. During the teaching-learning, the technology should not overpower the teacher, instead, it should be used as a teaching aid. It should help in developing meaningful communication towards a creative and innovative learning process. In other words, ICT Competency extends beyond technical skills and requires the ability to create and implement technology-enhanced material for the diverse needs of students. A properly integrated teaching material possesses the potential to encourage critical thinking, foster creativity, and collaboration among students. To summarize, ICT competencies are essential for teachers to effectively integrate technology into their teaching, fostering engaging, inclusive, and innovative learning environments. These skills enable educators to enhance instructional practices and promote digital literacy.

1.2.6 Training for Teachers on Enhancing ICT Competencies

Education systems globally, in both advanced and emerging countries, are under growing pressure to integrate ICT into their curricula. The purpose of this shift is to provide pupils with the essential knowledge and abilities required for the future's knowledge-based society. Many countries in the world including India have recognised the importance of ICT in teaching and learning and started providing teacher training. To achieve this, they have started providing teacher training to develop ICT-based competencies. These trainings are the most important programs to foster the skills and attitudes of teachers. The Government of India has proposed ICT training for preservice and in-service teachers through various policies and projects (Kusuma, 2017).

- **Online Training:** online training through video conferencing can be given to the teachers in order to increase their competencies. These sessions will help build their ICT competencies and use these skills to create a new technology-enhanced learning space. Partnering with international educational organizations can bring global best practices to local contexts. This collaboration can facilitate the sharing of innovative strategies and resources, thereby enriching the training programs.
- **Customized Training Modules:** training manuals should be developed to cater the different levels of ICT proficiency among teachers. According to their knowledge level, beginner, intermediate and advanced courses should be developed and shared.
- **Incentives and Motivational Strategies:** introducing a recognition system for the effective and innovative use of ICT integration in the classroom can motivate teachers. Teacher’s interest in ICT may develop if they are provided with resources such as computers, training materials and software for classroom use. An incentive or appreciation should be given to the teachers to increase their participation (Kusuma, 2017).
- **Continuous Professional Development programs:** programs should be conducted with focus areas: technology-supported content development, classroom management and skill development. These programs should provide hands-on experience to improve teachers' understanding of computers and software.

Teachers must engage in continuous professional development in order to improve their ICT skills. This encompasses engagement in training programmes, workshops and online courses specifically designed to emphasize the integration of ICT in education. These programmes not only facilitate the acquisition of new skills and information by teachers but also offer them the opportunity to interact and exchange best practices with their colleagues. Ultimately, proficiency in ICT is a crucial determinant of the achievement of contemporary education. Proficient teachers in ICT have the ability to construct innovative and captivating learning environments that equip students with the necessary skills to tackle the demands of the digital era. Thus, it is imperative for educators to consistently enhance their ICT skills and knowledge in order to fulfil the changing requirements of education in the 21st century.

1.3 Policy Perspective of ICT for Teachers

1.3.1 National Education Policy (NEP)- 2020

NEP 2020 in Para 24.3 emphasises that teachers require suitable training and development to be effective online educators. It recommends that teachers will undergo rigorous training in learner-centred pedagogy and on how to become high-quality online content creators themselves using online teaching platforms and tools (NEP 2020, Para 24.4 (g)). The ICT component under Samagra Shiksha provides the possibility of building the infrastructure in terms of human resources as well as material resources. One of the main components of this scheme is teacher-related interventions, such as provision for engagement of an exclusive teacher, capacity enhancement of all teachers in ICT and financial support is also provided to States/ UTs for in-service training of teachers in the use and integration of ICT. As NEP emphasizes 50 hours of capacity-building programs for teachers per annum, there is a scope to develop all these training and rollout out as online courses as well. As CIET-NCERT being a nodal agency in taking ICT to the nook and corner of the nation, it is essential to understand the impact of the training/ courses that are delivered to teachers through various modes in developing competencies to use and integrate technologies during digital education. It is also important to study the impact in terms of content and implementation strategies.

The National Education Policy (NEP 2020) emphasises the importance of a strong digital infrastructure in schools and higher education institutions, ensuring equitable access to digital resources for all students, regardless of socio-economic backgrounds. The policy aims to facilitate internet connectivity, provide digital devices to all students and create a more flexible and adaptive learning environment. Online and blended learning models are also recommended, recognizing the significance of digital platforms in content delivery, and assessment processes and fostering flexibility in learning approaches. The policy also explains the use of online resources, digital materials and other technological tools to disseminate information and conduct assessments. It further recommends the creation of high-quality and interactive electronic content (e-content) in regional languages, addressing linguistic diversity and catering to diverse linguistic backgrounds. The policy aims to make educational resources accessible and effective in facilitating learning, breaking down language barriers and promoting inclusivity. The National Education Policy (NEP) emphasises the potential of adaptive learning platforms and artificial intelligence (AI) in revolutionizing the education sector. AI can offer personalised learning experiences, tailoring educational content to suit individual students' needs and abilities. This aligns to foster inclusive and equitable education systems that accommodate diverse learning requirements. While education will play a critical role in this transformation (India’s transformation into a digitally empowered society and knowledge economy), technology itself will play an important role in the improvement of educational processes and outcomes; thus, the relationship between technology and education at all levels is bi-directional. [NEP 2020, 23.1]

1.3.2 National Curriculum Framework for Foundational Stage(NCF-FS)

Children of all ages and backgrounds are the growing consumers of technology through phones and television. It is important to recognise the need for digital literacy and digital safety so that children can make meaningful use of technology. It is also an opportunity to invest in and

develop quality materials catering to the diverse needs of children across the country. Songs, rhymes, riddles, puzzles, stories, movies, short films, and animation series are much needed in the early years. Section 5.4.7 (Technology, Digital and Audio-Visual Material) of the National Curriculum Framework for Foundational Stage (NCF-FS) highlights the importance of the usage of technology at a foundational level. The framework recognizes the need for age-appropriate, inclusive, and enjoyable integration of technology at a foundational level. The study material should be presented in different languages and formats for all children.

It recommends the development of diverse content formats in multiple modes to enhance understanding. The content should be developed differently in audio, video, text in digital formats, text with images, interactive content, and augmented reality-based content. The audio content through loudspeaker or radio will be helpful for children to improve their listening skills. Audiobooks and podcasts can serve as a valuable resource for visually impaired students. Videos with text, images, descriptive audio and sign language can be displayed via television or projector can make lessons more engaging and accessible to a wider audience. Textbooks and reading materials augmented with images can aid in better comprehension. Additionally, interactive digital games, puzzles and quizzes are effective for active learning. For these interactive activities, smartphones, tablets, computers and smart boards can be utilized to facilitate participation. Furthermore, virtual and augmented reality-based content can be used to provide an immersive virtual experience to children. AR-based content can provide an immersive learning experience, making abstract concepts more tangible and understandable.

Technology-enhanced teaching learning material has also been presented in the framework. The framework suggested that age-appropriate and relatable audio, video and audio-video content should be prepared and made accessible to Balvatikas, Anganwadis and Schools. Unfamiliar ideas should be presented in an entertaining manner to build vocabulary and different concepts. Digital storybooks, digital puzzles and games can be used to foster digital literacy among students. The framework recommends that technology-based markers such as QR codes can be used by teachers to gain easy access to a variety of teaching materials. Furthermore, technology in multilingual situations assists teachers so that they can take care of each child's need to be engaged in their mother tongue. Tools in the form of apps for children to help them read along, access free digital books, and puzzles and games would be beneficial for cognitive development. The policy further raises caution in using digital technology at the elementary level. It states that children should be protected from discrimination. They have a right to privacy, freedom of expression, and access to sources through different sources. A balanced approach between protection and participation must be ensured. The NCF/FS provides a comprehensive framework for integrating technology in early education and aims to create a dynamic and accessible learning environment. This approach not only enhances the learning experience but also prepares children for the demands of the digital era, fostering digital literacy and cognitive development while ensuring their safety and protection.

1.3.3 National Curriculum Framework for School Education (NCF-SE)

India is becoming a society where technology is a part of everyday life be it a child or adult. People are using ICT in daily life for shopping, farming, communicating and making payments. Technology has undoubtedly made life easier and also helped in making equations accessible.

The New Education Policy has emphasized the importance of ICT as a component in the teaching-learning process. To realize this goal, the National Curriculum Framework (2023) has proposed several recommendations to improve the integration of ICT in the classrooms. Para 6.1.1.1 “Evolving and Emerging Technology” of NCF-SE states that the emergence of technologies such as artificial intelligence, machine learning as well as data analytics and visualization will definitely find innovative applications in the education domain. These innovations possess the capacity to enhance teaching methods, learning methods and assessment processes. In addition to this, emerging technologies such as artificial intelligence, data science, interactive content, and immersive experiences (AR/VR) are also vital in improving teaching, assessment, educational access and streamlining educational planning.

Fig. 1.3: Potential of ICT in School Education

Technology in education has the potential to transform the teaching-learning experience by breaking down barriers and constraints. It allows the students to explore and access content on their own. They can explore ideas and places with the help of augmented reality. It also helps them in using technology in the classroom and also offers access to students with different abilities and needs. Video content with subtitles and sign language is essential for the hearing impaired, while audio content is crucial for the visually and print impaired. Additionally, text accompanied by audio can significantly benefit learners with learning disabilities. Furthermore, para 6.2.2 titled “Content Creation” states that ICT has not only made study material accessible but also enabled the creation of content. ICT enables the creation and presentation of diverse content forms including videos, audio clips, graphic simulations, and animated presentations. With simple ICT tools, a motivated and capable teacher can easily produce these varied content types, enhancing the teaching-learning process. These digital tools are also helpful in creating content for subjects such as arts, physical education and vocational education. Furthermore, Teachers can use Generative AI to create content tailored to their local context and specific

pedagogical needs. Digital textbooks, stories, novels, articles, and non-fiction in various languages are essential resources for school education. Various platforms provide access to digital books, for example, NCERT's textbooks are available on SWAYAM, DIKSHA, and ePathshala. Digital learning material deepens understanding of concepts, enables independent study, and makes interdisciplinary learning easier. The framework has also recommended the use of online platforms such as DIKSHA and SWAYAM for creating and sharing technology-integrated study material. Integration of ICT provides access to experiential learning environments and limited resources. Virtual labs and simulations deepen learning by providing experimentation along with practical concept application. Though often used in Mathematics and Sciences, they can also be adapted for teaching languages and other subjects.to summarize, The National Curriculum Framework (2023) highlights the critical role of ICT in transforming teaching and learning. The integration of ICT in education promises to transform the learning landscape by making it more accessible, engaging, and tailored to individual needs.

1.4 Emergence and Relevance of Techno-Pedagogy Interpretation

The education system has undergone a paradigm shift, moving away from the traditional teaching method towards digitized pedagogical approaches by integrating technical devices. During this transformation, techno-pedagogy has emerged as a transformative approach to teaching, learning and assessment. Techno-pedagogy is the purposeful infusion of technology into teaching techniques to enhance instruction, engage students, and improve learning outcomes. Its objective is to help teachers make effective use of digital tools, work on collaboration tools, and teach on different digital platforms. It is a novel method that includes both pedagogical (teaching principles, curriculum design, methods) and technological aspects (hardware, software, digital content, emerging technologies). The techno-pedagogy consists of three areas namely; Content, Pedagogy and Technology. Content refers to the subject matter to be taught and pedagogy describes the strategies, methods and processes of teaching-learning. Whereas, technology involves modern innovations like overhead projectors, interactive whiteboards and e-books. The integration of technology and pedagogy aims at enhancing and transforming educational practices. Effective use of technology is not simply about its integration into the curriculum, but rather it is making it meaningful by maintaining a relation between content and technology. Such integration has the potential to improve problems such as underachievement, student dissatisfaction, and educational exclusion. It further changes the role of a teacher and urges students to become active participants and collaborators in learning. Thus, helping both teachers and learners through the integration of technology into the curriculum.

Techno-pedagogy emerged as a response to the fast-paced technological changes in society. Integrating technology into learning became necessary to expose students to the increasingly digital world. With the Internet, mobile devices, and interactive software, gaining access and propagating knowledge has become unimaginable today. It was a shift inspired by the urge to see students equipped with digital literacy skills, navigating a changing technological environment. Inclusive access to quality education in remote and underserved areas is made possible through online learning platforms, digital textbooks, and virtual classrooms that break geographical and socio-economic barriers to a large extent.

The emergence and development of technology has raised the bar higher for learning standards. This has resulted in making necessary changes in classrooms so that students are prepared through exposure to technology-based instruction. Achieving this objective requires teachers to become proficient in technology, content, and pedagogy themselves (Singh and Gupta, 2022). Techno-pedagogy is important in today's digital era as it supports distance education through e-learning, improves the teaching-learning process, and provides timely feedback to the students after assessment. It aids students in improving their cognitive abilities such as critical thinking, problem-solving and divergent thinking. The integration of technology also promotes universal access to education and the development of essential life skills such as digital literacy, linguistic abilities, research activities, collaboration and self-directed learning. The integration of technology in teaching and learning promotes universal access to education, professional development for teachers and more efficient education management. Teachers can guide the students using online platforms and improve teaching by incorporating multimedia elements such as videos, simulations and interactive quizzes. Furthermore, digital tools simplify administrative tasks like enrolment, attendance tracking, examination process and reduce the administrative burden from teachers.

As technology continues to evolve, the integration of techno-pedagogy in education will be crucial in preparing students for the digital future, ensuring universal access to quality education, and creating more efficient and effective learning environments.

Technology evolves and changes every generation, as has been witnessed with radio, television, computers, the internet, mobile devices, and, more recently, Artificial Intelligence (AI) including generative AI. Introduction of technology by itself does not radically improve school education, unless it complements, supplements, and fundamentally supports the growth and learning of the Teacher and student

1.5 Need and Significance of the Study

The National Education Policy (NEP) 2020 of India embodies a progressive approach towards transforming the education system of the nation. An essential aspect of this policy is the incorporation of ICT into educational practices, which requires a substantial improvement in the skills and knowledge of teachers. The policy recognises the significant impact that technology can have on the transformation of teaching and learning methods and highlights the crucial role that teachers play in driving this progress. According to the NEP 2020, there is a specific requirement for teachers to receive thorough training and development in order to effectively use online educational platforms and resources. The emphasis here is not only on the integration of technology but also on the incorporation of learner-centric pedagogical approaches, which are crucial in the realm of education. The policy acknowledges the importance of a comprehensive understanding of technological tools and their integration into pedagogical practices to enhance student learning experiences in teaching.

In addition, it emphasises the importance of digitally competent teachers in modernising education. The policy advocates for comprehensive training programmes to develop teachers' digital competency and enable them to effectively use ICT in teaching practices. The policy focuses on the need to equip teachers with both basic ICT skills and advanced competencies in integrating technology with pedagogy. This holistic approach aims to create an educational

environment that is adaptable, innovative, and aligned with the demands of the 21st century, ensuring a more innovative and adaptable educational environment.

For this reason, it is essential for teachers to consistently engage in training in order to remain up-to-date with the most recent developments in teaching methods and technological advancements. Teachers need to possess the necessary skills for teaching and consistently update their methods to align with current educational trends and technologies. According to NEP 2020 and Samarg Shiksha, 50 hours of capacity-building training programmes are required for teachers to become digitally competent.

In light of these objectives, the CIET at the NCERT is playing a pivotal role. It has initiated research that focuses on the development and evaluation of the effectiveness of the 'Techno-Pedagogical Content Integration (TPCI) package, which aims at enhancing the digital competencies of inservice teachers at the secondary level. The TPCI package is composed of two sets of courses: ICT Basics and ICT-Pedagogy Integration in teaching, learning and assessment. The package is designed to seamlessly integrate technology with pedagogy, thereby enhancing the overall quality of education.

This research is a testament to the commitment to not only equip teachers with the necessary digital tools but also to ensure these tools are used effectively in educational settings.

1.6 Statement of the Problem

The effective integration of technology into teaching practices remains a challenge for many in-service secondary school teachers. Despite the availability of digital tools and resources, there is often a gap in teachers' digital competencies, which impacts their ability to leverage technology to improve educational outcomes. This research aims to evaluate the effectiveness of a Techno-Pedagogy Content Integration (TPCI) package in enhancing the digital competencies of these teachers. Specifically, it seeks to determine whether the TPCI package can significantly improve teachers' knowledge, attitude and confidence in using technology in their pedagogical practices. In this context, the study has been undertaken and is entitled *"Effectiveness of Techno-Pedagogy Content Integration (TPCI) package on Development of Digital Competencies of Inservice Teachers at Secondary Level".*

1.7 Operational Definition

1.7.1 ICT

Information and Communication Technology (ICT) refers to the use of digital tools and systems to handle and exchange information. This includes devices like computers and smartphones, software programs, and communication systems such as the Internet and email (Smith, 2022). In this study, ICT refers to any hardware, software, process or combination of it to create, store, retrieve, manipulate, send and receive digital information.

1.7.2 Techno-Pedagogy Content Integration

In this study, Techno-Pedagogy Content Integration (TPCI) refers to the systematic approach of incorporating digital tools and resources into teaching practices and educational content. This process involves selecting suitable technology that aligns with instructional goals, integrating these tools into lesson plans and classroom activities, and applying effective

pedagogical strategies to enhance student engagement and understanding. TPCI ensures that technology is not only used to support educational objectives but also effectively improves the learning experience. Continuous assessment and adaptation are key to refining the integration of technology to achieve better educational outcomes.

1.7.3 ICT Competencies

In this study, "ICT Competencies" refers to the competencies such as knowledge, confidence, and attitudes that teachers require to effectively integrate ICT into their teaching practices.

1.7.4 In-Service Teachers

According to (igi-global) In-service teachers are those who have already completed their basic training and are now teachers. In this study, In-service teachers refers to the teachers who are currently working in schools and are continuing to learn and improve their teaching skills while they are on the job.

1.7.5 Secondary Level

In this study, the secondary level refers to the stage of schooling that comes after primary education and typically includes students aged 12 to 18. It is divided into:Lower Secondary: Students in grades 6-8 or 7-9.Upper Secondary :Students in grades 9-12 or 10-12.

1.8 Variables of the study

1.8.1 Independent Variable:

The independent variable is the Techno-Pedagogy Content Integration (TPCI) package. This is the variable that is manipulated or introduced in the study to observe its effect on the dependent variable. In this case, the TPCI package is a specific program or intervention designed to integrate technology with pedagogical methods. The aim is to evaluate how this package impacts teachers' digital competencies, including their ability to use technology effectively in their teaching practices.

1.8.2 Dependent Variable:

The dependent variable is the digital competencies of in-service teachers. This variable measures the knowledge, attitude and confidence that teachers have in using ICT as part of their teaching. It includes their ability to effectively apply digital tools and resources, manage and communicate information using technology, and adapt to new technological advancements. The study evaluates how the Techno-Pedagogy Content Integration (TPCI) package influences these competencies.

1.8.3 Intervening Variables:

Gender, teaching experience, and prior exposure to technology affect how well teachers use the Techno-Pedagogy Content Integration (TPCI) package. Gender can influence how easily teachers adapt to new technology, with male teachers potentially adapting more quickly than female teachers. Teaching experience matters because more experienced teachers might be set in their ways and find it challenging to change. Prior exposure to technology is also important; teachers who have used technology before are likely to handle the TPCI package better than

those who haven’t. These factors can explain why some teachers may benefit more from the TPCI package than others.

1.9 Research Questions

RQ: Which specific digital competencies are most significantly improved through the TPCI package?

RQ: Does the TPCI package's efficacy vary significantly depending on the teachers' past experience with the digital tools?

RQ: What is the overall effectiveness of the TPCI package on developing digital competencies among in-service secondary school teachers?

1.10 Objectives of the Study

1. To assess the impact of the Techno-Pedagogy Content Integration (TPCI) package on the development of digital competencies among in-service teachers at the secondary level.
2. To evaluate the changes in Knowledge, Attitude, and Confidence regarding digital tools and technologies among in-service secondary school teachers after the implementation of the TPCI package.
3. To compare the levels of digital competencies among in-service secondary school teachers before and after the implementation of the TPCI package.
4. To determine the effectiveness of the TPCI package in enhancing the integration of technology into pedagogy among in-service secondary school teachers.

1.11 Hypotheses

To undertake a meaningful analysis, the following hypotheses were proposed. There are hypotheses which were clubbed under three broad hypotheses as given below:

H_1: There is no significant difference in Knowledge, Attitude, and Confidence across all dimensions from pre-data to mid-data with the ICT Basic Intervention Package in a face-to-face mode among in-service teachers.

$H_{1.1}$: There is no significant difference in Knowledge across all dimensions from pre-data to mid-data with the ICT Basic Intervention Package.

$H_{1.2}$: There is no significant difference in Attitude across all dimensions from pre-data to mid-data with the ICT Basic Intervention Package.

$H_{1.3}$: There is no significant difference in Confidence across all dimensions from pre-data to mid-data with the ICT Basic Intervention Package.

H2: There is no significant difference in Knowledge, Attitude, and Confidence across all dimensions from mid-data to post-data with the ICT Pedagogy intervention in an Online mode among in-service teachers.

$H_{2.1}$: There is no significant difference in Knowledge across all dimensions from mid-data to post-data with the ICT Pedagogy intervention.

$H_{2.2}$: There is no significant difference in Attitude across all dimensions from mid-data to post-data with the ICT Pedagogy intervention.

$H_{2.3}$: There is no significant difference in Confidence across all dimensions from mid-data to post-data with the ICT Pedagogy intervention.

H3: There is no significant difference in Knowledge, Attitude, and Confidence across all dimensions from pre-data to post-data with the TIC intervention in an Online mode among in-service teachers.

$H_{3.1}$: There is no significant difference in Knowledge across all dimensions from pre-data to post-data with the TIC intervention.

$H_{3.2}$: There is no significant difference in Attitude across all dimensions from pre-data to post-data with the TIC intervention.

$H_{3.3}$: There is no significant difference in Confidence across all dimensions from pre-data to post-data with the TIC intervention.

H4: There is no significant difference in Knowledge, Attitude, and Confidence across all dimensions from pre-data to mid-data with the ICT Basic Intervention Package in an Online mode among in-service teachers.

$H_{4.1}$: There is no significant difference in Knowledge across all dimensions from pre-data to mid-data with the ICT Basic Intervention Package.

$H_{4.2}$: There is no significant difference in Attitude across all dimensions from pre-data to mid-data with the ICT Basic Intervention Package.

$H_{4.3}$: There is no significant difference in Confidence across all dimensions from pre-data to mid-data with the ICT Basic Intervention Package.

H5: There is no significant difference in Knowledge, Attitude, and Confidence across all dimensions from mid-data to post-data with the ICT Pedagogy intervention in an Online mode among in-service teachers.

$H_{5.1}$: There is no significant difference in Knowledge across all dimensions from mid-data to post-data with the ICT Pedagogy intervention.

$H_{5.2}$: There is no significant difference in Attitude across all dimensions from mid-data to post-data with the ICT Pedagogy intervention.

$H_{5.3}$: There is no significant difference in Confidence across all dimensions from mid-data to post-data with the ICT Pedagogy intervention.

H6: There is no significant difference in Knowledge, Attitude, and Confidence across all dimensions from pre-data to post-data with the TIC intervention in an Online mode among in-service teachers.

$H_{6.1}$: There is no significant difference in Knowledge across all dimensions from pre-data to post-data with the TIC intervention.

$H_{6.2}$: There is no significant difference in Attitude across all dimensions from pre-data to post-data with the TIC intervention.

$H_{6.3}$: There is no significant difference in Confidence across all dimensions from pre-data to post-data with the TIC intervention.

H7: There is no significant difference in Knowledge, Attitude, and Confidence across all dimensions from pre-data to mid-data with the ICT Basic Intervention Package between face-to-face mode for Experimental Group 1 and online mode for Experimental Group 2 among in-service teachers.

$H_{7.1}$: There is no significant difference in Knowledge across all dimensions from pre-data to mid-data with the ICT Basic Intervention Package between Experimental Groups 1 & 2.

$H_{7.2}$: There is no significant difference in Attitude across all dimensions from pre-data to mid-data with the ICT Basic Intervention package between Experimental Groups 1 & 2.

$H_{7.3}$: There is no significant difference in Confidence across all dimensions from pre-data to mid-data with the ICT Basic Intervention package between Experimental Groups 1 & 2.

H8: There is no significant difference in Knowledge, Attitude, and Confidence across all dimensions from Mid-data to Post-data with the ICT Pedagogy Intervention Package in online mode for Experimental Groups 1& 2 among in-service teachers.

$H_{8.1}$: There is no significant difference in Knowledge across all dimensions from Mid-data to Post-data with the ICT Pedagogy Intervention Package between Experimental Groups 1 & 2.

$H_{8.2}$: There is no significant difference in Attitude across all dimensions from Mid-data to Post-data with the ICT Pedagogy Intervention Package between Experimental Groups 1 & 2.

$H_{8.3}$: There is no significant difference in Confidence across all dimensions from Mid-data to Post-data with the ICT Pedagogy Intervention Package between Experimental Groups 1 & 2.

H9: There is no significant difference in Knowledge, Attitude, and Confidence across all dimensions from Pre-data to Post-data with the TIC Intervention Package in online mode for Experimental Groups 1 & 2 among in-service teachers.

$H_{9.1}$: There is no significant difference in Knowledge across all dimensions from pre-data to Post-data with the TIC Intervention Package between Experimental Groups 1 & 2.

$H_{9.2}$: There is no significant difference in Attitude across all dimensions from pre-data to Post-data with the TIC Intervention Package between Experimental Groups 1 & 2.

$H_{9.3}$: There is no significant difference in Confidence across all dimensions from pre-data to Post-data with the TIC Intervention Package between Experimental Groups 1 & 2.

1.12 Methodology

1.12.1 Research Design

The study employed a quasi-experimental design group. This design is chosen for the reason that the quasi-experimental studies encompass a broad range of non-randomized intervention studies (Harris et al., 2006. (Needs to be revised) However, unlike a true experiment, a quasi-experiment does not rely on random assignment. Instead, subjects are assigned to groups based on non-random criteria. A quasi-experimental design is a useful tool in situations where true experiments cannot be used for ethical or practical reasons.

1.12.2 Population and Sample

Target Population: In-service secondary school teachers from 36 states/UTs of India across various state board-affiliated schools and CBSE schools.

1.12.3 Intervention

An intervention package, known as the Techno-Pedagogical Content Integration (TPCI) package, was developed and implemented to train in-service secondary school teachers. The TPCI package consists of two distinct sets of courses:

- ICT Basics
- ICT Pedagogy Integration in Teaching, Learning, and Assessment

1.12.4 Tool

In this study, the ICT *Knowledge scale*, *Attitude Towards ICT Scale*, and *Confidence in Using ICT Scale* were utilized and developed by Dr. Angel RathnabI S. (2023) to assess in-service teachers' knowledge, attitude and confidence towards ICT.

1.12.5 Statistical Analysis

In the present chapter, statistical techniques including the mean, standard deviation (S.D.), t-test and ANOVA were employed to analyze the data.

1.13 Delimitations

- The sample for this study was selected based on specific criteria.
- Both male and female teachers as well as teacher educators were taken for the study.

CHAPTER 2: REVIEW OF RELATED LITERATURE

2.1 Introduction

The 21st century is a crucial time where ICT has greatly transformed many aspects of society, particularly the education sector. ICT has revolutionised our daily lives and professional endeavours, leaving an indelible mark on the field of education. The rise of digital technology has brought about a significant change in pedagogical strategies and the role of educators, leading to a pressing need to reevaluate traditional teaching methods. In today's modern era, educators must possess ICT skills in order to elevate their teaching techniques and enhance the overall educational experience. The integration of ICT in education goes beyond just using digital tools. It involves developing the skills and knowledge that enable teachers to effectively utilize these technologies to enhance educational delivery. Given the rising significance of technology in education, there has been an increasing need for teachers to receive ICT training. This chapter thoroughly explores various aspects related to the integration of ICT in the field of education. This review aims to shed light on how ICT can be effectively used in teaching and learning, with a focus on key themes that provide a solid foundation for its implementation. Numerous studies have delved into the effectiveness of ICT training programmes and how they influence teaching and learning outcomes. This literature review aims to comprehensively examine and consolidate current research on the incorporation of ICT in education. It specifically emphasises the enhancement of ICT skills among teachers, the frameworks that govern these skills, and the impact of professional development and training initiatives. This report analyses multiple studies on ICT competencies, professional development, and in-service training for teachers. It aims to identify the crucial factors that impact the effectiveness of integrating ICT into education.

2.2 Methodology For Literature Review

By examining the existing literature on ICT for teachers, this review aims to contribute to the ongoing discussion on the integration of technology in education and the role of teachers in this process.

Data Sources

A thorough search strategy was employed in this literature review, covering a range of academic databases and digital libraries including JSTOR, ScienceDirect, Google Scholar, and the Educational Resources Information Centre (ERIC). Also, reports from esteemed organizations such as UNESCO and OECD were incorporated to guarantee the incorporation of grey literature, which frequently encompasses valuable perspectives on policy and practice.

Search Strategy

The search was guided by a combination of keywords and phrases pertaining to ICT in education. Those that were covered were "ICT competencies for teachers," "UNESCO ICT Competency Framework," "Techno-Pedagogical Content Knowledge," "Professional development in ICT," "ICT integration in teaching," and "Factors influencing ICT integration

in education."The search was made more effective by using Boolean operators to combine these terms and refine the results.

Inclusion and Exclusion Criteria

The criteria for inclusion were set to identify studies that focus on the improvement of ICT skills among teachers, frameworks for ICT proficiency, and the impact of professional development on the integration of ICT in education. The review covered a wide range of empirical and theoretical studies published in English from 2002 to 2023. It aimed to provide an accurate representation of the current challenges and solutions in the integration of ICT education. We applied exclusion criteria to studies that were not directly relevant to teacher education or those that focused on the use of ICT in contexts other than teaching and learning. We did not consider articles and reports that did not have a clearly defined methodology or did not prioritise the professional development of teachers in the field of ICT.

Data Extraction and Synthesis

The articles that were chosen underwent a rigorous process of extracting data, during which pertinent information pertaining to the research objectives was identified and condensed. The procedure encompassed the extraction of data pertaining to the study's objectives, methodologies, findings, and conclusions. A thematic analysis was subsequently performed in order to identify recurring themes and patterns within the literature that was chosen for this study. This analysis enabled the creation of a narrative that effectively portrays the present condition of ICT integration in education, the difficulties and possibilities it offers, and the recommended courses of action based on existing research. The primary ethical considerations in conducting a literature review revolve around the imperative of accurately citing and acknowledging all sources to prevent plagiarism and uphold intellectual property rights. Furthermore, meticulous attention was given to incorporating a wide array of viewpoints in order to present an equitable and comprehensive understanding of the topic at hand.

2.3 UNESCO Competence Framework (2016)

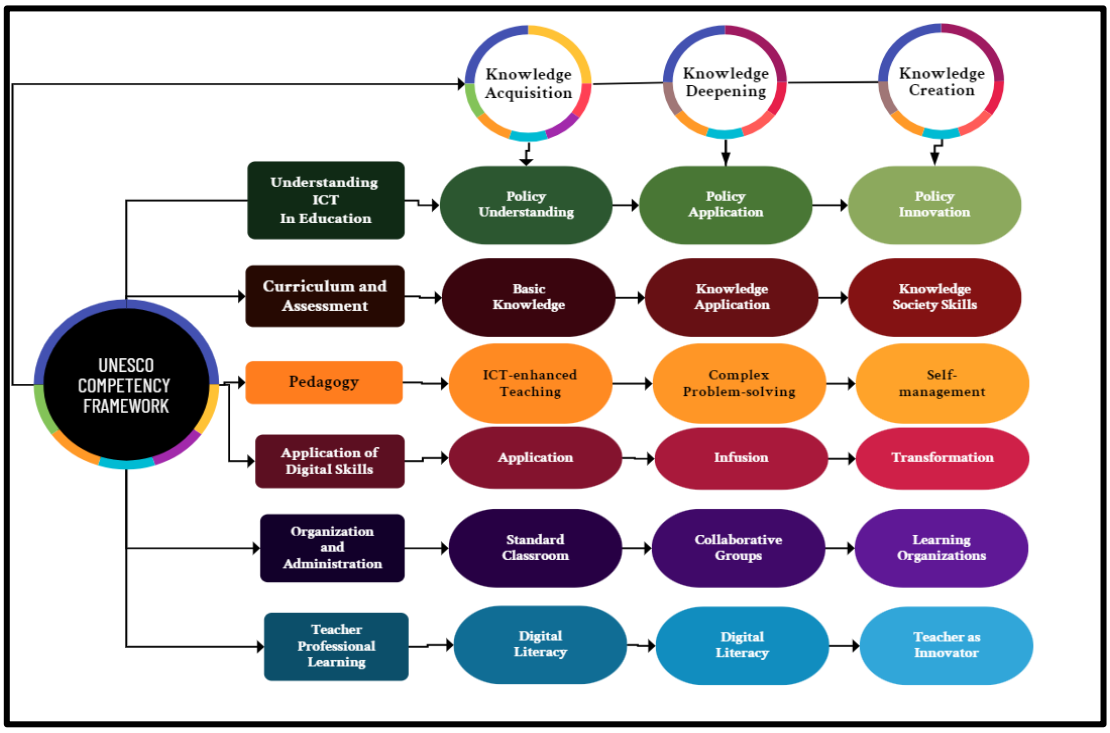
Integrating ICT into education has been widely acknowledged as a crucial strategy for improving education systems, sharing knowledge, increasing access to information, and enhancing the quality of learning. This was strongly emphasised at the 2015 World Education Forum and further explained in the 2015 Qingdao Declaration, held at the International Conference on ICT and Post-2015 Education. These forums highlighted the crucial role of teacher professional development in successfully integrating ICT into educational practices. The statements suggested that in order to effectively incorporate ICT into teaching and learning, there needs to be a fundamental change in the roles of teachers and their training and development. Building a strong emphasis on quality is essential for successfully incorporating ICT in education. This includes areas such as staff and student support, curriculum and course design, delivery methods, and strategic planning. Teachers play a crucial role in creating learning environments that utilise technology to promote innovative teaching methods, encourage active social interaction in the classroom, facilitate collaborative learning, and foster group cooperation. Teaching has evolved, requiring educators to develop new skills in order to

effectively incorporate technology into the learning environment. This allows for a more comprehensive approach to knowledge acquisition, deepening, and creation.

The professional development of teachers is seen as an ongoing and dynamic process, rather than a one-time occurrence. It is recommended to incorporate a combination of face-to-face and online learning options in teacher training programmes to effectively address the various obstacles encountered and promote critical thinking skills in students. In order to organise this developmental pathway, UNESCO has divided 18 competencies related to ICT in education into three levels: Knowledge Acquisition, Knowledge Deepening, and Knowledge Creation.

In the first level of *Knowledge Acquisition,* teachers acquire knowledge about the use of technology and basic skills related to ICT. This level requires teachers to be aware of the potential benefits of ICT in the classroom. They need to be able to manage and organise school ICT investments within national policies and priorities and use technology to engage in lifelong learning and professional development.

Knowledge Deepening is the second level, in which teachers acquire the necessary ICT competencies to facilitate learning environments that are student-centred, collaborative, and cooperative. Teachers are also capable of linking policy directives with real-life classroom actions, developing technology plans for maintaining the school's ICT assets and forecasting future requirements. The teacher can also study further by linking to national and international teacher networks.



Knowledge Creation, in which teachers acquire competencies that enable them to model good practices and create learning environments that encourage students to produce the kind of knowledge necessary for societies to thrive and prosper. However, all levels of education share the same six aspect components while requiring increasing sophistication and proficiency in using technology.

All three levels encapsulate six educational aspects: understanding ICT in Education Policy; Curriculum and Assessment; Pedagogy; Application of Digital Skills; Organization and Administration; and Teacher Professional Learning. These aspects underscore the importance of a holistic approach in teachers' ICT competency development, requiring escalating sophistication and proficiency at each stage.

The UNESCO Framework underscores the significance of ICT in revolutionizing educational paradigms and the pivotal role of teacher professional development in harnessing these technologies for educational excellence. Our study aims to further elucidate how the integration of technological and pedagogical content knowledge (TPACK) influences teachers' abilities to foster digital competence, a crucial skill in the 21st-century educational landscape. By exploring the intersections of ICT competency levels and educational aspects with the TPACK framework, this research endeavours to contribute valuable insights into effective strategies for enhancing teachers' digital competencies.

2.4 ICT Competency Frameworks of various countries.

2.4.1 Philippines

The ICT education policy of the Philippines is called the Enhanced Basic Education Act of 2013, also known as the K-12 program. It is a comprehensive education reform program that seeks to improve the quality of education in the Philippines by enhancing the curriculum, extending the number of years of basic education, and promoting ICT literacy among students. The program includes the integration of ICT into the curriculum to prepare students for the demands of the 21st century. This policy also includes provisions for ICT capacity building in teachers. The program recognizes the importance of providing teachers with the necessary skills and knowledge to effectively integrate ICT into their teaching practices. In line with this, the program mandates the Department of Education (DepEd) to provide training and professional development programs for teachers on ICT integration and utilization in the classroom.

Under the K-12 program, DepEd has implemented various initiatives to enhance the ICT capacity of teachers, such as the ICT Literacy Training Program (ILTP), which aims to provide teachers with the necessary skills and knowledge to integrate ICT in teaching and learning. DepEd also provides online learning resources and tools for teachers to further improve their ICT competencies. Specifically, the policy requires that all teachers in both public and private schools undergo mandatory training in ICT to ensure that they are equipped with the necessary skills and knowledge to effectively integrate technology into the teaching and learning process. The training should cover topics such as computer literacy, multimedia content creation, and the use of educational software and hardware. Furthermore, the law mandates that schools provide teachers with the necessary equipment and resources to effectively use ICT in their teaching. This includes access to computers, projectors, and other multimedia devices. These efforts are aimed at ensuring that teachers are equipped with the necessary ICT skills to effectively use technology in the classroom and prepare students for the demands of the digital age.

The goal of this provision is to ensure that teachers are equipped with the necessary skills and tools to deliver high-quality education that is relevant to the needs of the 21st century. By improving teacher competencies in ICT, students can benefit from innovative teaching methods that leverage technology to enhance their learning experience.

2.4.2 Nigeria

The ICT education policy of Nigeria is called the National Information Technology Development Agency (NITDA) ICT Policy. The policy was developed by the National Information Technology Development Agency (NITDA) in collaboration with other stakeholders to guide the development and implementation of Information and Communication Technology (ICT) education in Nigeria. The policy aims to improve the quality of ICT education in Nigeria, increase access to ICT education, promote ICT literacy, and develop a skilled workforce in the ICT sector.

The NITDA ICT Policy of Nigeria recognizes the importance of teacher ICT competence in the effective delivery of ICT education. The policy emphasizes the need to train and develop teachers to have the necessary ICT skills and competencies to effectively teach and integrate ICT into the curriculum. In particular, the policy states that "ICT must be integrated into teacher education and development programs to ensure that teachers are able to use ICT as a tool for teaching and learning." The policy also highlights the need for continuous professional development for teachers to update their skills and knowledge in ICT.

Furthermore, the NITDA ICT Policy calls for the establishment of ICT training centres for teachers, and for the provision of incentives to encourage teachers to acquire ICT skills and integrate technology into their teaching. Overall, the policy recognizes the critical role that teacher ICT competence plays in promoting the effective use of ICT in education in Nigeria.

2.4.3 Australia

In Austria, ICT (Information and Communication Technologies) is integrated into the education system, with a focus on promoting digital skills and competencies among students. The Austrian Federal Ministry of Education, Science and Research is responsible for setting the guidelines and policies for the integration of ICT in schools. The ministry has developed a digital strategy that aims to provide students with the necessary skills and knowledge to succeed in the digital age. According to a report by the European Commission, Austria has a relatively high level of digital skills among its population compared to other EU countries. The report also notes that the use of ICT in Austrian schools is widespread, with most schools having access to computers, the Internet, and other digital tools. However, there are still some challenges in terms of ensuring that all students have equal access to ICT and that teachers are fully trained and equipped to integrate ICT into their teaching.

In recent years, there have been several initiatives aimed at promoting the use of ICT in Austrian schools, such as the "eEducation Austria" project, which provides digital learning materials and resources for teachers and students. There are also ongoing efforts to improve digital infrastructure and connectivity in schools to ensure that all students have access to the necessary tools and resources. The European Commission's report on Austria's digital skills landscape does not explicitly mention a teacher ICT competence framework. However, the

report notes that there are ongoing efforts to improve teacher training and professional development related to ICT skills and competencies. The report highlights that "the quality of teachers' training in digital skills varies significantly across Austria" and that there is a need for "strategies to ensure the availability of well-trained teachers and support staff."

Additionally, the European Union has developed a common framework for the digital competence of educators, which includes a set of competencies that teachers should possess in order to effectively integrate ICT into their teaching practices. This framework, known as the DigCompEdu framework, provides a reference for the development of teacher training programs and can help to ensure that all teachers have the necessary skills and competencies to integrate ICT into their teaching. The specific mention of a teacher ICT competence framework is not present in the report on Austria, the need for improved teacher training and professional development in digital skills and competencies is recognized as a priority for ensuring the effective integration of ICT in education. The DigCompEdu framework provides a useful reference for the development of such training programs.

2.4.4 Turkey

The name of the ICT education policy of Turkey is "FATIH Project" (The Movement to Enhance Opportunities and Improve Technology). The project was initiated in 2010 by the Ministry of National Education of Turkey to provide equal opportunities to all students in the country by integrating technology into the education system. The project involves providing tablets and smart boards to schools, developing digital content, and providing teacher training on how to effectively use technology in the classroom. The ultimate goal of the project is to improve the quality of education in Turkey and prepare students for the digital age.

The FATIH Project recognizes that the success of integrating technology into the education system depends on the competence and readiness of teachers to effectively use technology in their teaching practices. Therefore, the project places significant emphasis on improving teacher ICT competence and has developed a comprehensive strategy to achieve this goal. One of the key components of the teacher ICT competence strategy is the provision of professional development opportunities for teachers. The Ministry of National Education has developed a range of training programs to enhance teachers' ICT skills and knowledge. These programs include face-to-face training workshops, online training courses, and in-service training programs. The project provides various training opportunities to teachers to help them integrate technology into their teaching practices. For example, the Ministry of National Education of Turkey has developed in-service training programs, workshops, and online training courses that focus on different aspects of ICT education.

The training programs aim to enhance teachers' digital skills, such as how to use digital content in the classroom, how to create digital content, and how to effectively use technology to engage students in the learning process. The training also covers topics such as digital citizenship, online safety, and responsible use of technology. In addition to training programs, the project also provides support to teachers in the form of technical assistance, online resources, and mentoring programs. The project has established a support network to help teachers overcome any challenges they may face while integrating technology into their teaching practices. Another key component of the strategy is the provision of technical support to teachers. The

FATIH Project has established a technical support system that provides teachers with access to technical assistance when they encounter challenges using technology in the classroom. This support system includes a helpdesk and a call centre that teachers can contact when they need assistance.

The FATIH Project also emphasizes the need for teachers to collaborate and share their experiences in using technology in the classroom. To support this, the project has created a digital content-sharing platform where teachers can share their digital content with each other and access digital content created by other teachers. This platform encourages teachers to learn from each other and share best practices.

2.4.5 Thailand

Thailand has made significant efforts to improve the integration of information and communication technology (ICT) in education, including policies aimed at enhancing the ICT competence of teachers. The Thai government has identified the development of digital literacy as a key priority in its education reform agenda and has established various policies and initiatives to support this goal. One of the key policies aimed at enhancing teacher ICT competence is the "ICT in Education Master Plan 2017-2021," which outlines strategies for promoting the use of ICT in teaching and learning and includes targets for increasing the number of ICT-literate teachers in the country. Under this policy, the Thai government has launched several initiatives to provide training and support for teachers to improve their ICT skills and incorporate technology into their teaching practices. For example, the "One Teacher One Notebook" program provides laptops and training for teachers to enhance their ICT skills and enable them to use technology in their classrooms. Additionally, the government has established the "Smart Teacher" program, which provides online resources and professional development opportunities for teachers to improve their digital literacy and ICT competencies.

The plan outlines several strategies to achieve this goal, including:

- *Developing a national standard for teacher ICT competence:* The Thai government has developed a national standard for teacher ICT competence, which outlines the essential ICT skills and knowledge that teachers need to have. This standard serves as a guide for teacher training and development programs.
- *Providing training and professional development for teachers:* The Thai government has launched several initiatives to provide training and support for teachers to improve their ICT skills and incorporate technology into their teaching practices. For example, the One Teacher One Notebook program provides laptops and training for teachers to enhance their ICT skills and enable them to use technology in their classrooms. Additionally, the Smart Teacher program provides online resources and professional development opportunities for teachers to improve their digital literacy and ICT competencies.
- *Incorporating ICT into teacher education programs:* The Thai government has also made efforts to incorporate ICT into teacher education programs, to ensure that future teachers have the necessary skills to effectively use technology in their teaching practices. The Thai government has invested in providing ICT resources and infrastructure in schools, including computer labs, internet connectivity, and

educational software. This infrastructure is essential for teachers to effectively incorporate technology into their teaching practices.

Thailand's ICT education policy on teacher ICT competence is aimed at developing the digital literacy of teachers and ensuring that they have the necessary skills and resources to effectively use technology in their teaching practices.

2.4.6 Switzerland

The name of Switzerland's ICT education policy is "Digital Strategy 2021-2024 for Education, Research, and Innovation." This policy explains how Switzerland wants to use digital technologies in education, research, and new ideas. Its goal is to help students, teachers, and researchers learn digital skills. It includes steps to improve digital infrastructure, help people get better at using digital technology, and encourage the use of digital tools in teaching and learning. The policy recognizes that teachers play a crucial role in helping students develop digital competencies and emphasizes the importance of ensuring that teachers themselves have the necessary ICT skills and competencies to effectively integrate digital technologies into their teaching. The policy emphasizes the importance of ensuring that teachers have the necessary ICT skills and competencies to integrate digital technologies into their teaching. To support this goal, the policy outlines several measures to enhance teacher ICT competence. These include:

- *Developing training programs:* The policy calls for the development of training programs and professional development opportunities for teachers to improve their digital competencies. These programs may be offered by educational institutions or other organisations and may cover a range of topics related to ICT, such as digital pedagogy, online teaching, and digital literacy.
- *Providing resources and support:* The policy calls for the provision of resources and support for teachers to improve their digital competencies, such as access to digital tools and technologies, online resources and training materials, and mentoring and coaching programs.
- *Promoting collaboration:* The policy encourages collaboration between teachers, education stakeholders, and other experts to share best practices, develop innovative approaches to integrating digital technologies in teaching and learning, and co-create new digital learning resources and tools.

All in all, Switzerland's "Digital Strategy 2021-2024 for Education, Research, and Innovation" policy recognises how important it is for teachers to help students learn the digital skills they need to be successful in a digital world that is changing quickly. By making teachers better at ICT, the policy hopes to improve the way digital technologies are used in teaching and learning and help build a workforce with digital skills for the future.

2.4.7 Ireland

The Digital Learning Framework (DLF) is a set of standards for ICT skills in Irish schools. It was made by the Irish Department of Education and Skills to help schools use digital technologies in teaching and learning. It can be used for self-evaluation and planning. The framework is made so that schools can use it as a guide to figure out how digitally integrated

they are now and how to improve in the future. The framework is based on eight key indicators, and each one has a set of statements that describe different levels of success. These indicators and associated statements are as follows:

- *Leadership, Vision, and Planning:* This indicator focuses on the leadership and vision needed to develop a school-wide digital learning culture. It includes statements about the development of a shared vision for digital learning, the allocation of resources, and the creation of a culture of innovation and risk-taking.
- *Digital Learning Culture:* This indicator looks at how a school's culture and practices support digital learning. It includes statements about teacher collaboration, the use of technology to support communication, and the importance of creating a positive digital learning environment.
- *Professional Learning:* This indicator focuses on the professional development of teachers to support digital learning. It includes statements about the need for ongoing professional development, the use of technology to support professional learning, and the importance of leadership in supporting professional development.
- Teaching and Learning: This indicator looks at how technology is integrated into teaching and learning practices. It includes statements about the use of technology to support creativity, critical thinking, and collaboration, and the need for assessment practices to support digital learning.
- *Digital Content and Resources:* This indicator focuses on the availability and quality of digital content and resources. It includes statements about the need for high-quality digital resources, the importance of digital citizenship, and the need to ensure that digital resources are accessible to all learners.
- *Assessment and Feedback:* This indicator looks at how assessment and feedback practices support digital learning. It includes statements about the use of technology to support formative assessment, the importance of providing timely feedback to learners, and the use of digital tools to support assessment practices.
- *ICT Infrastructure:* This indicator focuses on the ICT infrastructure needed to support digital learning. It includes statements about the importance of reliable and secure ICT infrastructure, the need for effective technical support, and the importance of accessibility.
- *Policies, Procedures, and Support:* This indicator looks at the policies and procedures needed to support digital learning. It includes statements about the need for policies to support digital learning, the importance of data protection, and the need to provide effective support to all stakeholders.

Overall, the Digital Learning Framework is designed to provide schools with a roadmap for developing and implementing effective digital learning strategies that support teaching and learning outcomes for all learners. The framework is aligned with other key policies and initiatives in Irish education and is designed to support schools in their efforts to create a positive and effective digital learning environment.

2.4.8 Spain

The Spanish Ministry of Education and Vocational Training made the Spanish ICT Competence Framework for Education (Marco Comn de Competencia Digital Docente) in 2017. Its goal is to create a set of digital skills that teachers must have in order to use technology in their classrooms effectively. The framework is designed to provide teachers in Spain with a common set of digital skills that will help them use technology in their classrooms more effectively. It is based on the European Union's Digital Competence Framework for Citizens (DigComp), which lists five key areas of digital competence: information and data literacy, communication and collaboration, digital content creation, safety, and problem-solving. In the Spanish ICT Competence Framework for Education, each of these areas is further broken down into different levels of competence, from basic to advanced. These levels make it clear what teachers need to know, how they need to act, and what skills they need to have in order to use digital tools to teach well.

The framework is divided into five different areas of competence, which are further subdivided into different levels:

1. *Information and data management:* This area focuses on the ability to find, evaluate, and use information and data effectively. Teachers with a high level of competence in this area are able to search for information efficiently, critically evaluate the quality and relevance of the information, and use it effectively to support their teaching.
2. *Communication and collaboration:* This area refers to the ability to communicate and collaborate effectively using digital tools. Teachers with a high level of competence in this area can use different types of digital communication tools (such as email, chat, or videoconferencing) to communicate with colleagues, students, and parents. They are also able to use digital collaboration tools (such as shared documents or project management tools) to work collaboratively with others.
3. *Digital content creation:* This area focuses on the ability to create and share digital content in different formats. Teachers with a high level of competence in this area can create and edit multimedia content (such as videos, audio recordings, or images), as well as written content (such as blog posts or reports). They are also able to share this content effectively using different digital platforms (such as social media, learning management systems, or websites).
4. *Safety:* This area refers to the ability to use digital technologies safely and responsibly. Teachers with a high level of competence in this area can identify and avoid online risks, protect their personal information and privacy, and promote safe and responsible use of technology among their students.
5. *Problem-solving:* This area focuses on the ability to use digital technologies to solve problems and make decisions. Teachers with a high level of competence in this area can use different digital tools and resources to analyze complex problems, identify potential solutions, and make informed decisions based on data and evidence.

The framework is designed to be flexible and adaptable to different educational contexts and levels of education, from early childhood to higher education. It provides a clear and comprehensive set of digital competencies that teachers can use to assess and develop their

skills and serves as a guide for teacher training programs to design their curricula and assessments. By supporting the effective integration of technology into teaching practices, the framework can help to improve the quality of education and prepare students for the digital world they will encounter in their future careers.

2.4.9 California

The California ICT (Information and Communication Technology) Digital Literacy Policy Framework is a set of rules and suggestions made by the California Department of Education to help students, teachers, and the rest of the community learn how to use technology well. The framework is made up of a set of principles, goals, and strategies that are meant to help education and workforce development programmes including digital literacy. It talks about how important it is to give students the skills and knowledge they need.

The California ICT Digital Literacy Policy Framework includes the following key components:

- *Principles of Digital Literacy:* The framework defines the key principles of digital literacy, including the ability to access and use information effectively, to communicate and collaborate using digital tools, and to think critically and make informed decisions in a digital context.
- *Goals for Digital Literacy:* The framework identifies key goals for digital literacy in California, including the need to provide equitable access to technology and digital resources, to support the development of digital citizenship skills, and to promote the use of technology to enhance teaching and learning.
- *Strategies for Implementation:* The framework provides recommendations for implementing digital literacy programs in schools and communities, including the need to provide professional development opportunities for educators, promote collaboration and partnerships among stakeholders, and leverage technology to improve access to education and workforce development programs.

The California ICT Digital Literacy Policy Framework is intended to guide the development of digital literacy programs and initiatives across the state of California and to promote the development of the knowledge and skills needed to thrive in a digital world.

2.4.10 Nepal

Nepal's ICT education policy is called the "ICT in Education Master Plan 2013-2017." It was made by Nepal's Ministry of Education to integrate information and communication technology (ICT) into the country's education system, from primary to higher education. The goal of the plan is to improve the quality of education, make it easier to get to educational resources and encourage teachers and students to use ICT to help them learn and teach better. It also wants to build up a skilled workforce that can help the ICT sector of the country grow.

The policy acknowledges that teachers play an extremely essential role in ensuring that information and communication technology is utilized effectively in the context of teaching and learning. Hence, one of the primary objectives of the policy is to provide educators with the necessary training as well as chances for further professional development for them to enhance their expertise and familiarity with ICT. To accomplish this goal, the policy stipulates the establishment of ICT resource centres and teacher training centres across the entirety of the

nation. The purpose of these centres is to provide teachers with access to training, resources, and support that will assist them in becoming more proficient in the use of information and communication technologies. In addition to this, they offer educators and teachers a forum in which they may discuss the most effective ways to carry out a task and share their own experiences. In addition, the policy emphasises how essential it is to both encourage and monitor the efforts of educators to advance their knowledge of information and communications technology (ICT). This involves providing mentoring and coaching, conducting periodic assessments of the individual's information and communications technology (ICT) skills and competencies, and providing feedback on the individual's performance.

In general, the policy recognises that developing the information and communication technology (ICT) abilities of teachers is a lengthy process that requires ongoing commitment and devotion. Yet it also adds that boosting teachers' ICT abilities may have major benefits, such as increasing the overall quality of education, making it simpler for students to have access to educational materials, and encouraging the use of technology to assist in both teaching and learning.

2.4.11 Russia

A national ICT competence framework for education has been established by the Russian Federation. This framework offers a complete set of principles and criteria for integrating technology into teaching and learning. The "ICT Competence Framework for Teachers" was established by the Ministry of Education and Science of the Russian Federation in partnership with the UNESCO Center for Information Technologies in Education. The name of the framework is "ICT Competency Framework for Teachers." The framework is built around the notion that teachers need to have the right ICT skills to help students learn effectively in the digital age. It acknowledges that technology is not a replacement for good teaching practices. Instead, it is a tool that can help make teaching and learning more effective.

The framework is broken up into six areas of competency, which are each explained in more detail below:

- *ICT Literacy:* This competency area focuses on the basic digital literacy skills that teachers need to have to use digital tools and technologies effectively and responsibly for personal and professional purposes. It includes skills like how to use digital devices, how to use productivity software, how to handle online communications, and how to understand the ethical and legal issues that come up when using ICT.
- *Pedagogical Competence:* This competency area is about how well teachers can come up with and use effective ways to teach and learn that make good use of technology. It includes skills like choosing the right digital tools and technologies, making digital learning materials and resources, making learning environments that are interesting and interactive, and helping people work together to learn.
- *Content Competence:* This competency area focuses on teachers' abilities to create and adapt digital learning materials and resources that help students learn. It includes skills like making digital multimedia resources, changing existing resources to meet specific learning goals, and making assessments with digital tools.

- *Assessment Competence:* This competency area is all about how well teachers can use digital tools and technologies to test and give feedback on their students' learning. It includes things like being able to design and give digital tests, analyse test results, and use digital tools to give students formative feedback.
- *Communication Competence:* This competency area is all about how well teachers can use digital tools and technologies to communicate. It includes skills like using digital communication tools to talk to students, parents, and coworkers, making and managing digital communication channels, and using digital tools to make multimedia presentations and teaching materials.
- *Professional Development:* This competency area looks at how well teachers can keep learning and improving their ICT skills throughout their careers. It includes skills like using digital tools and resources to learn about the latest changes in education technology, taking part in online professional development activities, and working with other teachers to share best practices and resources.

The ICT Competency Framework for Teachers in Russia is a complete set of rules and guidelines for using technology in teaching and learning. It is meant to be used by teachers at all levels of the education system, from primary school to higher education. It gives teachers a clear plan for developing the ICT skills they need to teach well in the digital age.

2.4.12 France

France's national ICT education policy is called "Plan numérique pour l'éducation" (Digital Plan for Education). This policy aims to integrate digital technologies and digital education into the French education system, from elementary school to higher education, so that students are ready for the digital world and the jobs of the future. One of the policy's main goals is to give teachers the skills and knowledge they need to use digital technologies in their classrooms. In order to do this, the French government has taken a number of steps, such as:

Opportunities for professional development: The policy gives teachers the chance to take part in professional development programmes that focus on how to use digital tools and resources in the classroom. Workshops, training sessions, and online courses are all part of these programmes, which are meant to help teachers improve their ICT skills and knowledge.

Dedicated digital training centres: The French government has set up a network of digital training centres called "CRI" (Centres de Ressources et d'Information sur les Multimédias pour l'Enseignement). These centres give teachers access to digital tools and resources and help them figure out how to use them in their classrooms.

Online resources and support networks: The policy gives teachers access to a variety of online resources and support networks, such as teaching materials, lesson plans, and online forums where they can work together and share best practices with other teachers.

Collaboration between teachers: The policy stresses how important it is for teachers to work together and share best practices. Teachers are encouraged to work together to come up with new ways to teach that use digital technologies and to share their ideas and experiences with each other.

Ultimately, the French "Plan numérique pour l'éducation" acknowledges the crucial role instructors play in educating children for the digital world. The French government intends to guarantee that students receive a high-quality education that prepares them for the digital future by providing teachers with the necessary training and resources to properly incorporate digital technology into their teaching methods.

2.4.13 Vietnam

The name of the Vietnam ICT competence framework for teachers is "Vietnam ICT Competency Framework for Teachers (ICT-CFT)". It was developed by the Ministry of Education and Training (MOET) of Vietnam in collaboration with UNESCO and other partners and aims to provide a comprehensive framework for the development of ICT competencies among teachers in Vietnam. The ICT-CFT is designed to support the integration of technology into teaching and learning and to help teachers develop the skills and knowledge necessary to effectively use technology in their classrooms. The framework is based on the UNESCO ICT Competence Framework for Teachers but has been tailored to Vietnam's particular requirements and circumstances.

The ICT-CFT is structured around three primary domains:

- *Literacy in ICT:* This area focuses on the fundamental ICT abilities that teachers need to acquire in order to utilise technology in their teaching practice successfully. This includes the ability to use productivity software, to create and edit digital information, and to communicate online.
- This area focuses on the pedagogical knowledge and skills instructors need to create and implement effective technology-enhanced learning experiences. This involves planning ICT-enhanced lesson plans, finding relevant digital materials, and incorporating ICT into evaluation and assessment.
- *Professional Development and Leadership:* This area focuses on the continuing professional development and leadership abilities that teachers must possess to continue to build their ICT competence and promote the efficient use of technology in classrooms. This includes the ability to identify and engage in professional development opportunities, mentor and coach colleagues, and advocate for the use of technology in education.

The ICT-CFT is meant to serve as a guide for teacher education and professional development programmes in Vietnam, as well as a tool for teachers to assess and build their own ICT capabilities. The ICT-CFT seeks to improve the quality of teaching and learning in Vietnam and to prepare students for the challenges of the 21st century by encouraging the development of ICT competencies among instructors.

2.4.14 Denmark

The "Digital Strategy 2016-2020 - The Digital Road to Development" of Denmark is a strategy that intends to encourage the integration of technology into the educational system to enhance

students' digital capabilities and assist economic growth. The policy includes a number of important objectives and measures targeted to attain this purpose. The policy specifies three primary target areas: digital competencies, infrastructure, and innovation.

Digital capabilities, the policy seeks to guarantee that all students have the skills necessary to utilise technology as an effective instrument for learning, communication, and collaboration. This involves designing a national curriculum with digital competencies as a fundamental component and offering teacher training and professional development opportunities to assist teachers in integrating technology into their teaching methods.

Infrastructure, the policy seeks to guarantee that all schools have access to a dependable and high-speed internet connection, as well as the gear and software required to properly implement technology in the classroom. The government has invested in renovating school infrastructure and giving technical support to schools to ensure they have the necessary resources.

In terms of innovation, the strategy intends to encourage the creation of new technologies and digital tools that may be utilised to improve the educational system. This involves funding research and development in the field of educational technology and developing relationships between schools and the commercial sector to promote innovation.

2.4.15 Germany

Germany's education policy outlook on ICT competence is focused on ensuring that students and teachers have the skills and knowledge necessary to effectively use technology in teaching and learning. This includes several key initiatives:

- *Integration of digital skills into the curriculum:* Germany is working to integrate digital skills into the curriculum at all levels of education. This includes teaching basic computer skills, as well as more advanced skills such as coding and data analysis.
- *Professional development for teachers:* Germany recognizes the importance of ensuring that teachers have the necessary ICT competencies to effectively integrate technology into their teaching. As such, the government provides funding for teacher training programs and professional development opportunities focused on ICT competencies.
- *Digital infrastructure:* Germany is investing in the development of digital infrastructure in schools, including high-speed internet and up-to-date hardware and software. This ensures that students and teachers have access to the tools necessary to effectively use technology in teaching and learning.
- *Collaboration with industry:* Germany is working closely with the technology industry to ensure that the skills taught in schools align with the needs of the labour market. This includes partnerships with tech companies to develop curricula and provide training programs for teachers and students.

Germany's education policy outlook on ICT competence is focused on ensuring that students and teachers have the skills and tools necessary to effectively use technology in teaching and learning. This includes integrating digital skills into the curriculum, providing professional development for teachers, investing in digital infrastructure, and collaborating with industry to ensure that students are prepared for the challenges of the 21st century.

2.5 Techno- Pedagogy Content Knowledge

The integration of ICT or educational technology in the classroom teaching-learning process has utilized the Technological Pedagogical Content Knowledge (TPACK) framework, which was developed by Mishra and Koehler (2006) and is widely acknowledged. This is a continuation of Shulman's (1986) research on PCK (Pedagogical Content Knowledge).

The focus of the teacher's knowledge lies in the pedagogy and content, as emphasised by the concept of Content Knowledge. Shulman emphasised the importance of teachers possessing a comprehensive understanding of basic pedagogical procedures to effectively teach specific topics. Furthermore, he stressed the need for teachers to tailor their pedagogical approach based on the unique characteristics of the content being taught. In 2003, it gained formal recognition in the literature of education journals. The integration of technology with teaching and learning is facilitated through the concept of 'TPACK'. Mishra & Koehler (2006) proposed that there is a third main type of knowledge, known as TK, which refers to the teachers' expertise in effectively incorporating technology into the classroom.

The PCK framework was expanded to TPACK, which integrates technology with content and pedagogy, thanks to breakthroughs in science and technology (Anjeli & Valanides, 2008). Initially, TPCK was the abbreviation assigned to the framework, which was subsequently altered to TPACK to facilitate its pronunciation. (Chai, Koh, & Tsai, 2016). In addition, it was said that the constructs TPK, TCK, and PCK are regarded as the fundamental elements of TPACK. The objective of the TPACK framework is to ensure the equitable integration of three domains of knowledge, namely technological knowledge (TK), pedagogical knowledge (PK), and content knowledge (CK), in the teaching and learning process. Aside from the basic forms of knowledge, TK, PK, and CK, there exist three additional forms of knowledge, namely TCK (Technological Content Knowledge), PCK (Pedagogical Content Knowledge), and TPK (Technological Pedagogical Knowledge). These secondary forms of knowledge are created by combining the basic forms of knowledge. The Venn diagram in Figure 2.1 demonstrates the convergence of fundamental types of knowledge, which leads to the emergence of secondary forms.

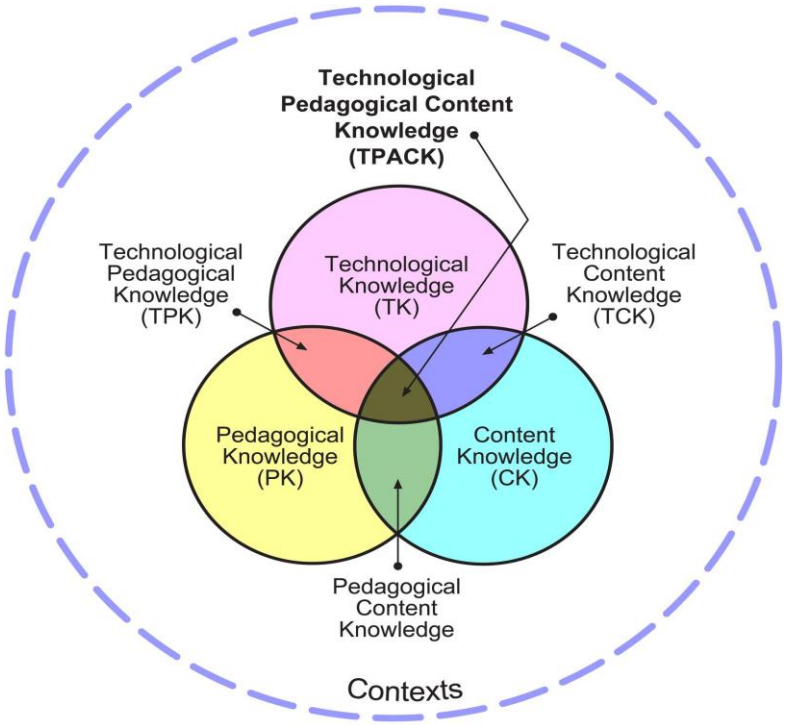


Fig. 2.1: TPACK Source: https://educationaltechnology.net

Multiple studies have been carried out in the field of Technological Pedagogical Content Knowledge (TPACK) specifically focusing on educators. Pre-service teachers can acquire pedagogical content knowledge (PCK) through both school activities and their teaching practice (Van Driel et al., 2002). The TPACK framework encompasses both primary and secondary types of knowledge, including technological knowledge (TK), pedagogical knowledge (PK), content knowledge (CK), technological pedagogical knowledge (TPK), technological content knowledge (TCK), and pedagogical content knowledge (PCK). According to Russell et al. (2003), pre-service teachers have a higher level of computer proficiency compared to experienced teachers. A study on online teachers revealed that they possess high levels of confidence in three specific domains: pedagogical knowledge (PK), content knowledge (CK), and pedagogical content knowledge (PCK). However, their level of confidence diminishes when it comes to technology (Archambault & Crippen, 2009).

The utilisation of diverse technological tools such as GeoGebra and interactive whiteboards facilitates the promotion of Technological Pedagogical Content Knowledge (TPACK) among teachers. Interactive whiteboards are specifically created to substitute traditional blackboards and make up for the absence of instructional materials. Regarding pre-service teachers, the incorporation of interactive whiteboards has proven to be effective in enhancing their Technological Pedagogical Content Knowledge (TPACK). Holmes (2009) noted that pre-service teachers efficiently design their lesson plans by incorporating the capabilities of Interactive Whiteboards (IWB) and simultaneously enhancing their Technological Pedagogical Content Knowledge (TPACK). The use of an Interactive Whiteboard (IWB) also enhances student engagement by improving their conceptual knowledge through visual presentations. Additionally, Jang and Chen (2010) reported that the implementation of the TPACK-COPR (TPACK Comprehension, Observation, Practice, and Reflection) model facilitates the

cultivation of TPACK skills among science pre-service teachers. The TPACK framework has a strong and positive correlation with its individual components: technological knowledge (TK), pedagogical knowledge (PK), and content knowledge (CK) (Chai, Koh & Tsai, 2010). Moreover, they get the opportunity to observe experienced instructors, enabling them to mimic and implement a diverse range of instructional practices in their own classroom instruction (Jang & Chen, 2010).

Koh and Divaharan (2011) conducted a study on pre-service teachers to observe their techno-pedagogical skills. The study revealed that pre-service teachers prioritize acquiring technological knowledge above developing the skills to effectively integrate technological devices into the classroom. Subsequently, as teachers commence the integration of technology, they encounter challenges associated with Technological Pedagogical Knowledge (TPK) and Technological Content Knowledge (TCK) (Koh & Divaharan, 2011). Keeping this in view, Pamuk (2012) stated that the lack of pedagogical abilities hinders teacher's ability to confidently integrate technology into their instruction. It was further suggested that the professional development programs should focus not only on technical skills but also on pedagogical strategies for effective technology use. This approach can empower teachers to design and implement technology-enhanced learning experiences that are engaging and meaningful for students.

A study conducted by Jang & Tsai (2012) explained that elementary teachers who utilise interactive whiteboards exhibit substantial differences in their Technological Pedagogical Content Knowledge (TPACK) compared to instructors who do not utilise interactive whiteboards. The pre-service teachers' development of Technological Pedagogical Content Knowledge (TPACK) is facilitated through design activities. This growth occurs as they critically analyse their reflections on specific design tasks that are assigned to them during their training in Information and Communication Technology (ICT). Research has shown that after completing ICT training, the most significant improvement is shown in the areas of Technological Pedagogical Knowledge (TPK) and Technological Pedagogical Content Knowledge (TPACK), leading to an enhancement in the quality of their reflections (Graham, Borup, & Smith, 2012). The development of Technological Pedagogical Content Knowledge (TPACK) in pre-service teachers is more prominently demonstrated in qualitative investigations. TPACK is highly advantageous in preparing pre-service teachers for the incorporation of technology in the classroom. Activities such as 3D material design, PPT design, and instructional website development, which are based on Technological Pedagogical Content Knowledge (TPACK), help to enhance the skills of elementary school pre-service teachers in instructional material design (IMD) (Tokmak, Yelken & Konokman, 2013).

Despite the familiarity of techno-pedagogical tools the pre-service teachers lack sufficient pedagogical skills to effectively incorporate technology into teaching and learning. Teacher education programs should be improved so that they can offer a range of courses for technology integration, but the design of these courses varies. (Lee & Lee, 2014). Additionally, Koh et al., (2014) revealed that teachers can more readily use new technologies in the classroom when they collaborate in a group rather than working independently. The cooperation between teachers who are still in training and those who are already working in the field contributes to

the enhancement of their abilities to incorporate technology into their teaching practices. When pre-service instructors assist in using technological tools and preparing instructional material, in-service teachers can effectively integrate curriculum and technology. This cooperative approach helps teachers blend technological tools with instructional content more effectively, fostering a deeper understanding of Technological Pedagogical Content Knowledge (TPACK). Moreover, Pamuk et al., (2015) found that the secondary forms of knowledge (TCK, TPK, and PCK) are more predictive of TPACK development than the primary forms of knowledge (TK, PK, and CK). This underscores the importance of a well-rounded understanding and collaborative practice in developing robust, technology-enhanced teaching methods.

The selection of teaching methods and technology, when used together, greatly impacts the other elements of TPACK (Patahuddin, Lowrie, & Dalgarno, 2016). A further study showed that the TPACK (Technological Pedagogical Content Knowledge) of mathematics pre-service teachers was enhanced after participating in a GeoGebra workshop (Bhagat, Chang & Huang, 2017). Benning et al., (2018) noted that the GeoGebra-based professional development programme is an effective method for equipping mathematics instructors with the necessary skills to integrate technology into their classrooms. They highlighted the critical role of targeted professional development and content knowledge in preparing teachers for effective technology integration in the classroom. Upon examination of the topic knowledge of middle school mathematics preservice teachers in an Australian school of education, it has been determined that their proficiency in mathematics content is lacking (Norton, 2019). Beri et al., (2019) carried out in the Punjab region of India and found that the teacher educators in Punjab possess a high level of Technological Pedagogical Content Knowledge (TPACK).

Beri and Sharma (2019) studied the teaching pedagogical skills of 200 teacher educators with respect to their gender, locality of college, stream, and type of colleges. A descriptive survey method was used for this study. It was noted that the educators significantly differ based on their gender, locality and type of college. However, in general, the level of techno-pedagogical skills was noted to be high. Another study by Kalaimani and Stephen (2022) examined the level of techno-pedagogical content knowledge in 30 high school teachers in Chennai. The data was collected using a questionnaire developed by the investigator and interpreted using mean, S.D and t-test. The results of the study show a moderate level of content knowledge among teachers. The findings further suggest that It will assist the administration in providing the facilities such as sufficient classrooms, computers, internet access, and communication technologies that schools require to run efficiently.

Kumar and Praveena (2022) studied the technological and pedagogical knowledge of teacher trainees at Mysore. The blended teaching approach known as "Techno Pedagogy" uses ICT resources to facilitate classroom transactions. The application of techno-pedagogical abilities can greatly enhance the effectiveness of curriculum activities. It further encourages the use of multimedia resources in the curricular process and digital literacy. From the analysis, it was noted that the teacher trainees had a moderate level of techno-pedagogical skills. Therefore, teacher trainees should prioritize using technology in their instruction by using new techniques and procedures. In addition to this, Baregama and Arora (2023) reviewed tools developed to measure the TPACK knowledge of the teachers. After reviewing the data collection scales, it

was noted that most tools covered the techno pedagogy skills for subjects such as mathematics, science, Hindi, English and social science. The study recommended that more TPACK knowledge assessment tools should be developed for other subjects also. The TPACK awareness among 80 secondary school teachers of Assam was assessed by using a self-developed TPACK scale. According to the study's findings, the majority of Assamese secondary school teachers were aware of the significance of TPACK in 21st-century teaching and learning environments. The majority of them agreed that a teacher needs more than just subject-matter expertise. They ought to be educated about various approaches and techniques for efficiently delivering their material based on the various demands of their students Devi (2023).

Konyak (2023) conducted a study aimed at determining the Technological Pedagogical Content and Knowledge (TPACK) of aspiring elementary teachers with respect to gender, age, academic level, and field of study. Using simple randomization, 150 aspiring instructors were chosen as a sample and TTPACKS was utilized for data collection. The current study showed that the technological pedagogical and content knowledge of aspiring teachers was above average. Additionally, it was revealed that there were no significant disparities between prospective teachers in terms of gender, level of education, and field of study. Moreover, Teachers and students will be able to use technology in the teaching and learning process more successfully if they have a thorough understanding of the relationships between technology, content, pedagogy, and context. Furthermore, another study assessed the techno-pedagogical content knowledge of teachers to identify the knowledge gap. The results showed that the teachers understood TPACK at a fundamental level. The teachers' familiarity with technology and aptitude for online learning were different. The study recommended that in order to increase TPACK capacity for online classes, stakeholders in education should set up specialized training programs. This will let teachers grasp the concept at a deeper level. Adequate equipment, software, and internet access are necessary for high-quality online instruction Kennedy (2024).

Reethumol (2024) investigated the impact of e-resources on the teacher’s ability to use TPACK. The advantages of e-resources like increased accessibility, personalized learning, and interactive engagement, and challenges like technological barriers, the digital divide, and the need for pedagogical adaptation were also discussed. To overcome them, it was recommended that governments and educational institutions prioritize policy and funding support for e-resources, invest in infrastructure development, provide comprehensive teacher training programs, foster collaborative partnerships, address issues of accessibility and inclusivity, and encourage continuous evaluation and research. Another study on the TPACK knowledge of 156 pre-service teachers of Odisha was done by Sahoo (2024). The TPACK scale was used for this descriptive study. The present study found that Technological Pedagogical and Content Knowledge (TPACK) among B.Ed students in Khordha district are moderate, possibly due to the widespread role of technology and the internet in daily life. Integrating technology, content, and pedagogical knowledge enables pre-service teachers to teach and learn more effectively in the current educational landscape. TPACK enhances their knowledge and skills, contributing to their professional development. Additionally, technology-enhanced classroom environments boost student confidence and encourage active learning.

2.6 Digital Competencies of Inservice Teachers

A variety of terms have been used to describe the use of ICT by teachers-information literacy, digital literacy and competence, ICT skills and competency, IT skills, and technological pedagogical content knowledge (TPACK)-and all may be closely interrelated. Teachers' digital competence is understood as the integrated and practical application of digital knowledge, skills, and attitudes. As emphasized by Krumsvik (2008), it should be understood that teachers' digital competence involves the ability to use ICT with pedagogical-didactic judgment and awareness of the consequences this has on learning strategies and the digital education of students. However, in the field of education, digital competence and digital literacy are considerably closer. Digital literacy encompasses the integration of computer literacy, information literacy, and media literacy. The concept of digital competence is built on digital literacy. Digital competence means confident, critical, and responsible use and engagement with digital technologies for learning, at work, and in society. It involves the use of information and data literacy, communication and collaboration, media literacy, digital content creation, including programming, safety-including digital well-being and cybersecurity-related competence-intellectual property rights, problem-solving, and critical thinking. Digital competence can be explained as a set of knowledge, attitudes, capabilities, approaches, skills and awareness required to use the ICT and digital media. These competencies help perform tasks, solve problems, manage information, collaborate, create and share content.

Pan and Franklin (2011) identified the effect of professional development on 559 in-service teachers. The study aimed to identify the role of in-service training in the utilization of digital tools (Web 2.0 tools) in the classroom. The results of the study revealed that the public in-service teachers reported a low level of efficacy in the utilization and integration of Web 2.0 tools in the classrooms. The findings further revealed that increased professional development results in increased utilization of digital tools in teaching-learning. These programs also help in enhancing teacher's self-confidence, self-efficacy and willingness to implement technologies in the instruction. Furthermore, Sanchez et al., (2012) conducted a study on 170 in-service teachers teaching in kindergarten to high school in order to investigate their attitude towards the use of ICT in classrooms. The findings of the study revealed that the teacher's attitude towards the use of ICT was positive however they were lacking in digital skills. It was also noted that the traditional training practices were not impactful in improving their digital competence. Therefore, proper in-service training of teachers should be arranged.

To identify the effectiveness of a training program for in-service school teachers Sanchez-Gracia et al., (2013) conducted a year-long program for eighty-five teachers. The program consisted of three training modules on how to use ICT tools. These training modules covered information on digital tools such as digital boards, word, PPT, use of the internet, web designing etc. The results of the study revealed that after receiving in-service training school teachers displayed high levels of enthusiasm in integrating ICT tools in teaching-learning. The study also reported a significant development in the teaching skills of teachers. Thus, it can be stated that in-service training needs to be organized in order to improve effective teaching practices, collaboration with peers and innovation. In support of this, Omar (2014) also stated that in-service training for improving teacher competency is essential. The in-service training

programs are beneficial in enhancing teachers' knowledge, skills, and attitudes towards new developments in education. This training can be delivered through various methods, such as in-service training or specialized programs that do not require teachers to leave their primary teaching responsibilities.

Liu, M.H. and Kleinsasser (2015) studied the impact of in-service training on six EFL teachers of teaching in two private vocational schools in Taiwan. Teachers were selected for this study based on their previous knowledge of technology applications such as PPT, emails, and online resources. However, they were not familiar with using online learning platforms for their English curriculum. Keeping this in mind, a sixty-minute training session was developed with the main focus on enhancing teachers' digital literacy, how it facilitates or hampers their implementation of technology in the classroom and to promote the integration of online instruction into English education. The findings of the study revealed improvement in the technology knowledge of teachers and noted a promising beginning in integrating technology into online language instruction. In support of this, Li et al., (2016) also reported that online training is the primary way of in-service training that can improve the digital competency of school teachers.

Almekhalfi, (2016) discussed the perceptions of 262 in-service school teachers regarding the effective use of eLearning digital collaboration tools in the United Arab Emirates k-12 schools and universities. A questionnaire on the types of digital tools and their effectiveness in instruction was developed and handed out to the participants. The findings of the study revealed that the in-service teachers believe in the utility of digital collaboration tools for teaching and learning, professional development of teachers and enabling them to create digital content. The results of digital collaboration learning showed that despite having a high perception towards collaboration tools the teachers themselves were not using them in the classrooms. It was further suggested that enough support should be given to the teachers for the effective use of digital tools. Professional development programs should be organized by the administrations. In addition to this, digital infrastructure should also be placed in the schools.

With the introduction of various communication methods, digital competency has grown in importance within academics. They now play a crucial role in both the inside and outside of the classroom for teachers. Along with linguistic competence, knowledge of information and communication tools are now regarded as an essential skill for foreign language teachers. To measure the digital competence of in-service teachers of Saudi Arabia and its applications in the English language Al Khateeb (2017) carried out a study to assess instructors' capacity, knowledge and abilities for developing, implementing, assessing, and planning ICT-based courses. The results of the study revealed that the majority of instructors did not possess the degree and standards of digital competence needed to effectively teach students in the twenty-first century. Only about 25% of respondents were found to possess digital competency and understanding of learning management systems and collaboration tools. It was found that the teachers lacked the necessary level of digital competency and should be encouraged to acquire additional digital competencies as part of their ongoing professional development (CPD) and teacher education programs. Furthermore, MOOCs are simply one of the methods for promoting teachers' online involvement and helping them become more digitally competent.

Williams (2017) recommended that teacher education programs are required in order to guarantee that teachers have the newly acquired abilities to effectively integrate new technologies into the classroom. One of the eight essential competencies for lifelong learning that the European Commission has established is digital competence, which is necessary for work in a knowledge-based society, personal fulfilment and professional growth. Training programs (beginning or ongoing) that are thoughtfully created are desperately needed in order to bridge the gap between the end-of-course profile of recently formed secondary school teachers and the expectations of a knowledge society. It should cover the three main areas: technology proficiency, pedagogical compatibility, and social awareness. Proficiency in these areas is essential for teachers to effectively and meaningfully integrate technology in the classroom. It was recommended in the study that along with the initial training is important to provide in-service training as well for the professional development of teachers (Fraile et al., 2018)

Novoa-Echaurren and Canales-Tapia (2018) presented a review of the emerging ICT technologies, their use in the classroom and in-service training for teachers in Chile to master these technologies. An instructor's ICT proficiency is crucial and along with the initial training continuous learning opportunities should be provided to increase their comprehension and application of technology in pedagogy. Teaching involves a variety of interrelated domains and teachers' cognitive, pedagogical and evaluation skills. Therefore, a wide range of abilities related to using technology in the classroom should be fostered among the teachers. Online centralized training is advised by Zhang et al. (2019). Flexible, self-paced learning is made possible with this method, which is essential for in-service teachers to improve their digital competency. Furthermore, online training can offer possibilities for ongoing professional development, keeping educators informed of the most recent developments in pedagogy and educational technology.

Xie et al. (2019) proposed creating an IT-rich atmosphere for school teachers as a means of fostering the deep integration of technology and education. This would make it possible for in-service educators to successfully integrate digital technologies into their lesson plans, giving students a more participatory and interesting educational experience. Additionally, an IT-rich workplace fosters lifelong professional development by assisting educators in keeping up with new technologies. To examine the in-service teachers' digital competence Lucas (2021) conducted a study on 1071 school teachers. Simple and linear regression analysis was done to examine the relationship between digital competence and personal factors. The findings demonstrate that every analysis carried out supports the ability to predict and dominate personal characteristics over environmental ones. There were differences in gender and age, but the most significant predictor of teachers' digital competence was the quantity of tools they utilized for instruction and learning, followed by simplicity of use, comfort level with digital technology, and responsiveness to new ideas. These results underscore the necessity of ongoing in-service training to enhance teachers' proficiency with digital tools and their integration into the classroom. The COVID pandemic forced the education system to shift from in-person learning to virtual classrooms. The sudden introduction of technology in teaching and learning revealed the digital competency level of teachers. The sudden shift caught many teachers off guard and revealed gaps in their knowledge of how to use digital tools and online learning platforms. The

situation revealed the critical need for training and development for educators to improve digital literacy and incorporate technology into teaching methods.(Vasquez, et al, 2021).

Radhamani and Kalaivani (2022) studied the digital competence of 155 secondary school teachers and designed a questionnaire to assess their knowledge regarding the use of technology in education. The data collected was analyzed by using mean, S.D., t-test and F-test. The findings of the study revealed that the teachers' subject mastery and computer literacy had high levels of digital competence. The study also made recommendations for the importance of in-service training in raising teachers' levels of digital competency. Institutions that prepare teachers for teaching also have a significant impact on their ability to educate digitally. The need for urgency for developing teachers' digital competencies especially for those working in school was discussed by Rani and Gandhi (2022). Digital competence is essential to function effectively, productively and to facilitate young minds. The study reviewed different digital competence frameworks and made suggestions to promote digital skills among teachers. In-service training of teachers can be organized based on these frameworks and a positive attitude towards the use of technology can be promoted among teachers.

Yang, et al., (2022) explored the relationship between the competence level of pre and in-service teachers and their influencing factors by using a theoretical framework validated in the Chinese context. A non-experimental cross-sectional experimental design was used to diagnostically evaluate the level of digital competence. The findings showed that in-service teachers with advanced degrees in education had greater levels of digital competency. Higher education level in-service teachers typically possess greater digital competency in terms of technical support learning and instruction. In-service teachers exhibit a higher level of consciousness and attitude regarding the use of ICT in the classroom. In support of this, Avci and Pederson (2023) proposed the need for in-service training to improve their digital competence. The goal of in-service training is to give educators the skills they need to integrate and use technology to improve instruction. To improve learning, educators need to be aware of how technology, pedagogy, and subject matter interact. By using technology in the classroom, teachers may help students improve their constructivist skills and create their own knowledge.

Furthermore, Bentri and Hidayati (2023) determined the effectiveness of in-service training of elementary school teachers by using a quantitative experimental method. The outcomes demonstrated a statistically significant difference in teacher abilities pre and post-training according to the curriculum for digital pedagogy. Accordingly, it is suggested that in order for teachers to carry out learning in the digital era as effectively as possible, they should receive in-service training to enhance their digital pedagogical competencies. One efficient method to maximize teacher competency without taking the students out of the classroom is through in-service training. Yang et al., (2023) reviewed several research papers to assess the digital competence of in-service teachers teaching at primary and secondary schools. Establishing a good ICT environment, conducting teacher training, and employing effective pedagogical strategies are three main proposals for improving teachers' digital competence in China.

Tzafilkou et al., (2023) developed a questionnaire containing 20 items to assess the digital skills of 845 primary and secondary school teachers. These items focused on assessing the skills of teachers regarding video conferencing platforms, learning management systems, digital assessment tools, management of online classes, and development of digital teaching material. The study offers insightful information about the state of digital competency among educators as well as the variables (teaching subject gender, educational level) affecting its advancement. The findings also emphasize the importance of continuous professional development for primary and secondary school teachers in order to equip them with digital literacy skills.

The digital competencies for teachers involve the ability to track progress, personalize learning, evaluate the students' performance, identify learning needs, interpret the assessment data, design instructional strategies and provide regular feedback using digital tools. It is not just related to the integration of ICT in education but also develops the student's digital literacy. Digital transformation raises the key question about teacher's digital competence. These competencies are valuable in facing global challenges and crises. Hence, it is essential to develop digital skills in various fields to cultivate the potential of digitalization (Althubyani, 2024). Additionally, digital competency is considered one of the multidisciplinary fundamental skills related to a variety of other 21st-century skills like language, math, and cultural sensitivity. For teachers to effectively transform their teaching through the use of ICT, they must acquire digital competencies and skills. To develop students' digital literacy and get them ready for the demands of the modern world, this shift is imperative. To ensure that they can use technology to improve educational outcomes, educators must undergo continuous in-service training to maintain and develop their digital abilities. (Rahimi and Mosali, 2024).

2.7 Research Gap

Despite extensive research on educators' digital competencies and the integration of technology in education, there is a notable gap in understanding of the Techno-Pedagogy Content Integration (TPCI) package and the level of digital competencies among in-service teachers at the secondary level. While prior studies have identified factors such as ICT knowledge, attitude, and confidence that influence educators' digital abilities, there is limited empirical evidence on the specific interventions designed to address these factors. Additionally, the interaction of demographic variables like age, gender, educational background, and teaching experience in shaping educators' digital proficiency and their adoption of technology has been underexplored. Further research is needed to assess the impact of the TPCI package on enhancing in-service teachers' digital competencies and to examine how these interventions can be tailored to accommodate various demographic and situational factors. This will contribute to a deeper understanding of how to effectively equip educators with the necessary skills and knowledge to navigate the evolving landscape of technology in education.

CHAPTER 3: METHODOLOGY

3.1 Introduction

The methodology is a crucial element of any research project that the investigators pre-determine to ensure a simpler and more seamless execution of their research in practice. It is the methodology that draws the outline for the research design to be employed, the appropriate tool(s) and the format of such tools to be selected and utilized for the study. The research methodology tends to outline the approach and methods of collecting and examining information with regard to a particular research question. It is a process through which the researchers ensure that they have taken various steps to allow them to use the research instruments of their choice to enable them to attain their objectives. It covers all stages of research, from the conception of the research idea, sample, the choice of method of data collection and method of data analysis and the general framework of the research. Perhaps it is so crucial to get the right methodology to get the appreciate and accurate results in any study.

3.2 Research Design

According to Cormack (1996), the research design represents the major methodological thrust of the study, being the distinctive and specific approach, which is best suited to answer the research questions. The research questions, the aim and the objectives of the study thus influence the selection of the research design (Brink, 1999). Research design is a fundamental framework that guides the systematic investigation of a research question or hypothesis. It outlines the procedures and methods for collecting and analyzing data to ensure that the research is conducted in a methodical and organized manner. The purpose of the research design is to study, the effectiveness of the TPCI intervention package in influencing the knowledge, attitude and confidence of in-service is measured.

The research is a quasi-experimental design, which is a type of quantitative research methodology. A quasi-experimental design with Nonequivalent experimental design. Quasi-experimental studies encompass a broad range of nonrandomized intervention studies (Harris et al., 2006). Unlike a true-experimental design, in a quasi-experiment subjects are instead divided into groups based on non-random criteria. It is a useful tool in situations where true experiments cannot be used for ethical or practical reasons. The sample is a convenient or not a random one.

Design Structure:

Experimental Group 1: O_1 - X_1 - O_2 - X_3 - O_3

Experimental Group 2: O_1 - X_2 - O_2 - X_3 - O_3

Where:

O_1 = Pre-data

O_2 = Mid-data

O_3 = Post-data

X_1 = ICT Basics Intervention (Face-to-Face Mode)

X_2 = ICT Basics Intervention (Online Mode)

X_3= ICT Pedagogy Integration in Teaching, Learning and Assessment (Online Mode)

Group	Pre-data	Treatment-1	Mid-data	Treatment-2	Post-data
Experimental Group 1	O_1	X_1	O_2	X_3	O_3
Experimental Group 2	O_1	X_2	O_2	X_3	O_3

The effectiveness of the training package was evaluated through its implementation in both online and blended modes for 5 days. Two Experimental groups of secondary-level in-service teachers, who have limited experience with ICT, have been selected for this research. Experimental Group 1 will comprise 41 participants from state board-affiliated schools and CBSE schools. The Techno-Pedagogical Content Integration (TPCI) package included these two sets of courses. The training for the first group was conducted in two modes. The ICT Basics course was delivered face-to-face from pre-data to mid-data, while the ICT Pedagogy Integration in teaching, learning and assessment intervention was administered online from mid-data to post-data. Group 2 will include 34 participants from state board-affiliated schools and CBSE schools. The training for the second group was conducted in one mode. The ICT Basics course was delivered online from pre-data to mid-data, while the ICT Pedagogy Integration in Teaching, learning and assessment intervention was administered again online from mid-data to post-data. The ICT Basics course includes 16 modules, and ICT Pedagogy integration in Teaching, Learning and Assessment consists of 11 modules.

Procedure of the study

Experimental Group 1 received a mixed training approach, with face-to-face mode for ICT Basics and ICT Pedagogy Integration in online mode., participated in a fully online training program. Both groups began with a pre-test to assess their initial digital competencies. Following the pre-test, the ICT Basics intervention was delivered according to the respective modes: face-to-face for Group 1 and online for Group 2. After completing the ICT Basics intervention, a mid-test was administered to evaluate progress after the ICT Basics intervention. Subsequently, both groups engaged in the ICT Pedagogy Integration intervention in Teaching, Learning and Assessment, which was delivered through online mode for both Experimental groups. This component of the training focused on the advanced integration of technology into teaching practices. After completing the ICT Pedagogy Integration intervention in Teaching, Learning and Assessment, both groups were administered post-tests to evaluate the impact of the training on their digital competencies. These post-tests were

conducted in Online mode to maintain consistency with the delivery method of the Techno Integration Competency. The post-tests aimed to measure the effectiveness of the intervention by assessing changes in participants' knowledge, attitudes and confidence towards integrating technology into teaching practices. The tests were designed to cover all aspects of the TPCI Package.

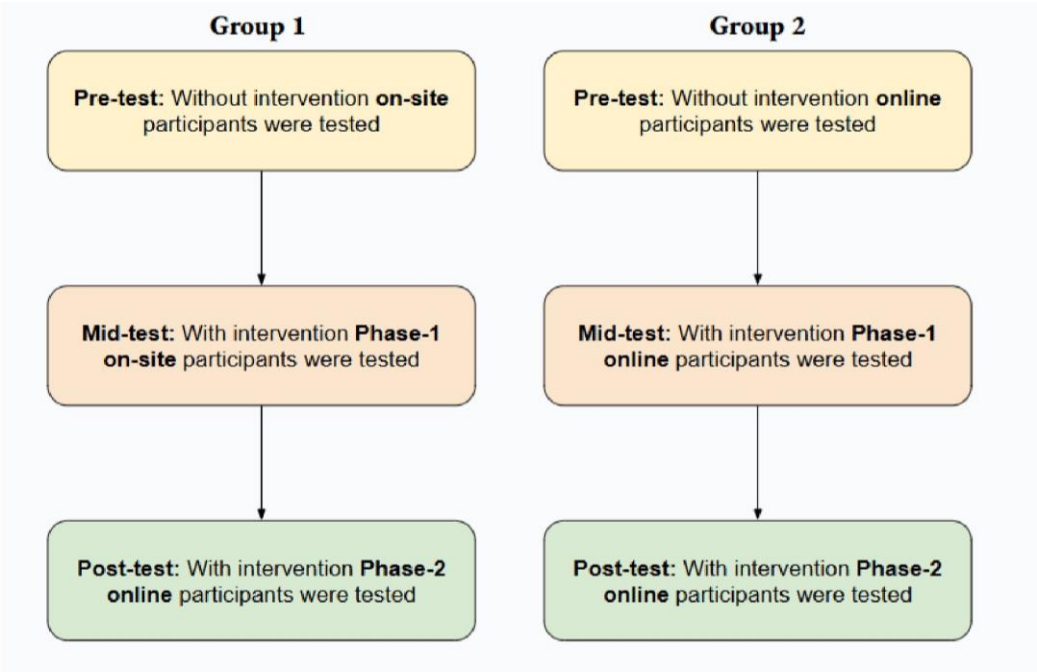


Fig 3.1: Research Design of the Study

3.3 Sampling Strategy

3.3.1 Population of the Study

In-service secondary school teachers from 36 states/UTs of India across various state board-affiliated schools and CBSE schools.

3.3.2 Sampling Technique

In educational research, sampling strategies are pivotal to establish the true representation, generalization and reliability, with respect to the findings of the investigated study. However, depending on the research objectives, available resources, and the desired level of generalizability the choice is made between the probability and non-probability sampling techniques. Probability sampling is ideal for studies aiming to make inferences about a larger population where every member of the population has a known chance of being selected for the sample. Whereas, Non-probability sampling can be useful for exploratory research, when a probability sample is not feasible, or when specific groups need to be overrepresented and the selection of individuals is not based on random chance but on other criteria such as convenience or judgment.

In this study, the purposive sampling technique was preferred over other available sampling techniques as the primary data was obtained purposively from all the in-service teachers of various secondary levels of different boards across India. These teachers were active

participants in both online and on-site modes of the training programme organized by CIET, NCERT.

3.3.3 Sample Size

To conduct the research, purposive sampling was employed. Nine states/UTs and autonomous organizations were approached to select and depute in-service secondary school teachers. A total of 75 participants were recruited from these states/UTs and autonomous organizations. The participants were divided into two groups: the first group consisted of 15 female teachers and 26 male teachers, while the second group included 16 female teachers and 18 male teachers.

Table 3.2 Gender-wise sample distribution

S. No.	Group	Gender	Sample
1	Experimental Group 1 (41)	Female	15
		Male	26
2	Experimental Group 2 (34)	Female	16
		Male	18
Total			75

Table 3.3: Detailed List of the Sample

S. No.	State/ UT/ Autonomous Organization	Number of Participants
1.	Andhra Pradesh	6
2.	Chandigarh	6
3.	Delhi	10
4.	Gujarat	6
5.	Haryana	19
6.	Karnataka	7
7.	Puducherry	6
8.	Tamil Nadu	4
9.	Uttarakhand	15
	Total	75

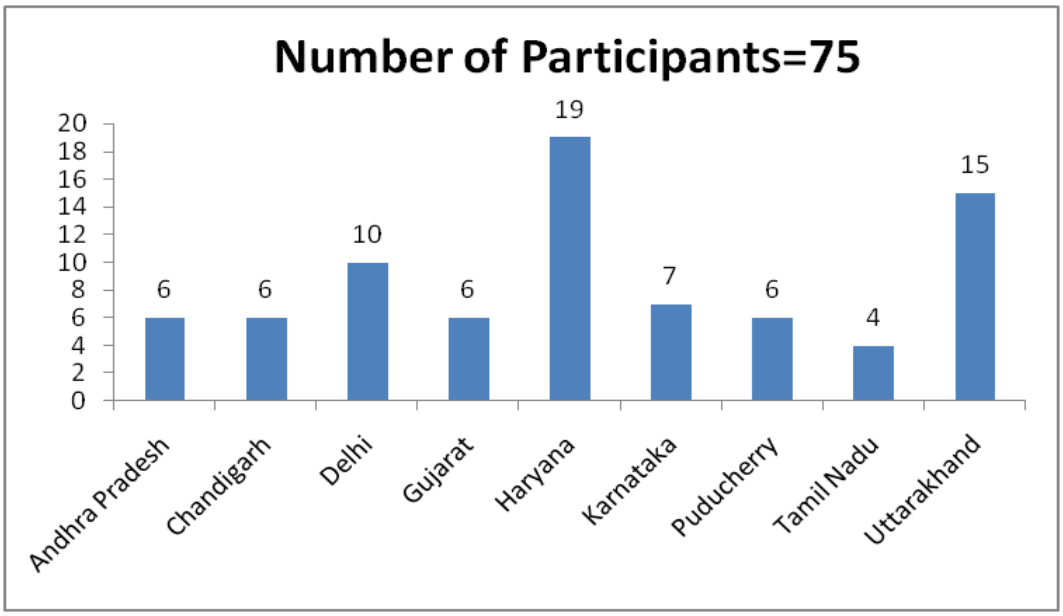


Fig. 3.2: Representation of the Number of Participants

3.2 Research Tool

A 5-point Likert Scale was developed by the investigator Dr. Angelrathnabai S. to measure the ICT competencies of in-service school teachers. The content validity of the scale was established with the experts from the field. Items of the scale are distributed in three tools ie., ICT Knowledge, Attitude towards ICT, and confidence on using ICT. These tools had items to measure the knowledge, attitude, and confidence of secondary school teachers in integrating the ICT tools. These tools are further divided into dimensions and the distribution of the items are provided in the tables given below.

Tool 1: ICT Knowledge Scale

The ICT Knowledge tools has eight dimensions. These were Hardware and Software; Operating Systems; Working with Word processors; Working with Images; Working with Audio and Video; Working with Spreadsheets; Internet, Web Browsers and Browsing; and Working Email. In all, 156 statements had a five-point scale. The five points were Strongly Agree, Agree, Undecided, Disagree and Strongly Agree.

Table 3.4: Dimension-wise number of items in the ICT Knowledge

Tool	Dimensions	Item Numbers
ICT Knowledge	1. Hardware and Software	1.1-1.26
	2. Operating System	2.1-2.15
	3. Working with Word Processor	3.1-3.25

	4. Working with Images	4.1-4.20
	5. Working with Audio and Video	5.1-5.10
	6. Working with Spreadsheet	6.1-6.15
	7. Internet, Web Browser and Browsing	7.1-7.30
	8. Working with an Email	8.1-8.15

Tool 2: Attitude towards ICT Scale

There were four dimensions of attitude towards ICT. These were the technical aspects of handling ICT; Pedagogical usability of ICT; Social and ethical aspects related to ICT; and Professional use of ICT. In all, 34 statements had a five-point scale. The five points were Strongly Agree, Agree, Undecided, Disagree and Strongly Agree.

Table 3.5: Dimension-wise number of items of the Attitude towards ICT

Tool	Dimensions	Items
Attitude towards ICT	1. Technical aspect of handling ICT	4*, 5*, 9, 13*, 15*
	2. Pedagogical usability of ICT	1, 2, 3, 6, **10***, 11, 20, 21, 24, 25, 32, 34
	3. Social and ethical aspects related to ICT	**8***,**14***, 16, 17, **18***, **19***, 26, 33
	4. Professional use of ICT	7, **12***, 22, 23, 27, 28, 29, 30, 31

*****Negative Items of Attitude towards ICT scale are: 4, 5, 8, 10, 12, 13, 14, 15, 18, 19

Tool 3: Confidence in using the ICT Scale

The three dimensions of this scale were Handling ICT Tools; Managing the use of ICT to learn and teach; and Solving the issues arising during the use of ICT. In all, 10 statements had a five-point scale. The five points were Strongly Agree, Agree, Undecided, Disagree and Strongly Agree.

Table 3.6: Dimension-wise number of items in the Confidence in using ICT

Tools	Dimensions	Items
Confidence in using ICT	1. Handling ICT Tools	1,2,7,10
	2. Managing the use of ICT to learn and teach	3,5,6
	3. Solving the issues arising during the use of ICT	4,8,9

3.2.1 Validity & Reliability

Validation of Tool: The validity and reliability of the scales employed in research are critical aspects that allow the research to provide useful results. For this reason, it is important to understand how researchers appropriately assess the scales' reliability and validity (Surucu & Maslakci, 2020). A research study may comprise only part of the methodological subspace's elements, which include scientific standards, procedures, and principles. Examples of these elements are validity systems. This subspace is utilized in substantive research to establish knowledge claims and comprises information derived from methodological research (Lund, 2022).

The literature synthesis produced themes and codes for item development in scale based on worldwide and Indian research papers, reports, and policy guidelines, as well as the identified research deficit. The expert members structured the questions and items on the background variables and dimensions of the scale using the themes and codes. The scale contains three tools and 15 dimensions, Individual Items were developed using the dimensions. The items were labeled as Strongly Agree, Agree, Neutral, Disagree and Strongly Disagree. The scale has four parts which are mentioned below:

Part 1:Demographic information of respondents (Personal information)

Part 2: ICT Knowledge

Part 3: Attitude towards ICT

Part 4: Confidence in using ICT

The developed questions on the background variables and items under each dimension were then examined for face validity and content validity by the national-level experts. Based on their validity examination, some items were removed, and a few were added.

- **Face Validity:** Face validity was checked by the research team members first, and then by the Program Coordinator, 200 questions and 15 dimensions were finalized.
- **Content Validity**. The rating scale was validated by 7 experts in the field. Later, the panel of experts was formed based on expertise in psychology, sociology, law, and educational technology; a minimum of five years of experience in concerned fields was required. Three professors and four assistant professors constituted the panel of experts.

The experts' suggestions regarding objectivity, and suitability of items were taken into consideration. Language difficulty was removed by replacing difficult words with easy ones. In the final rating scale out of 250 items, 200 items were selected and reframed according to the need of the study and the rest were removed. All the suggestions given by experts were incorporated into the final tool. It is only after the validation; that the tool was administered to the sample.

To determine the flaws and limitations and to achieve reliability and validity of the rating scale, pilot testing was done on a small sample of 25 secondary school teachers. It enables us to refine the instrument and make necessary improvements before the final implementation. A pilot test was conducted on 25 in-service teachers to ensure the accuracy of items and whether it addressed research questions or not.

Reliability of Research Tool:

Reliability refers to the consistency and stability of a measurement over repeated administrations or observations. A reliability score close to 1.0 indicates a high level of consistency, meaning that the measurement is highly dependable and yields similar results under consistent conditions. The statistical analysis was conducted using version 28.0 of the Statistical Package for the Social Sciences (SPSS). Cronbach's alpha was used to determine the CSSAS quality score's internal consistency. A reliability score of 0.9933 was derived from statistical analyses, indicating that the measurement instrument has demonstrated exceptional reliability in the context of the research study. In research, a reliability score of 0.9933 typically indicates a very high level of reliability of the tool. It also suggests that the measurement instrument or tool used in the study demonstrates an extremely high level of consistency and stability. This high reliability score implies that the measurement is highly trustworthy and can be relied upon to produce consistent and accurate results across multiple administrations or observations.

Table 3.7: Scoring Key

Response Variables	Positive Item Scoring	Negative Item Scoring
Strongly Agree	5	1
Agree	4	2
Neutral	3	3
Disagree	2	4
Strongly Disagree	1	5

Table 3.8: Tool-wise Maximum and Minimum Scores

Tool	Maximum Score	Minimum Score
ICT Knowledge	780	156
Attitude towards ICT	170	34
Confidence in using ICT	50	10
Total	**1000**	**200**

3.3 Intervention Package

The Intervention Package is designed to enhance in-service secondary school teachers' digital competencies through the Techno-Pedagogy Content Integration (TPCI) Program. It includes

both face-to-face and online training modules covering key aspects of technology integration in teaching. The package features a blend of workshops, interactive sessions, and practical exercises, supported by resources such as instructional guides and online forums. The training is structured to provide ongoing support and feedback, with effectiveness evaluated through pre- Mid and post-intervention assessments of teachers' knowledge, attitude, and confidence in using technology.

Design of Intervention Package:

The Techno-Pedagogical Content-integrated (TPCI) Training package for intervention is designed, developed, and implemented into two courses namely,

- ICT Basics
- ICT Pedagogy Integration

The intervention package comprises two distinct modes: Face-to-face and Online, designed to enhance digital competencies among in-service secondary school teachers. The ICT Basics course includes 16 modules, while the ICT Pedagogy Integration course consists of 11 modules. Each course encompasses a detailed course outline, objectives, assignments, assessment activities, and practical sessions. The training package was created using the ADDIE instructional design framework, providing a systematic approach to developing the course content. The effectiveness of the intervention was evaluated through a structured testing process involving two distinct groups.

- Experimental Group 1
- Experimental Group 2

Experimental Group 1 received face-to-face training, where participants engaged in offline sessions for the ICT Basics intervention., while Group 2 participated in Online training. Both groups first completed a Pre-test to assess their initial digital competencies. After the Pre-test, the ICT Basics intervention package was delivered according to their respective modes: Face-to-face for Experimental Group 1 and Online for Experimental Group 2. The intervention covered key topics listed below.

Course 1: ICT Basics		
Module Number	**Title of the Module**	**Content Outline of the Module**
Module 1	Communication through Images	-Images: Source of Communication -Creating an image as a piece of communication -Storing and Retrieving images.
Module 2	Communicating through Audio and Video	-Audio and Video as forms of non-textual communication -Creating audio/video-based communication -Storing and retrieving audio/videos
Module 3	Communicating through text	-Scope of Text-based communication

		-Creation of Text-based Communication using text editor -Creation of Text-based Communication using word processor
Module 4:	Communicating through Data	-Need and Scope of Data -Comprehending and responding to the data.
Module 5	Bringing Together Hardware and Software	-Concept Hardware and Software -Handling Hardware -Interacting with Software -Hardware and Software - Safety
Module 6	Introduction to Browser and Browsing	-Internet as the Window to the World -Web Browser -Website and Webpages -Navigating a website
Module 7	Accessing information through the web (Text)	-Scope of Web Search -Searching information on the web -Saving information
Module 8	Exploring Web Resources- I (Images)	-Possibilities of an image search -Search images -Downloading and saving images
Module 9	Communication through Email	-Understanding Email as a mode of digital communication -Setting up an Email Account -Composing and Sending an email -Receiving, Replying and forwarding an email
Module 10	Exploring Web resources-II (Documents and Multimedia)	-Possibilities of multimedia resources -Accessing audio and video resources from the web -Accessing other media resources from the web
Module 11:	Working with data - Exploring spreadsheets I	-Need and scope of handling data -Collection of data in a spreadsheet -Organising data in a spreadsheet -Analysing data
Module 12	Working with data - Exploring Spreadsheet II	-Need and scope for visualizing data -Types of Graphical Data -Creation of a chart -Customization of Chart -Saving the Charts and tables

Module 13	Working with text - Exploring word processor	-Working with symbols & formulae -Working with Images -Inserting tables -Working with media resources -Compiling document -Printing document
Module 14	ICT in the classroom - Hardware and Software	-ICT Environment in a School -Connecting and using various devices in the Classroom -ICT environment in Online Class
Module 15	Features to enable accessibility	-Need for accessibility features. -Accessibilities features of desktop. -Accessibilities features of mobile. -Accessibilities features of browsers.
Module 16	Communicating and Learning Using ICT	-Learning through communication -Learning through e-resources -Learning through online courses

After completing the ICT Basics intervention, a Mid-test was administered to both Experimental groups to assess their progress. Subsequently, both groups engaged in the ICT Pedagogy Integration intervention, which was delivered through online mode. This component of the training focused on the advanced integration of technology into teaching practices. The following ICT Pedagogy Integration modules are listed below.

Course 2: ICT Pedagogy Integration		
Module Number	**Title of the Module**	**Content Outline of the Module**
Module 1	Policy Perspectives on Educational Technology as Envisioned in NEP (2020), NCF-FS (2022), NCF-SE (2023)	-An Overview of Educational Technology. -NEP 2020 and Educational Technology -Recommendations of NEP 2020 for leveraging Technology in Education -Emerging and Disruptive Technologies in the light of NEP 2020 -Digital Initiatives of the Government of India
Module 2	Leveraging Digital Technology in Education	-Leveraging Digital Technology in Education: An Overview -Digital Initiatives in School Education -ePathshala -NISHTHA -ICT in School Curriculum -Capacity Building on Educational Technology (ET) and ICT -Recommendations for Future Enhancement

Module 3	Open Educational Resources and FOSS	-Open Educational Resource -Definition of eContent -Process of Curation, Benefits and Limitations of Content Curation -Need for Creation of OERs -FOSS for Developing eContent
Module 4:	Visual Resources: Concept, Scope, Formats and Process of Development	-Concept of Visual Resources -Scope of Visual Resources -Forms/Types of Visual Resources -Repository of Visual Resources -Digital Tools for Developing Visual Resources -Development of Visual Resources
Module 5	Audio Video Resources: Concept, Scope, Formats and Process of Development	-Concept, Scope and Types of Audio and Video Resources -Online Repository of Audio and Video Resources -Digital Tools for Developing Audio and Video Resources -Audio Resources Development Process -Video Resources Development Process
Module 6	Interactive Resources: Concept, Scope, Formats and Process of Development Process	-Concept of Interactive Resources -Scope of Interactive Resources -Types/Format of Interactive Resources -Best practices to create reusable interactive resources
Module 7	Collaborative Tools for Teaching, Learning and Assessment	-Concept of Collaborative Tools -Scope of Collaborative Tools -Types/Format of Collaborative Tools -Collaborative Tools for Developing Resources -Collaborative Tools for Assessment -Tools for Collaborative Activities
Module 8(a)	Subject-Specific Resources and Tools: English	-Types/Format of Subject-Specific Tools -Software for English Teaching -English Writing tools -Reference Websites or Language Teachers -Mobile Apps for English
Module 8(b)	Subject-Specific Resources and Tools: Mathematics	-Introduction to Mathematical ICT tools -Web Applications for Mathematics Instruction -Mobile Applications (Apps) for Mathematics Learning -Software for Mathematics Education -Exploring ICT Resources for Mathematical Literacy
Module 8(c)	Subject-Specific Resources and Tools: Science	-Introduction to Simulation and Modeling -Exploring Virtual Lab Environments -Conducting Experiments and Observations

		-Building and Manipulating Molecular Structures -Online Collaboration Platforms
Module 8(d)	Subject-Specific Resources and Tools: Social Sciences	-Importance of ICT integration in Social Science learning -Exploring the benefits and challenges of using ICT in the classroom -Overview of diverse subject-specific ICT tools available -Understanding ethical considerations and responsible online practices
Module 9	Mobile Apps for Teaching, Learning and Assessment	-Types of mobile applications. -Criteria for selecting appropriate mobile applications. -Integration of mobile applications in teaching and learning. -Exemplars for Education mobile applications -Installing an app on a mobile phone. -Managing permissions while installing a mobile app.
Module 10	Digital Tools for Assessment	-Differentiate between formative and summative assessment -Explain the scope of digital tools for assessment -Enlist various digital tools for assessment -Enumerate digital tools for formative assessment and summative assessment -Select and use various digital tools for assessment in their classrooms

After completing the ICT Pedagogy Integration intervention, both Experimental groups were administered post-tests to evaluate the impact of the training on their digital competencies. These post-tests were conducted in Online mode to maintain consistency with the delivery method of the ICT Pedagogy Integration component. The post-tests aimed to measure the effectiveness of the intervention by assessing changes in participants' knowledge, attitude and Confidence towards the integration of ICT into teaching practices. The tests were designed to cover all aspects of the ICT Pedagogy Integration modules listed above.

3.4 Procedural of Data Collection:

The study aims to compare the ICT competence of in-service teachers following interventions delivered in both face-to-face and online modes. The CIET department issued a formal letter to the principals of both government and private schools, inviting them to participate in the intervention. Upon receiving approval from the principals, participants were selected and divided into two Experimental groups: Experimental Group I and Experimental Group II. A five-day workshop was conducted, with Experimental Group I attending in person while Experimental Group II received the intervention online. A pre-test was done on the participants to assess their knowledge, attitude, and confidence in using ICT tools. The first intervention, "ICT Basics," consists of 16 modules. Following this, a mid-test was administered to evaluate the teachers' understanding.

After 15 days, a second workshop was held online for both groups. This second intervention, "ICT Pedagogy Integration," consisted of 11 modules focusing on the advanced use of technology in the classroom. During this workshop, participants engaged with instructional modules and activities designed to enhance their ICT competencies and encourage positive attitudes toward ICT integration in education. A post-test, using the ICT Pedagogy Integration, was conducted to assess the participants' knowledge, attitude, and confidence in utilizing ICT in the classroom. Finally, participants were invited to share their feedback on their experiences with the course, providing valuable insights into its effectiveness and areas for improvement. This structured framework ensures a systematic and thorough evaluation of the intervention's impact on the targeted outcomes, enabling evidence-based conclusions and recommendations for teacher professional development.

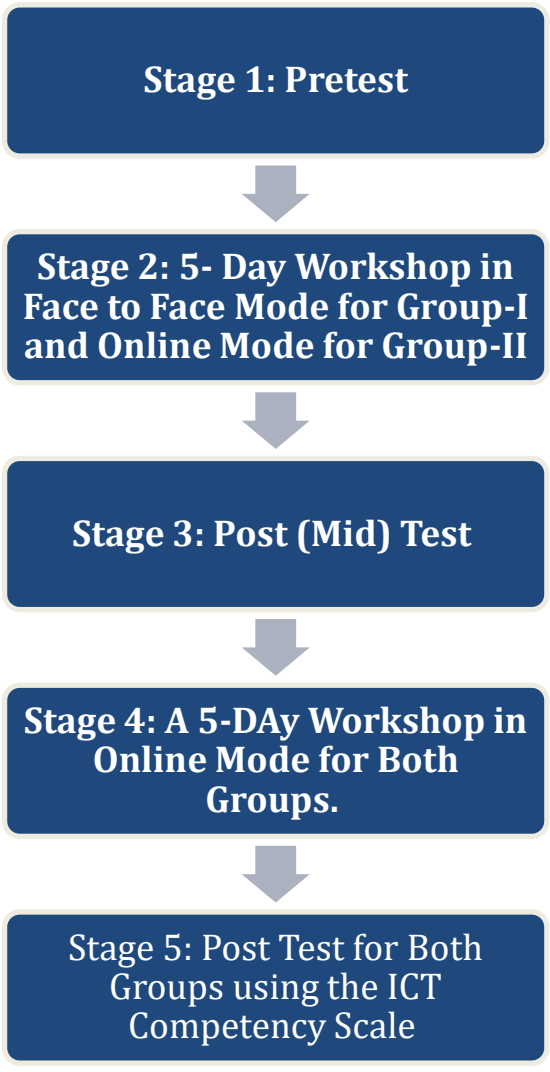


Figure 3.1: Procedural Framework for the study

3.5 Feedback Analysis

This feedback form is designed to gather your experiences, insights, and recommendations concerning the training on ‘Techno-Pedagogy Content Integration (TPCI)” on ICT basics and ICT Pedagogy Integration. This study aimed to assess how effectively the training addressed your needs, the quality of the content and delivery, and any areas where improvements could

be made. The analysis revealed that the FACE-TO-FACE mode of training was significantly more effective in enhancing participants' competencies in ICT Basics compared to the Online mode. Specifically, the FACE-TO-FACE training showed substantial improvements in three key areas: ICT Knowledge, Attitude towards ICT, and Confidence in using ICT. In contrast, the Online mode was found to be less effective. However, it was noted that the Online mode had some success in improving participants' ICT Knowledge within the ICT Pedagogy Integration. This means that while Online training is useful for some aspects of ICT Pedagogy Integration, it wasn't as effective as blended training for the broader ICT Basics as well as ICT Pedagogy Integration.

3.6 Statistical Techniques for Data Analysis

The quantitative data was analyzed under descriptive and inferential parameters. The items which are in the scale have five-point rating scale connotations based on the connotations with respect to digital Competency. Each item has 5 responses. All items that are labeled as true have responses as strongly agree, agree, undecided, disagree, and strongly disagree with scoring 5, 4, 3, 2, and 1, respectively. All items that are labeled as false have responses as strongly disagree, disagree, undecided, agree, and strongly agree with scoring 1,2,3,4,5, respectively. The results were presented in tables and figures. The quantitative data was analyzed under descriptive and inferential parameters. Ms-Excel was used for Descriptive analysis, and SPSS Software for inferential analysis; t-test, and ANOVA were used. The result was presented in tables and figures.

CHAPTER 4: ANALYSIS AND INTERPRETATION OF DATA

4.1. Introduction

The data interpretation and analysis are quite important. If the data is not correctly analyzed and understood, it has no meaning in and of itself. It might be accurate to state that, generally speaking, research consists of two major steps: data collecting and data analysis. Interpretation necessitates critically reviewing the analysis findings in the context of all the data's constraints. No matter how legitimate, trustworthy, and sufficient the data is, it is only useful if it is thoroughly examined, methodically categorised, scientifically tallied, edited, and logically concluded.

All researchers must understand that the successful completion of their goals depends not only on careful data collection and tool selection but also on having sufficient expertise in applying statistical analysis. The process of changing data in order to extract meaningful information and facilitate conclusion-making is known as data analysis. The process of methodically using statistical and/or logical tools to explain, illustrate, summarize, and assess data is known as data analysis.

To make sense of the raw data gathered, it is required to organize, analyze, and analyze the data before drawing conclusions and making generalizations. The objective material that the researcher possesses as well as objective responses to extract underlying meanings from the data in connection to the issue is both involved in the analysis and interpretation of the data. The process of deriving conclusions from the data gathered during an analytical and experimental investigation is known as interpretation. It's an attempt to interpret research findings more broadly. There are two main components to the task of interpretation: (1) attempting to create a sense of continuity in the research by establishing connections between the findings of different studies, and (2) developing some conceptual frameworks for explanation.

Using a variety of statistical approaches, the researcher has attempted to examine and interpret the data from the current investigation. This study aims to determine the effectiveness of Techno Pedagogical Content Integration of in-service teachers' ICT knowledge, attitude towards ICT and confidence in using ICT. This chapter is devoted to the analysis of the information gathered through the use of ICT knowledge, attitude towards ICT and confidence in using ICT scales as well as the ICT Basic and the ICT Pedagogy Integration.

4.2 Tool Wise Description

Table 4.1: Mean and standard deviation obtained on the Pre-Mid- Post-test performance of the teachers

Tool	Treatment	N	M	SD
ICT Knowledge	Pre	75	454.07	156.612
	Mid	75	663.45	128.662
	Post	75	663.72	127.407

Attitude towards ICT	Pre	75	135.11	16.616
	Mid	75	132.95	19.452
	Post	75	132.59	20.002
Confidence in using ICT	Pre	75	33.17	8.983
	Mid	75	39.20	9.187
	Post	75	40.44	7.762

The treatment had a significant impact on ICT knowledge, attitudes towards ICT, and confidence in using ICT, though the effects varied across these dimensions. Participants' mean scores for ICT knowledge increased significantly from 454.07 in the pre-test to 663.45 in the mid-data, and this progress was sustained in the post-data with a mean score of 663.72. This indicates that the intervention successfully enhanced participants' knowledge and maintained these improvements over time.

Despite the significant improvements observed in participants' ICT knowledge and confidence, attitudes towards ICT showed a different trend. Specifically, mean scores for attitudes towards ICT decreased from 135.11 in the pre-data to 132.95 in the mid-data, and further to 132.59 in the post-data. This reflects a modest overall decline in attitudes towards ICT. The pattern suggests that while the intervention effectively enhanced participants' knowledge and confidence in using ICT, it did not have a positive impact on their attitudes towards ICT. In fact, their attitudes slightly worsened throughout the study. This indicates that the intervention may not have addressed or influenced the factors affecting participants' attitudes towards ICT as effectively as it did their ICT knowledge and confidence in using ICT.

The mean scores for confidence in using ICT increased significantly from 33.17 at the pre-data to 39.20 at the mid-data, and further to 40.44 at the post-data. This upward trend indicates a notable enhancement in participants' confidence in using ICT. The results demonstrate that the treatment effectively increased participants' confidence and that this improvement was not only sustained but slightly enhanced over time.

Overall, the treatment was successful in raising ICT knowledge and confidence in using ICT, and these gains have either been maintained or somewhat increased. Nonetheless, the small decline in mean scores indicates that the treatment had no beneficial impact on attitude towards ICT.

4.2.1 Analysis of data related to Knowledge, Attitude, and Confidence in using ICT among in-service teachers at the secondary level in Experimental Group 1.

Note:

- ICT Knowledge: Knowledge
- Attitude towards ICT: Attitude
- Confidence in using ICT: Confidence
- ICT Pedagogy Integration in Teaching, Learning and Assessment: ICT Pedagogy Intervention
- Techno Integration Competency Intervention: TIC Intervention

H_1: There is no significant difference in Knowledge, Attitude, and Confidence across all dimensions from pre-data to mid-data with the ICT Basic Intervention Package in a face-to-face mode among in-service teachers.

$H_{1.1}$: There is no significant difference in Knowledge across all dimensions from pre-data to mid-data with the ICT Basic Intervention Package.

Table 4.2: Testing-wise M, SD, N and correlated t-values of towards ICT Knowledge and its' dimensions separately of in-service Teachers

Variable	Testing	M	SD	N	Correlated t-value	Remark
ICT knowledge	Pre Mid	455.78 691.93	149.96 96.753	41	19.517	p<0.01
Hardware & Software dimension	Pre Mid	77.39 110.73	26.339 18.736	41	18.814	p<0.01
Operating System dimension	Pre Mid	35.24 60.15	15.144 12.295	41	14.902	p<0.01
Working with word processor dimension	Pre Mid	71.17 113.76	29.368 16.595	41	15.517	p<0.01
Working with image dimension	Pre Mid	67.10 91.78	19.649 11.924	41	21.865	p<0.01
Working with audio and video dimension	Pre Mid	36.07 45.20	10.66 6.600	41	21.655	p<0.01
Working with spreadsheet dimension	Pre Mid	42.15 69.12	15.819 9.605	41	17.060	p<0.01
Internet, web browser & browsing dimension	Pre Mid	78.32 132.59	30.514 18.735	41	16.434	p<0.01
Working with an email dimension	Pre Mid	48.34 68.61	17.023 8.625	41	18.183	p<0.01

From the above table, there was a significant increase in ICT knowledge from the pre-test (M = 455.78) to the mid-test (M = 691.93). The high t-value of 19.517 and the significance level ($p < 0.01$) indicate that this change is statistically significant. This suggests that the intervention effectively enhanced participants' ICT knowledge. Similarly, scores for the hardware and software dimension increased from 77.39 to 110.73 (t-value = 18.814, $p < 0.01$), and the operating system dimension improved from 35.24 to 60.15 (t-value = 14.902, $p < 0.01$). The working with word processor dimension increased from 71.17 to 113.76 (t-value = 15.517, $p < 0.01$), while the working with images dimension showed growth from 67.10 to 91.78 (t-value = 21.865, $p < 0.01$). The working with audio and video dimensions improved from 36.07 to

45.20 (t-value = 21.655, $p < 0.01$), and the spreadsheet dimension increased from 42.15 to 69.12 (t-value = 17.060, $p < 0.01$). Knowledge of the internet and browsing increased significantly from 78.32 to 132.59 (t-value = 16.434, $p < 0.01$), and skills in working with email improved from 48.34 to 68.61 (t-value = 18.183, $p < 0.01$). These results indicate that the intervention effectively enhanced participants' ICT knowledge across all areas tested.

$H_{1.2}$: There is no significant difference in Attitude across all dimensions from pre-data to mid-data with the ICT Basic Intervention Package.

Table 4.3: Testing-wise M, SD, N and correlated t-values of Attitude towards ICT and its' dimensions separately of in-service Teachers

Variable	Testing	M	SD	N	Correlated t-value	Remark
Attitude towards ICT	Pre Mid	139.39 137.29	12.824 18.965	41	69.601	p<0.01
Technical aspects of handling ICT	Pre Mid	17.27 16.37	4.599 4.443	41	24.042	p<0.01
Pedagogical utility of ICT	Pre Mid	42.80 52.49	3.116 7.746	41	87.954	p<0.01
Social and Ethical aspects related to ICT	Pre Mid	30.66 29.44	4.252 4.517	41	41.732	p<0.01
Professional use of ICT	Pre Mid	39.29 39.00	3.970 6.241	41	40.013	p<0.01

From the above table, the analysis of Attitudes towards ICT revealed nuanced changes across different dimensions from the pre-test to the mid-test. Overall, the mean score for attitudes towards ICT slightly decreased from 139.39 to 137.29, with a high t-value of 69.601 ($p < 0.01$), indicating a significant but minimal decline. In terms of specific dimensions, attitudes towards the technical aspects of handling ICT saw a reduction from 17.27 to 16.37, with a t-value of 24.042 ($p < 0.01$), reflecting a notable decline in this area. Conversely, the pedagogical utility of ICT showed a significant improvement, with the mean score increasing from 42.80 to 52.49 and a t-value of 87.954 ($p < 0.01$), indicating enhanced positive attitudes towards the use of ICT for teaching purposes. Attitudes regarding the social and ethical aspects related to ICT decreased slightly from 30.66 to 29.44, with a t-value of 41.732 ($p < 0.01$), showing a significant but minor decline in perceptions of these aspects. Finally, attitudes towards the professional use of ICT remained relatively stable, with the mean score decreasing marginally from 39.29 to 39.00 and a t-value of 40.013 ($p < 0.01$), suggesting that attitudes in this dimension were stable but still significantly measured. In summary, while there was a slight overall decline in attitudes towards ICT, improvements were observed in the pedagogical utility dimension, whereas technical aspects and social/ethical considerations saw minimal declines.

$H_{1.3}$: There is no significant difference in Confidence across all dimensions from pre-data to mid-data with the ICT Basic Intervention Package.

Table 4.4: Testing-wise M, SD, N and correlated t-values of Confidence in using ICT and its' dimensions separately of in-service Teachers

Variable	Testing	M	SD	N	Correlated t-value	Remark
Confidence in using ICT	Pre Mid	33.56 40.61	8.972 9.303	41	23.951	p<0.01
Handling ICT tools	Pre Mid	13.54 16.32	3.515 3.745	41	24.659	p<0.01
Managing the use of ICT	Pre Mid	10.22 12.20	2.920 2.741	41	22.411	p<0.01
Solving the issues that arise during the use of ICT	Pre Mid	9.80 12.10	2.848 2.914	41	22.044	p<0.01

From the above table, the analysis of confidence in using ICT demonstrated significant improvements across several key dimensions from the pre-test to the mid-test. The overall confidence in using ICT increased from a mean score of 33.56 to 40.61, with a high t-value of 23.951 ($p < 0.01$), indicating a substantial and statistically significant enhancement in participants' confidence. In terms of handling ICT tools, confidence improved from 13.54 to 16.32, with a t-value of 24.659 ($p < 0.01$), reflecting a significant increase in participants' ability to handle various ICT tools effectively. Similarly, confidence in managing the use of ICT increased from 10.22 to 12.20, with a t-value of 22.411 ($p < 0.01$), indicating a notable improvement in managing ICT resources. Finally, participants' confidence in solving issues that arise during the use of ICT increased from 9.80 to 12.10, with a t-value of 22.044 ($p < 0.01$), demonstrating a significant gain in their problem-solving abilities related to ICT. Overall, these results show that the intervention effectively enhanced participants' confidence across all tested dimensions related to using and managing ICT.

H2: There is no significant difference in Knowledge, Attitude, and Confidence across all dimensions from mid-data to post-data with the ICT Pedagogy intervention in an Online mode among in-service teachers.

$H_{2.1}$: There is no significant difference in Knowledge across all dimensions from mid-data to post-data with the ICT Pedagogy intervention.

Table 4.5: Testing-wise M, SD, N and correlated t-values of ICT knowledge and its' dimensions separately of in-service Teachers

Variable	Testing	M	SD	N	Correlated t-value	Remark
ICT knowledge	Mid Post	691.93 683.71	96.753 104.489	41	45.792	p<0.01
Hardware & Software dimension	Mid Post	110.73 113.80	18.736 17.770	41	37.842	p<0.01

Operating System dimension	Mid Post	60.15 60.73	12.295 12.588	41	31.323	p<0.01
Working with word processor dimension	Mid Post	113.76 108.73	16.595 21.824	41	43.893	p<0.01
Working wimageages dimension	Mid Post	91.78 90.24	11.924 14.766	41	49.287	p<0.01
Working with audio and video dimension	Mid Post	45.20 44.59	6.600 6.906	41	43.336	p<0.01
Working with spreadsheet dimension	Mid Post	69.12 66.51	9.605 12.050	41	46.079	p<0.01
Internet, web browser & browsing dimension	Mid Post	132.59 131.95	18.735 21.423	41	45.314	p<0.01
Working with an email dimension	Mid Post	68.61 67.15	8.625 10.461	41	50.934	p<0.01

From the above table, the analysis of ICT knowledge from the mid-test to the post-test indicates several noteworthy trends. Overall, the mean score for ICT knowledge slightly decreased from 691.93 to 683.71, with a t-value of 45.792 ($p < 0.01$), suggesting a minor but statistically significant reduction in overall knowledge while still maintaining a high level. In specific dimensions, hardware and software knowledge increased from 110.73 to 113.80 (t-value = 37.842, $p < 0.01$), reflecting a significant improvement. Knowledge in the operating system dimension increased marginally from 60.15 to 60.73 (t-value = 31.323, $p < 0.01$), indicating a slight but significant gain. Conversely, there was a decrease in working with word processors from 113.76 to 108.73 (t-value = 43.893, $p < 0.01$) and in working with images from 91.78 to 90.24 (t-value = 49.287, $p < 0.01$), both showing significant but minor reductions. Knowledge in handling audio and video slightly decreased from 45.20 to 44.59 (t-value = 43.336, $p < 0.01$), and in working with spreadsheets from 69.12 to 66.51 (t-value = 46.079, $p < 0.01$), indicating small but significant declines. The internet, web browser, and browsing dimension saw a slight decrease from 132.59 to 131.95 (t-value = 45.314, $p < 0.01$), and working with email knowledge decreased from 68.61 to 67.15 (t-value = 50.934, $p < 0.01$), both showing significant but minor reductions. Overall, while the intervention resulted in some minor declines in specific areas, it effectively maintained or improved knowledge in most ICT dimensions.

$H_{2.2}$: There is no significant difference in Attitude across all dimensions from mid-data to post-data with the ICT Pedagogy intervention.

Table 4.6: Testing-wise M, SD, N and correlated t-values of Attitude towards ICT and its' dimensions separately of in-service Teachers

Variable	Testing	M	SD	N	Correlated t-value	Remark
Attitude towards ICT	Mid Post	137.29 135.37	18.965 20.010	41	46.355	p<0.01
Technical aspects of handling ICT	Mid Post	16.37 16.27	4.443 4.410	41	23.587	p<0.01
Pedagogical utility of ICT	Mid Post	52.49 51.59	7.746 8.795	41	43.386	p<0.01
Social and Ethical aspects related to ICT	Mid Post	29.44 29.41	4.517 4.770	41	41.732	p<0.01
Professional use of ICT	Mid Post	39.00 38.10	6.241 6.564	41	40.013	p<0.01

From the above table, the analysis of attitudes towards ICT from the mid-test to the post-test reveals some significant but modest changes. Overall, attitudes towards ICT slightly declined from a mean score of 137.29 to 135.37, with a t-value of 46.355 ($p < 0.01$), indicating a statistically significant but minor reduction. In the dimension of technical aspects of handling ICT, attitudes decreased slightly from 16.37 to 16.27 (t-value = 23.587, $p < 0.01$), reflecting a small but significant decline in perceptions of technical handling. For the pedagogical utility of ICT, attitudes fell from 52.49 to 51.59 (t-value = 43.386, $p < 0.01$), showing a significant decrease in views on the educational value of ICT. In terms of social and ethical aspects related to ICT, scores dropped slightly from 29.44 to 29.41 (t-value = 41.732, $p < 0.01$), indicating a minimal yet significant decline in attitudes towards these aspects. Finally, professional use of ICT saw a decrease from 39.00 to 38.10 (t-value = 40.013, $p < 0.01$), reflecting a small but significant reduction in attitudes towards the professional application of ICT. Overall, the intervention resulted in statistically significant but relatively minor reductions in attitudes across various dimensions, suggesting that while there were some decreases, the overall impact on attitudes was limited.

$H_{2.3}$: There is no significant difference in Confidence across all dimensions from mid-data to post-data with the ICT Pedagogy intervention.

Table 4.7: Testing-wise M, SD, N and correlated t-values of Confidence in using ICT and its' dimensions separately of in-service Teachers

Variable	Testing	M	SD	N	Correlated t-value	Remark
Confidence in using ICT	Mid Post	40.61 41.68	9.303 7.157	41	27.951	p<0.01
Handling ICT tools	Mid Post	16.32 16.76	3.745 2.922	41	27.902	p<0.01

Managing the use of ICT	Mid Post	12.20 12.68	2.741 2.067	41	28.492	p<0.01
Solving the issues that arise during the use of ICT	Mid Post	12.10 12.24	2.914 2.343	41	26.585	p<0.01

From the above table, the analysis of confidence in using ICT from the mid-test to the post-test shows clear improvements across all measured dimensions. Overall, participants' confidence in using ICT increased from a mean score of 40.61 in the mid-test to 41.68 in the post-test, with a significant t-value of 27.951 ($p < 0.01$), indicating a notable enhancement in their general confidence with ICT. Specifically, confidence in handling ICT tools rose from 16.32 to 16.76, with a t-value of 27.902 ($p < 0.01$), demonstrating improved ability and assurance in using various ICT tools. Similarly, confidence in managing the use of ICT increased from 12.20 to 12.68 (t-value = 28.492, $p < 0.01$), reflecting better skills in overseeing ICT resources. Additionally, participants' confidence in solving issues that arise during the use of ICT grew slightly from 12.10 to 12.24, with a t-value of 26.585 ($p < 0.01$), showing enhanced capability in troubleshooting ICT problems. Overall, the data indicates significant improvements in confidence across all areas, suggesting that the intervention effectively boosted participants' competence and assurance in various aspects of ICT usage.

H3: There is no significant difference in Knowledge, Attitude, and Confidence across all dimensions from pre-data to post-data with the TIC intervention in an Online mode among in-service teachers.

$H_{3.1}$: There is no significant difference in Knowledge across all dimensions from pre-data to post-data with the TIC intervention.

Table 4.8: Testing-wise M, SD, N and correlated t-values of ICT knowledge and its' dimensions separately of in-service Teachers

Variable	Testing	M	SD	N	Correlated t-value	Remark
ICT knowledge	Pre Post	455.78 683.71	149.530 104.489	41	19.517	p<0.01
Hardware & Software dimension	Pre Post	77.39 113.80	26.339 17.770	41	18.814	p<0.01
Operating System dimension	Pre Post	35.24 60.73	15.144 12.588	41	14.902	p<0.01
Working with word processor dimension	Pre Post	71.17 108.73	29.368 21.824	41	15.517	p<0.01
Working with image dimension	Pre Post	67.10 90.24	19.649 14.766	41	21.865	p<0.01
Working with audio and video dimension	Pre Post	36.07 44.59	10.666 6.906	41	21.655	p<0.01

Working with spreadsheet dimension	Pre Post	42.15 66.51	15.819 12.050	41	17.060	p<0.01
Internet, web browser & browsing dimension	Pre Post	78.32 131.95	30.514 21.423	41	16.434	p<0.01
Working with an email dimension	Pre Post	48.34 67.15	17.023 67.15	41	18.183	p<0.01

From table, 4.7 the data analysis demonstrated that there is a significant improvement in digital competencies following the intervention. Overall ICT knowledge increased markedly from a pre-test mean of 455.78 to a post-test mean of 683.71, with a t-value of 19.517 ($p<0.01$), indicating a comprehensive enhancement in participants' understanding. Specific dimensions also showed notable gains: Hardware & Software knowledge improved from 77.39 to 113.80 ($t=18.814$, $p<0.01$); Operating System skills increased from 35.24 to 60.73 ($t=14.902$, $p<0.01$); proficiency in Word Processing rose from 71.17 to 108.73 ($t=15.517$, $p<0.01$); Image Handling skills went up from 67.10 to 90.24 ($t=21.865$, $p<0.01$); Audio and Video competencies improved from 36.07 to 44.59 ($t=21.655$, $p<0.01$); Spreadsheet skills increased from 42.15 to 66.51 ($t=17.060$, $p<0.01$); Internet & Browsing knowledge rose from 78.32 to 131.95 ($t=16.434$, $p<0.01$); and Email skills improved from 48.34 to 67.15 ($t=18.183$, $p<0.01$). These significant changes across all dimensions affirm the effectiveness of the intervention in enhancing participants' digital competencies.

$H_{3.2}$: There is no significant difference in Attitude across all dimensions from pre-data to post-data with the TIC intervention.

Table 4.9: Testing-wise M, SD, N and correlated t-values of Attitude towards ICT and its' dimensions separately of in-service Teachers

Variable	Testing	M	SD	N	Correlated t-value	Remark
Attitude towards ICT	Pre Post	139.39 135.37	12.824 20.010	41	69.601	p<0.01
Technical aspects of handling ICT	Pre Post	17.27 16.27	4.599 4.410	41	24.042	p<0.01
Pedagogical utility of ICT	Pre Post	42.80 51.59	3.116 8.795	41	87.954	p<0.01
Social and Ethical aspects related to ICT	Pre Post	30.66 29.41	4.252 4.770	41	46.168	p<0.01
Professional use of ICT	Pre Post	39.29 38.10	3.970 6.564	41	63.372	p<0.01

From the above table, the data analysis revealed that there is a significant change in participants' attitudes towards ICT across various dimensions. Overall, attitudes towards ICT slightly decreased from a pre-test mean of 139.39 to a post-test mean of 135.37, with a significant t-

value of 69.601 ($p<0.01$). In specific dimensions, technical aspects of handling ICT decreased from 17.27 to 16.27 ($t=24.042$, $p<0.01$), indicating a notable reduction in technical confidence. Conversely, the pedagogical utility of ICT increased significantly from 42.80 to 51.59 ($t=87.954$, $p<0.01$), reflecting improved perceptions of ICT's usefulness in teaching. The social and ethical aspects related to ICT saw a slight decrease from 30.66 to 29.41 ($t=46.168$, $p<0.01$), and the professional use of ICT also decreased from 39.29 to 38.10 ($t=63.372$, $p<0.01$), suggesting minor reductions in professional integration and awareness. Overall, these significant t-values indicate noteworthy changes in participants' attitudes, highlighting both improvements in pedagogical utility and areas of decline in technical, social, and professional aspects.

$H_{3.3}$: There is no significant difference in Confidence across all dimensions from pre-data to post-data with the TIC intervention.

Table 4.10: Testing-wise M, SD, N and correlated t-values of Confidence in using ICT and its' dimensions separately of in-service Teachers

Variable	Testing	M	SD	N	Correlated t-value	Remark
Confidence in using ICT	Pre Post	33.56 41.68	8.972 7.157	41	23.951	p<0.01
Handling ICT tools	Pre Post	13.54 16.76	3.515 2.922	41	24.659	p<0.01
Managing the use of ICT	Pre Post	10.22 12.68	2.920 2.067	41	22.411	p<0.01
Solving the issues that arise during the use of ICT	Pre Post	9.80 12.24	2.848 2.343	41	22.044	p<0.01

From the above table, the analysis of confidence in using ICT revealed that there are significant improvements across all measured dimensions. Participants' overall confidence increased from a pre-test mean of 33.56 to a post-test mean of 41.68, with a significant t-value of 23.951 ($p<0.01$), indicating a substantial enhancement in their confidence levels. Specifically, handling ICT tools improved from a pre-test mean of 13.54 to a post-test mean of 16.76 ($t=24.659$, $p<0.01$), demonstrating increased proficiency in using these tools. Managing the use of ICT also saw an increase from 10.22 to 12.68 ($t=22.411$, $p<0.01$), reflecting better management skills. Additionally, solving issues arising during ICT use improved from 9.80 to 12.24 ($t=22.044$, $p<0.01$), indicating a greater ability to address and resolve problems. The significant t-values across all dimensions confirm that the intervention effectively enhanced participants' confidence and skills in various aspects of ICT use.

4.2.2 Analysis of data related to Knowledge, Attitude, and Confidence in using ICT among in-service teachers at the secondary level in Experimental Group 2.

H4: There is no significant difference in Knowledge, Attitude, and Confidence across all dimensions from pre-data to mid-data with the ICT Basic Intervention Package in an Online mode among in-service teachers.

$H_{4.1}$: There is no significant difference in Knowledge across all dimensions from pre-data to mid-data with the ICT Basic Intervention Package.

Table 4.11: Testing-wise M, SD, N and correlated t-values of ICT knowledge and its' dimensions separately of in-service Teachers

Variable	Testing	M	SD	N	Correlated t-value	Remark
ICT knowledge	Pre Mid	452.00 626.12	167.004 153.466	34	15.782	p<0.01
Hardware & Software dimension	Pre Mid	73.18 99.00	26.333 26.511	34	16.204	p<0.01
Operating System dimension	Pre Mid	30.41 51.41	15.943 16.770	34	11.123	p<0.01
Working with word processor dimension	Pre Mid	78.74 103.71	31.675 28.549	34	14.494	p<0.01
Working with image dimension	Pre Mid	64.59 86.00	22.796 19.306	34	16.521	p<0.01
Working with audio and video dimension	Pre Mid	33.74 42.79	11.355 9.406	34	17.324	p<0.01
Working with spreadsheet dimension	Pre Mid	43.32 62.03	19.662 17.314	34	12.848	p<0.01
Internet, web browser & browsing dimension	Pre Mid	78.74 121.38	36.668 29.195	34	12.520	p<0.01
Working with an email dimension	Pre Mid	49.29 62.79	17.930 16.629	34	16.031	p<0.01

From the above table, the data analysis indicated that there is a significant improvement in ICT knowledge across various dimensions from pre-test to mid-test. Overall ICT knowledge increased from a pre-test mean of 452.00 to a mid-test mean of 626.12, with a significant t-value of 15.782 ($p<0.01$), reflecting substantial growth in participants' understanding. In specific dimensions, the Hardware & Software dimension improved from a pre-test mean of 73.18 to a mid-test mean of 99.00 ($t=16.204$, $p<0.01$), indicating enhanced skills in this area. The Operating System dimension rose from 30.41 to 51.41 ($t=11.123$, $p<0.01$), showing better familiarity with operating systems. Proficiency in Working with Word Processors increased

from 78.74 to 103.71 (t=14.494, p<0.01), while Working with Images improved from 64.59 to 86.00 (t=16.521, p<0.01). Skills in Working with Audio and Video went up from 33.74 to 42.79 (t=17.324, p<0.01), and Working with Spreadsheets increased from 43.32 to 62.03 (t=12.848, p<0.01). Knowledge in Internet, Web Browser & Browsing rose from 78.74 to 121.38 (t=12.520, p<0.01), and skills in Working with Email improved from 49.29 to 62.79 (t=16.031, p<0.01). These significant changes across all dimensions demonstrate the effectiveness of the intervention in enhancing participants' ICT competencies.

$H_{4.2}$: There is no significant difference in Attitude across all dimensions from pre-data to mid-data with the ICT Basic Intervention Package.

Table 4.12: Testing-wise M, SD, N and correlated t-values of Attitude towards ICT and its' dimensions separately of in-service Teachers

Variable	Testing	M	SD	N	Correlated t-value	Remark
Attitude towards ICT	Pre	129.94	19.223	34	39.416	p<0.01
	Mid	127.71	18.994			
Technical aspects of handling ICT	Pre	16.97	3.555	34	27.838	p<0.01
	Mid	16.09	3.753			
Pedagogical utility of ICT	Pre	39.41	5.182	34	44.345	p<0.01
	Mid	48.00	8.804			
Social and Ethical aspects related to ICT	Pre	28.82	6.068	34	27.699	p<0.01
	Mid	27.82	4.116			
Professional use of ICT	Pre	35.47	6.011	34	34.407	p<0.01
	Mid	35.79	6.786			

From the above table, the analysis of attitudes towards ICT from pre-data to mid-data showed significant changes across various dimensions. Overall, the general attitude towards ICT slightly decreased from a pre-test mean of 129.94 to a mid-test mean of 127.71, with a significant t-value of 39.416 (p<0.01), indicating a minor decline in participants' overall attitude. In specific dimensions, technical aspects of handling ICT decreased from a pre-test mean of 16.97 to a mid-test mean of 16.09, with a t-value of 27.838 (p<0.01), suggesting a reduction in confidence or skill in this area. Conversely, the pedagogical utility of ICT saw a significant increase from a pre-test mean of 39.41 to a mid-test mean of 48.00 (t=44.345, p<0.01), reflecting an improved perception of ICT's usefulness in teaching. The social and ethical aspects related to ICT slightly decreased from a pre-test mean of 28.82 to a mid-test mean of 27.82 (t=27.699, p<0.01), indicating a small reduction in awareness or attitudes towards these issues. Finally, the professional use of ICT increased slightly from a pre-test mean of 35.47 to a mid-test mean of 35.79 (t=34.407, p<0.01), demonstrating a modest improvement in integrating ICT into professional practices. These significant t-values highlight both areas of improvement and minor declines in participants' attitudes towards ICT.

$H_{4.3}$: There is no significant difference in Confidence across all dimensions from pre-data to mid-data with the ICT Basic Intervention Package.

Table 4.13: Testing-wise M, SD, N and correlated t-values of Confidence in using ICT and its' dimensions separately of in-service Teachers

Variable	Testing	M	SD	N	Correlated t-value	Remark
Confidence in using ICT	Pre Mid	32.71 37.50	9.107 8.884	34	20.940	p<0.01
Handling ICT tools	Pre Mid	13.47 15.06	3.527 3.219	34	22.271	p<0.01
Managing the use of ICT	Pre Mid	9.91 11.35	2.800 2.838	34	20.640	p<0.01
Solving the issues that arise during the use of ICT	Pre Mid	9.32 11.09	2.972 2.989	34	18.294	p<0.01

From the above table, the analysis of confidence in using ICT from pre-data to mid-data indicated notable improvements across all measured dimensions. Overall confidence increased from a pre-data mean of 32.71 to a mid-test mean of 37.50, with a significant t-value of 20.940 ($p<0.01$), suggesting a substantial enhancement in participants' self-assurance regarding ICT use. Specific areas also showed improvement: handling ICT tools rose from a pre-test mean of 13.47 to 15.06, with a t-value of 22.271 ($p<0.01$), reflecting enhanced proficiency with these tools. Managing the use of ICT improved from 9.91 to 11.35 ($t=20.640$, $p<0.01$), indicating better skills in overseeing ICT resources. Additionally, the ability to solve issues arising during ICT use increased from 9.32 to 11.09, with a t-value of 18.294 ($p<0.01$), demonstrating improved problem-solving capabilities. These significant t-values confirm that the intervention effectively boosted participants' confidence and competencies in various aspects of ICT usage.

H5: There is no significant difference in Knowledge, Attitude, and Confidence across all dimensions from mid-data to post-data with the ICT Pedagogy intervention in an Online mode among in-service teachers.

$H_{5.1}$: There is no significant difference in Knowledge across all dimensions from mid-data to post-data with the ICT Pedagogy intervention.

Table 4.14: Testing-wise M, SD, N and correlated t-values of ICT knowledge and its' dimensions separately of in-service Teachers

Variable	Testing	M	SD	N	Correlated t-value	Remark
ICT knowledge	Mid Post	629.12 639.62	153.466 148.566	34	23.903	p<0.01
Hardware & Software dimension	Mid Post	99.00 106.12	26.511 22.153	34	21.774	p<0.01
Operating System dimension	Mid Post	51.41 54.03	16.770 16.973	34	17.876	p<0.01

Working with word processor dimension	Mid Post	103.71 106.82	28.549 26.591	34	21.181	p<0.01
Working with image dimension	Mid Post	86.00 86.76	19.306 18.029	34	25.974	p<0.01
Working with audio and video dimension	Mid Post	42.79 43.32	9.406 8.591	34	26.529	p<0.01
Working with spreadsheet dimension	Mid Post	62.03 61.76	17.314 16.339	34	20.890	p<0.01
Internet, web browser & browsing dimension	Mid Post	121.38 117.97	29.195 32.975	34	24.243	p<0.01
Working with an email dimension	Mid Post	62.79 62.82	16.629 15.367	34	22.018	p<0.01

From the above table, the analysis of ICT knowledge from mid-test to post-test highlighted several significant changes. Overall ICT knowledge increased from a mid-test mean of 629.12 to a post-test mean of 639.62, with a significant t-value of 23.903 ($p<0.01$), reflecting an overall enhancement in participants' ICT skills. Specifically, the hardware and software dimension saw an improvement from a mean of 99.00 to 106.12 ($t=21.774$, $p<0.01$). The operating system dimension also showed progress, rising from 51.41 to 54.03 ($t=17.876$, $p<0.01$). Skills in working with word processors improved from 103.71 to 106.82 ($t=21.181$, $p<0.01$), indicating increased proficiency. Although the working with images dimension remained relatively stable, increasing slightly from 86.00 to 86.76 ($t=25.974$, $p<0.01$), the knowledge in working with audio and video improved from 42.79 to 43.32 ($t=26.529$, $p<0.01$). There was a slight decline in spreadsheet skills, with the mean decreasing from 62.03 to 61.76 ($t=20.890$, $p<0.01$). The internet, web browser, and browsing dimension saw a reduction from 121.38 to 117.97 ($t=24.243$, $p<0.01$), while skills in working with email remained largely unchanged, with a post-test mean of 62.82 compared to 62.79 ($t=22.018$, $p<0.01$). These findings indicate both improvements and minor declines in ICT knowledge following the intervention.

$H_{5.2}$: There is no significant difference in Attitude across all dimensions from mid-data to post-data with the ICT Pedagogy intervention.

Table 4.15: Testing-wise M, SD, N and correlated t-values of Attitude towards ICT and its' dimensions separately of in-service Teachers

Variable	Testing	M	SD	N	Correlated t-value	Remark
Attitude towards ICT	Mid Post	127.71 129.24	18.994 19.765	34	39.205	p<0.01
Technical aspects of handling ICT	Mid Post	16.09 16.88	3.753 3.852	34	24.998	p<0.01
Pedagogical utility of ICT	Mid Post	48.00 48.15	8.804 8.791	34	31.790	p<0.01
Social and Ethical aspects related to ICT	Mid Post	27.82 28.35	4.116 4.444	34	39.421	p<0.01
Professional use of ICT	Mid Post	35.79 35.85	6.786 6.946	34	30.757	p<0.01

From the above table, the analysis of attitudes towards ICT from mid-test to post-test demonstrated notable changes across various dimensions. The overall attitude towards ICT increased from a mid-test mean of 127.71 to a post-test mean of 129.24, with a significant t-value of 39.205 ($p<0.01$), indicating an overall positive shift in participants' attitudes. Specifically, the technical aspects of handling ICT improved from a mean of 16.09 to 16.88 ($t=24.998$, $p<0.01$). The pedagogical utility of ICT showed a slight increase from 48.00 to 48.15 ($t=31.790$, $p<0.01$), suggesting a positive change in perceptions of ICT's educational value. Social and ethical aspects related to ICT also saw a positive change, with the mean increasing from 27.82 to 28.35 ($t=39.421$, $p<0.01$). Finally, the professional use of ICT remained relatively stable, with a mean increase from 35.79 to 35.85 ($t=30.757$, $p<0.01$). These results indicate an overall enhancement in participants' attitudes towards ICT, reflecting improvements in various dimensions of their perceptions.

$H_{5.3}$: There is no significant difference in Confidence across all dimensions from mid-data to post-data with the ICT Pedagogy intervention.

Table 4.16: Testing-wise M, SD, N and correlated t-values of Confidence in using ICT and its' dimensions separately of in-service Teachers

Variable	Testing	M	SD	N	Correlated t-value	Remark
Confidence in using ICT	Mid	37.50	8.884	34	24.613	p<0.01
	Post	38.94	8.294			
Handling ICT tools	Mid	15.06	3.219	34	27.280	p<0.01
	Post	15.62	3.294			
Managing the use of ICT	Mid	11.35	2.838	34	23.327	p<0.01
	Post	11.82	2.504			
Solving the issues that arise during the use of ICT	Mid	11.09	2.989	34	21.634	p<0.01
	Post	11.50	2.654			

From the above table, the analysis of confidence in using ICT from mid-test to post-test revealed significant improvements across all dimensions. The overall confidence in using ICT increased from a mid-test mean of 37.50 to a post-test mean of 38.94, with a t-value of 24.613 ($p<0.01$), indicating a positive shift in participants' self-assurance. Specifically, confidence in handling ICT tools improved from a mean of 15.06 to 15.62 ($t=27.280$, $p<0.01$). Managing the use of ICT also saw an increase, with the mean rising from 11.35 to 11.82 ($t=23.327$, $p<0.01$). Additionally, the ability to solve issues arising during ICT use improved slightly, with the mean increasing from 11.09 to 11.50 ($t=21.634$, $p<0.01$). These results highlight an overall enhancement in participants' confidence in using ICT, reflecting improvements in their capabilities across various aspects of ICT usage.

H6: There is no significant difference in Knowledge, Attitude, and Confidence across all dimensions from pre-data to post-data with the TIC intervention in an Online mode among in-service teachers.

$H_{6.1}$: There is no significant difference in Knowledge across all dimensions from pre-data to post-data with the TIC intervention.

Table 4.17: Testing-wise M, SD, N and correlated t-values of ICT knowledge and its' dimensions separately of in-service Teachers

Variable	Testing	M	SD	N	Correlated t-value	Remark
ICT knowledge	Pre Post	452.00 639.62	167.004 148.566	34	15.782	p<0.01
Hardware & Software dimension	Pre Post	73.18 106.12	26.333 22.153	34	16.204	p<0.01
Operating System dimension	Pre Post	30.41 54.03	15.943 16.973	34	11.123	p<0.01
Working with word processor dimension	Pre Post	78.74 106.82	31.675 26.591	34	14.494	p<0.01
Working with image dimension	Pre Post	64.59 86.76	22.796 18.029	34	16.521	p<0.01
Working with audio and video dimension	Pre Post	33.74 43.32	11.355 8.591	34	17.324	p<0.01
Working with spreadsheet dimension	Pre Post	43.32 61.76	19.662 16.339	34	12.848	p<0.01
Internet, web browser & browsing dimension	Pre Post	78.74 117.97	36.668 32.975	34	12.520	p<0.01
Working with an email dimension	Pre Post	49.29 62.82	17.930 15.367	34	16.031	p<0.01

From the above table, the analysis of ICT knowledge from pre-test to post-test demonstrated substantial improvements across various dimensions. Overall ICT knowledge increased significantly, with the mean score rising from 452.00 to 639.62 ($t=15.782$, $p<0.01$). Specifically, the Hardware & Software dimension improved from a mean of 73.18 to 106.12 ($t=16.204$, $p<0.01$). The Operating System dimension also showed significant enhancement, with the mean increasing from 30.41 to 54.03 ($t=11.123$, $p<0.01$). Proficiency in working with word processors improved from a mean of 78.74 to 106.82 ($t=14.494$, $p<0.01$), and skills in working with images increased from 64.59 to 86.76 ($t=16.521$, $p<0.01$). The ability to handle audio and video improved from 33.74 to 43.32 ($t=17.324$, $p<0.01$), while knowledge of using spreadsheets increased from 43.32 to 61.76 ($t=12.848$, $p<0.01$). Competence in internet, web browsing, and email usage also saw significant improvements, with mean scores rising from 78.74 to 117.97 ($t=12.520$, $p<0.01$) and from 49.29 to 62.82 ($t=16.031$, $p<0.01$), respectively. These results indicate a comprehensive enhancement in participants' ICT knowledge across multiple dimensions.

$H_{6.2}$: There is no significant difference in Attitude across all dimensions from pre-data to post-data with the TIC intervention.

Table 4.18: Testing-wise M, SD, N and correlated t-values of Attitude towards ICT and its' dimensions separately of in-service Teachers

Variable	Testing	M	SD	N	Correlated t-value	Remark
Attitude towards ICT	Pre Post	129.94 129.24	19.223 19.765	34	39.416	p<0.01
Technical aspects of handling ICT	Pre Post	16.97 16.88	3.555 3.852	34	27.838	p<0.01
Pedagogical utility of ICT	Pre Post	39.41 48.15	5.182 8.791	34	44.345	p<0.01
Social and Ethical aspects related to ICT	Pre Post	28.82 28.35	6.068 4.444	34	27.699	p<0.01
Professional use of ICT	Pre Post	35.47 35.85	6.011 6.946	34	34.407	p<0.01

From the above table, the analysis of attitudes towards ICT from pre-test to post-test revealed varied outcomes. Overall, the mean score for attitudes towards ICT slightly decreased from 129.94 to 129.24 ($t=39.416$, $p<0.01$). Specifically, the technical aspects of handling ICT saw a minor decrease, with the mean score dropping from 16.97 to 16.88 ($t=27.838$, $p<0.01$). In contrast, the pedagogical utility of ICT showed a significant improvement, with the mean score rising from 39.41 to 48.15 ($t=44.345$, $p<0.01$), indicating a more positive view of ICT's usefulness in teaching. The social and ethical aspects related to ICT also experienced a slight decrease in the mean score from 28.82 to 28.35 ($t=27.699$, $p<0.01$). Meanwhile, the professional use of ICT saw a small increase in the mean score from 35.47 to 35.85 ($t=34.407$, $p<0.01$), suggesting a minor improvement in attitudes towards ICT in professional contexts.

$H_{6.3}$: There is no significant difference in Confidence across all dimensions from pre-data to post-data with the TIC intervention.

Table 4.19: Testing-wise M, SD, N and correlated t-values of Confidence in using ICT and its' dimensions separately of in-service Teachers

Variable	Testing	M	SD	N	Correlated t-value	Remark
Confidence in using ICT	Pre Post	32.71 38.94	9.107 8.294	34	20.940	p<0.01
Handling ICT tools	Pre Post	13.47 15.62	3.527 3.294	34	22.271	p<0.01
Managing the use of ICT	Pre Post	9.91 11.82	2.800 2.504	34	20.640	p<0.01

Solving the issues that arise during the use of ICT	Pre Post	9.32 11.50	2.972 2.654	34	18.294	p<0.01

From the above table, the analysis of confidence in using ICT from pre-test to post-test revealed significant improvements. The mean confidence score increased from 32.71 to 38.94 (t=20.940, p<0.01), indicating a notable enhancement in overall confidence. Specifically, handling ICT tools saw a rise in the mean score from 13.47 to 15.62 (t=22.271, p<0.01). Additionally, managing the use of ICT improved with the mean score increasing from 9.91 to 11.82 (t=20.640, p<0.01). Solving issues related to ICT usage also showed progress, with the mean score going up from 9.32 to 11.50 (t=18.294, p<0.01). These results collectively highlight a significant positive change in participants' confidence in various aspects of ICT use.

4.2.3 Analysis of data related to Knowledge, Attitude, and Confidence in using ICT among in-service teachers at the secondary level in Experimental Groups 1 & 2.

H7: There is no significant difference in Knowledge, Attitude, and Confidence across all dimensions from pre-data to mid-data with the ICT Basic Intervention Package between face-to-face mode for Experimental Group 1 and online mode for Experimental Group 2 among in-service teachers.

$H_{7.1}$: There is no significant difference in Knowledge across all dimensions from pre-data to mid-data with the ICT Basic Intervention Package between Experimental Groups 1 & 2.

Table 4.20: Testing-wise M, SD, N and correlated t-values of ICT knowledge and its' dimensions separately of in-service Teachers

Variable	Testing	Groups	N	M	SD	Correlated t-value	Remark
ICT knowledge	Pre	Exp 1 Exp 2	41 34	455.78 452.00	149.530 167.004	0.103	p<0.01
	Mid	Exp 1 Exp 2	41 34	691.93 629.12	96.753 153.466	2.156	p<0.01
Hardware & Software dimension	Pre	Exp 1 Exp 2	41 34	77.39 73.18	26.339 26.333	0.690	
	Mid	Exp 1 Exp 2	41 34	110.73 99.00	18.739 26.511	2.239	p<0.01
Operating System dimension	Pre	Exp 1 Exp 2	41 34	35.24 30.41	15.144 15.943	1.343	p<0.01
	Mid	Exp 1 Exp 2	41 34	60.15 51.41	12.295 16.770	2.599	p<0.01
Working with word processor dimension	Pre	Exp 1 Exp 2	41 34	71.17 78.74	29.368 31.675	1.072	p<0.01
	Mid	Exp 1	41	113.76	16.595	1.901	p<0.01

		Exp 2	34	103.71	28.549		
Working with image dimension	Pre	Exp 1	41	67.10	19.649	0.512	p<0.01
		Exp 2	34	64.59	22.796		
	Mid	Exp 1	41	91.78	11.924	1.588	p<0.01
		Exp 2	34	86.00	19.306		
Working with audio and video dimension	Pre	Exp 1	41	36.07	10.66	.918	p<0.01
		Exp 2	34	33.74	11.355		
	Mid	Exp 1	41	45.20	6.600	1.295	p<0.01
		Exp 2	34	47.79	9.406		
Working with spreadsheet dimension	Pre	Exp 1	41	42.15	15.819	0.287	p<0.01
		Exp 2	34	43.32	19.662		
	Mid	Exp 1	41	69.12	9.605	2.242	p<0.01
		Exp 2	34	62.03	17.314		
Internet, web browser & browsing dimension	Pre	Exp 1	41	78.32	30.514	0.054	p<0.01
		Exp 2	34	78.74	36.668		
	Mid	Exp 1	41	132.59	18.735	2.010	p<0.01
		Exp 2	34	121.38	29.195		
Working with an email dimension	Pre	Exp 1	41	48.34	17.023	0.236	p<0.01
		Exp 2	34	49.29	17.930		
	Mid	Exp 1	41	68.61	17.023	1.947	p<0.01
		Exp 2	34	62.79	17.930		

From the above table, the comparison of ICT knowledge between Experimental Groups 1 and 2 from pre-test to mid-test showed notable changes. At the pre-test, Group 1 had a mean ICT knowledge score of 455.78 with a standard deviation of 149.530, while Group 2 scored slightly lower at 452.00 with a standard deviation of 167.004, yielding a non-significant t-value of 0.103. By the mid-test, Group 1's mean score increased significantly to 691.93 (SD = 96.753), whereas Group 2's mean score was 629.12 (SD = 153.466), with a significant t-value of 2.156. In the Hardware & Software dimension, Group 1's score improved from 77.39 (SD = 26.339) at pre-data to 110.73 (SD = 18.739) at mid-data, compared to Group 2's increase from 73.18 (SD = 26.333) to 99.00 (SD = 26.511), resulting in a significant t-value of 2.239. For the Operating System dimension, Group 1's mean score rose from 35.24 (SD = 15.144) to 60.15 (SD = 12.295), while Group 2's score increased from 30.41 (SD = 15.943) to 51.41 (SD = 16.770), with a significant t-value of 2.599. Group 1's score in Working with word processors went from 71.17 (SD = 29.368) to 113.76 (SD = 16.595), whereas Group 2's score increased from 78.74 (SD = 31.675) to 103.71 (SD = 28.549), producing a significant t-value of 1.901. For the Working with image dimension, Group 1 improved from 67.10 (SD = 19.649) to 91.78 (SD = 11.924), and Group 2's score improved from 64.59 (SD = 22.796) to 86.00 (SD = 19.306), with a t-value of 1.588. In Working with audio and video, Group 1's score increased

from 36.07 (SD = 10.66) to 45.20 (SD = 6.600), while Group 2's score went from 33.74 (SD = 11.355) to 47.79 (SD = 9.406), showing a t-value of 1.295. For the Working with spreadsheet dimension, Group 1's score rose from 42.15 (SD = 15.819) to 69.12 (SD = 9.605), whereas Group 2's score increased from 43.32 (SD = 19.662) to 62.03 (SD = 17.314), resulting in a significant t-value of 2.242. The Internet, web browser, and browsing dimensions showed Group 1 increasing from 78.32 (SD = 30.514) to 132.59 (SD = 18.735), compared to Group 2's increase from 78.74 (SD = 36.668) to 121.38 (SD = 29.195), with a significant t-value of 2.010. Finally, for Working with an email dimension, Group 1 improved from 48.34 (SD = 17.023) to 68.61 (SD = 17.023), while Group 2's score changed from 49.29 (SD = 17.930) to 62.79 (SD = 17.930), with a t-value of 1.947.

$H_{7.2}$: There is no significant difference in Attitude across all dimensions from pre-data to mid-data with the ICT Basic Intervention package between Experimental Groups 1 & 2.

Table 4.21: Testing-wise M, SD, N and correlated t-values of Attitude towards ICT and its' dimensions separately of in-service Teachers

Variable	Testing	Groups	N	M	SD	Correlated t-value	Remark
Attitude towards ICT	Pre	Exp 1	41	139.39	12.824	2.540	p<0.01
		Exp 2	34	129.94	19.223		
	Mid	Exp 1	41	137.29	18.965	2.178	
		Exp 2	34	127.71	18.994		
Technical aspects of handling ICT	Pre	Exp 1	41	17.27	4.599	0.309	p<0.01
		Exp 2	34	16.97	3.555		
	Mid	Exp 1	41	16.37	4.443	0.289	
		Exp 2	34	16.09	3.573		
Pedagogical utility of ICT	Pre	Exp 1	41	42.80	3.116	3.501	p<0.01
		Exp 2	34	39.41	5.182		
	Mid	Exp 1	41	52.49	7.746	2.348	
		Exp 2	34	48.00	8.804		
Social and Ethical aspects related to ICT	Pre	Exp 1	41	30.66	4.252	1.535	p<0.01
		Exp 2	34	28.82	6.068		
	Mid	Exp 1	41	29.44	4.517	1.605	
		Exp 2	34	27.82	4.116		
Professional use of ICT	Pre	Exp 1	41	39.29	3.970	3.297	p<0.01
		Exp 2	34	35.47	6.011		
	Mid	Exp 1	41	39.00	6.241	2.129	
		Exp 2	34	35.79	6.786		

From the above table, the analysis of attitudes towards ICT between Experimental Groups 1 and 2 revealed notable differences. At the pre-test, Group 1 had a mean score of 139.39 (SD = 12.824) for attitude towards ICT, while Group 2 had a mean of 129.94 (SD = 19.223), with a significant t-value of 2.540. By the mid-test, Group 1's mean score was 137.29 (SD = 18.965) compared to Group 2's 127.71 (SD = 18.994), yielding a t-value of 2.178. For technical aspects of handling ICT, Group 1's pre-test score was 17.27 (SD = 4.599) and Group 2's was 16.97 (SD = 3.555), with a t-value of 0.309, and at the mid-test, Group 1's mean was 16.37 (SD = 4.443) versus Group 2's 16.09 (SD = 3.573), showing a t-value of 0.289, indicating no significant difference. Regarding the pedagogical utility of ICT, Group 1's pre-test mean was 42.80 (SD = 3.116) and Group 2's was 39.41 (SD = 5.182), with a significant t-value of 3.501. At the mid-test, Group 1's mean was 52.49 (SD = 7.746) compared to Group 2's 48.00 (SD = 8.804), with a t-value of 2.348. For social and ethical aspects related to ICT, Group 1's pre-test mean was 30.66 (SD = 4.252) and Group 2's was 28.82 (SD = 6.068), with a t-value of 1.535. At the mid-test, Group 1's mean was 29.44 (SD = 4.517) compared to Group 2's 27.82 (SD = 4.116), with a t-value of 1.605, indicating no significant changes between groups. For professional use of ICT, Group 1's pre-test mean was 39.29 (SD = 3.970) and Group 2's was 35.47 (SD = 6.011), with a significant t-value of 3.297. At the mid-test, Group 1's score was 39.00 (SD = 6.241) while Group 2's was 35.79 (SD = 6.786), showing a t-value of 2.129, reflecting significant improvements in Group 1's professional use of ICT.

$H_{7.3}$: There is no significant difference in Confidence across all dimensions from pre-data to mid-data with the ICT Basic Intervention package between Experimental Groups 1 & 2.

Table 4.22: Testing-wise M, SD, N and correlated t-values of Confidence in using ICT and its' dimensions separately of in-service Teachers

Variable	Testing	Groups	N	M	SD	Correlated t-value	Remark
Confidence in using ICT	Pre	Exp 1	41	33.56	8.972	0.408	p<0.01
		Exp 2	34	32.71	9.107		
	Mid	Exp 1	41	40.61	9.303	1.471	
		Exp 2	34	37.50	8.884		
Handling ICT tools	Pre	Exp 1	41	13.54	3.515	0.081	p<0.01
		Exp 2	34	13.47	3.527		
	Mid	Exp 1	41	16.32	3.745	1.543	
		Exp 2	34	15.06	3.219		
Managing the use of ICT	Pre	Exp 1	41	10.22	2.920	0.463	p<0.01
		Exp 2	34	9.91	2.800		
	Mid	Exp 1	41	12.20	2.741	1.304	
		Exp 2	34	11.35	2.838		
Solving the issues that arise during the use of ICT	Pre	Exp 1	41	9.80	2.848	0.714	p<0.01
		Exp 2	34	9.32	2.972		
	Mid	Exp 1	41	12.10	2.914	1.476	
		Exp 2	34	11.09	2.989		

From the above table, the comparative analysis of confidence in using ICT between Experimental Groups 1 and 2 showed some interesting patterns. At the pre-test, Group 1 reported a mean confidence score of 33.56 (SD = 8.972) compared to Group 2's 32.71 (SD = 9.107), with a t-value of 0.408, indicating no significant difference. By the mid-test, Group 1's confidence increased to a mean of 40.61 (SD = 9.303), while Group 2's mean was 37.50 (SD = 8.884), with a t-value of 1.471, reflecting a significant improvement in Group 1. For handling ICT tools, Group 1's pre-test mean was 13.54 (SD = 3.515) and Group 2's was 13.47 (SD = 3.527), showing a t-value of 0.081. By mid-test, Group 1's mean increased to 16.32 (SD = 3.745), whereas Group 2's mean was 15.06 (SD = 3.219), with a t-value of 1.543, indicating a significant enhancement in Group 1's handling of ICT tools. Concerning managing the use of ICT, Group 1's pre-test mean was 10.22 (SD = 2.920) compared to Group 2's 9.91 (SD = 2.800), with a t-value of 0.463. At the mid-test, Group 1's mean was 12.20 (SD = 2.741) while Group 2's was 11.35 (SD = 2.838), showing a t-value of 1.304, suggesting Group 1 showed greater progress. For solving issues during ICT use, Group 1's pre-test mean was 9.80 (SD = 2.848) and Group 2's was 9.32 (SD = 2.972), with a t-value of 0.714. At the mid-test, Group 1's mean was 12.10 (SD = 2.914) compared to Group 2's 11.09 (SD = 2.989), showing a t-value of 1.476, which indicates a significant improvement in problem-solving capabilities within Group 1.

H8: There is no significant difference in Knowledge, Attitude, and Confidence across all dimensions from Mid-data to Post-data with the ICT Pedagogy Intervention Package in online mode for Experimental Groups 1& 2 among in-service teachers.

$H_{8.1}$: There is no significant difference in Knowledge across all dimensions from Mid-data to Post-data with the ICT Pedagogy Intervention Package between Experimental Groups 1 & 2.

Table 4.23: Testing-wise M, SD, N and correlated t-values of ICT knowledge and its' dimensions separately of in-service Teachers

Variable	Testing	Groups	N	M	SD	Correlated t-value	Remark
ICT knowledge	Mid	Exp 1 Exp 2	41 34	691.933 629.12	96.753 153.466	2.156	p<0.01
	Post	Exp 1 Exp 2	41 34	683.71 639.62	104.489 148.566	1.505	p<0.01
Hardware & Software dimension	Mid	Exp 1 Exp 2	41 34	110.73 99.00	18.736 26.511	2.239	
	Post	Exp 1 Exp 2	41 34	113.80 106.12	17.770 22.153	1.668	p<0.01
Operating System dimension	Mid	Exp 1 Exp 2	41 34	60.15 51.41	12.295 16.770	2.599	p<0.01
	Post	Exp 1 Exp 2	41 34	60.73 54.03	12.588 16.973	1.961	p<0.01

Working with word processor dimension	Mid	Exp 1 Exp 2	41 34	113.76 103.71	16.595 28.549	1.901	p<0.01
	Post	Exp 1 Exp 2	41 34	108.73 106.82	21.824 26.591	0.341	p<0.01
Working with image dimension	Mid	Exp 1 Exp 2	41 34	91.78 86.00	11.924 19.306	1.588	p<0.01
	Post	Exp 1 Exp 2	41 34	90.24 86.76	14.766 18.029	0.919	p<0.01
Working with audio and video dimension	Mid	Exp 1 Exp 2	41 34	45.20 42.79	6.600 9.406	1.295	p<0.01
	Post	Exp 1 Exp 2	41 34	44.59 43.32	6.906 8.591	0.705	p<0.01
Working with spreadsheet dimension	Mid	Exp 1 Exp 2	41 34	69.12 62.03	9.605 17.314	2.242	p<0.01
	Post	Exp 1 Exp 2	41 34	66.51 61.76	12.050 16.339	1.446	p<0.01
Internet, web browser & browsing dimension	Mid	Exp 1 Exp 2	41 34	132.59 121.38	18.735 29.195	2.010	p<0.01
	Post	Exp 1 Exp 2	41 34	131.95 121.38	21.423 32.975	2.211	p<0.01
Working with an email dimension	Mid	Exp 1 Exp 2	41 34	68.61 62.79	8.625 16.629	1.947	p<0.01
	Post	Exp 1 Exp 2	41 34	67.15 62.82	10.461 15.367	1.443	p<0.01

From the above table, the results showed that Experimental Group 1 consistently outperformed Group 2 across various ICT knowledge dimensions. At the mid-test, Group 1 had higher scores in overall ICT knowledge, Hardware & Software, Operating Systems, and several other dimensions compared to Group 2, with statistically significant differences. By the post-test, Group 1 maintained superior scores in most areas, though some differences diminished. Key results include:

- ICT Knowledge: Group 1 scored higher than Group 2 both mid-test (691.93 vs. 629.12) and post-test (683.71 vs. 639.62).
- Hardware & Software: Group 1 had a higher mean at mid-test (110.73 vs. 99.00) and post-test (113.80 vs. 106.12).
- Operating Systems: Group 1 outperformed Group 2 at mid-test (60.15 vs. 51.41) and post-test (60.73 vs. 54.03).
- Working with Word Processors: Group 1 had a higher mean mid-test (113.76 vs. 103.71), but scores were closer at post-test (108.73 vs. 106.82).

- Internet & Browsing: Group 1 had higher scores on both mid-test (132.59 vs. 121.38) and post-test (131.95 vs. 121.38).

These results highlight Group 1's stronger performance in ICT knowledge and skills across multiple dimensions.

$H_{8.2}$: There is no significant difference in Attitude across all dimensions from Mid-data to Post-data with the ICT Pedagogy Intervention Package between Experimental Groups 1 & 2.

Table 4.24: Testing-wise M, SD, N and correlated t-values of Attitude towards ICT and its' dimensions separately of in-service Teachers

Variable	Testing	Groups	N	M	SD	Correlated t-value	Remark
Attitude towards ICT	Mid	Exp 1 Exp 2	41 34	137.29 127.71	18.965 18.994	2.178	p<0.01
	Post	Exp 1 Exp 2	41 34	135.37 129.24	20.010 19.765	1.328	
Technical aspects of handling ICT	Mid	Exp 1 Exp 2	41 34	16.37 16.09	4.443 3.753	0.289	p<0.01
	Post	Exp 1 Exp 2	41 34	16.27 16.88	4.410 3.852	0.635	
Pedagogical utility of ICT	Mid	Exp 1 Exp 2	41 34	52.49 48.00	7.746 8.804	2.348	p<0.01
	Post	Exp 1 Exp 2	41 34	51.59 48.15	8.795 8.791	1.686	
Social and Ethical aspects related to ICT	Mid	Exp 1 Exp 2	41 34	29.44 27.82	4.517 4.116	1.605	p<0.01
	Post	Exp 1 Exp 2	41 34	29.41 28.35	4.77 4.116	0.990	
Professional use of ICT	Mid	Exp 1 Exp 2	41 34	39.00 35.79	6.241 6.786	2.129	p<0.01
	Post	Exp 1 Exp 2	41 34	38.10 35.85	6.654 6.946	1.436	

From the above table, the results showed that Experimental Group 1 consistently outperformed Group 2 across various attitudes towards ICT dimensions.

Attitude Towards ICT: Group 1 consistently had higher scores than Group 2 at both the mid-test and post-test, though the difference narrowed over time.

Technical Aspects of Handling ICT: Differences between groups were not significant at either test phase.

Pedagogical Utility of ICT: Group 1 scored higher at both mid-data and post-dat, with a significant difference at the mid-test.

Social and Ethical Aspects Related to ICT: Group 1 had higher scores at mid-data, but the difference was minimal at post-data.

Professional Use of ICT: Group 1 scored higher than Group 2 at both test phases, with significant differences at mid-test.

$H_{8.3}$: There is no significant difference in Confidence across all dimensions from Mid-data to Post-data with the ICT Pedagogy Intervention Package between Experimental Groups 1 & 2.

Table 4.25: Testing-wise M, SD, N and correlated t-values of Confidence in using ICT and its' dimensions separately of in-service Teachers

Variable	Testing	Groups	N	M	SD	Correlated t-value	Remark
Confidence in using ICT	Mid	Exp 1 Exp 2	41 34	40.61 37.50	9.303 8.884	1.471	p<0.01
	Post	Exp 1 Exp 2	41 34	41.68 38.94	7.157 8.294	1.537	
Handling ICT tools	Mid	Exp 1 Exp 2	41 34	16.32 15.06	3.745 3.219	1.543	p<0.01
	Post	Exp 1 Exp 2	41 34	16.76 15.62	2.922 3.294	1.585	
Managing the use of ICT	Mid	Exp 1 Exp 2	41 34	12.20 11.35	2.741 2.838	1.304	p<0.01
	Post	Exp 1 Exp 2	41 34	12.68 11.82	2.067 2.504	1.629	
Solving the issues that arise during the use of ICT	Mid	Exp 1 Exp 2	41 34	12.10 11.09	2.343 2.654	1.476	p<0.01
	Post	Exp 1 Exp 2	41 34	12.24 11.50	2.343 2.654	1.289	

From the above table, the result showed that Experimental Group 1 consistently outperformed Group 2 across various Confidence in using ICT dimensions.

Confidence in Using ICT: Group 1 consistently scored higher than Group 2 at both mid-test and post-test, with significant differences observed.

Handling ICT Tools: Group 1 demonstrated higher scores than Group 2 at both testing phases, with significant differences at both mid-test and post-test.

Managing the Use of ICT: Group 1 scored higher at both mid-test and post-test compared to Group 2, with significant differences noted.

Solving Issues During ICT Use: Group 1 had higher scores than Group 2 at both mid-data and post-test, with significant differences observed at mid-data.

H9: There is no significant difference in Knowledge, Attitude, and Confidence across all dimensions from Pre-data to Post-data with the TIC Intervention Package in online mode for Experimental Groups 1 & 2 among in-service teachers.

$H_{9.1}$: There is no significant difference in Knowledge across all dimensions from pre-data to Post-data with the TIC Intervention Package between Experimental Groups 1 & 2.

Table 4.26: Testing-wise M, SD, N and correlated t-values of ICT knowledge and its' dimensions separately of in-service Teachers

Variable	Testing	Groups	N	M	SD	Correlated t-value	Remark
ICT knowledge	Pre	Exp 1	41	455.78	149.530	0.103	p<0.01
		Exp 2	34	452.00	167.004		
	Post	Exp 1	41	683.71	104.489	1.505	p<0.01
		Exp 2	34	639.62	148.566		
Hardware & Software dimension	Pre	Exp 1	41	77.39	26.339	0.690	
		Exp 2	34	73.18	26.333		
	Post	Exp 1	41	113.80	17.770	1.668	p<0.01
		Exp 2	34	106.12	22.153		
Operating System dimension	Pre	Exp 1	41	35.24	15.144	1.343	p<0.01
		Exp 2	34	30.41	15.943		
	Post	Exp 1	41	60.73	12.588	1.961	p<0.01
		Exp 2	34	54.03	16.973		
Working with word processor dimension	Pre	Exp 1	41	71.17	29.368	1.072	p<0.01
		Exp 2	34	78.74	31.675		
	Post	Exp 1	41	108.73	21.824	0.341	p<0.01
		Exp 2	34	106.82	26.591		
Working with image dimension	Pre	Exp 1	41	67.10	19.649	0.512	p<0.01
		Exp 2	34	64.59	22.796		
	Post	Exp 1	41	90.24	14.766	0.919	p<0.01
		Exp 2	34	86.76	18.029		
Working with audio and video dimension	Pre	Exp 1	41	36.07	10.666	0.918	p<0.01
		Exp 2	34	33.74	11.355		
	Post	Exp 1	41	44.59	6.906	0.705	p<0.01
		Exp 2	34	43.32	8.591		
Working with spreadsheet dimension	Pre	Exp 1	41	42.15	15.819	0.287	p<0.01
		Exp 2	34	43.32	19.662		
	Post	Exp 1	41	66.51	12.050	1.446	p<0.01
		Exp 2	34	61.76	16.339		

Internet, web browser & browsing dimension	Pre	Exp 1 Exp 2	41 34	78.32 78.74	30.514 36.668	0.054	p<0.01
	Post	Exp 1 Exp 2	41 34	131.95 117.97	21.423 32.975	2.211	p<0.01
Working with an email dimension	Pre	Exp 1 Exp 2	41 34	48.34 49.29	17.023 17.930	0.236	p<0.01
	Post	Exp 1 Exp 2	41 34	67.15 62.82	10.461 15.367	1.443	p<0.01

In a comparative analysis of ICT knowledge across two experimental groups, significant differences were observed in several dimensions. For ICT knowledge overall, Group 1 demonstrated higher scores than Group 2 in the post-test, with a significant increase noted. In the Hardware & Software dimension, Group 1 also outperformed Group 2 post-intervention, indicating significant improvement. Similarly, Group 1 scored higher in the Operating System dimension and the Internet, Web Browser & Browsing dimension in the post-test, with significant differences from Group 2. Although Group 1 had higher scores in the Working with Word Processor and Working with Email dimensions post-test, the differences were not statistically significant. Conversely, Group 2 had higher pre-test scores for Working with Word Processor, but Group 1 surpassed them in the post-test. For Working with Image, Audio and Video dimensions, Group 1 exhibited higher scores post-test compared to Group 2, though these differences were not significant. In the Working with Spreadsheet dimension, Group 1 showed significant improvement in the post-test. Overall, Group 1 displayed notable advancements in various ICT competencies following the intervention.

$H_{9.2}$: There is no significant difference in Attitude across all dimensions from pre-data to Post-data with the TIC Intervention Package between Experimental Groups 1 & 2.

Table 4.27: Testing-wise M, SD, N and correlated t-values of Attitude towards ICT and its' dimensions separately of in-service Teachers

Variable	Testing	Groups	N	M	SD	Correlated t-value	Remark
Attitude towards ICT	Pre	Exp 1 Exp 2	41 34	139.39 129.94	12.824 19.223	2.540	p<0.01
	Post	Exp 1 Exp 2	41 34	135.37 129.94	20.010 19.765	1.328	
Technical aspects of handling ICT	Pre	Exp 1 Exp 2	41 34	17.27 16.27	4.599 3.555	0.309	p<0.01
	Post	Exp 1 Exp 2	41 34	16.27 16.88	4.410 3.852	0.635	
Pedagogical utility of ICT	Pre	Exp 1 Exp 2	41 34	42.80 39.41	3.116 5.182	3.501	p<0.01

	Post	Exp 1 Exp 2	41 34	51.59 48.15	8.795 8.791	1.686	
Social and Ethical aspects related to ICT	Pre	Exp 1 Exp 2	41 34	30.66 28.82	4.252 6.068	1.535	p<0.01
	Post	Exp 1 Exp 2	41 34	29.41 28.35	4.770 4.444	0.990	
Professional use of ICT	Pre	Exp 1 Exp 2	41 34	39.29 35.47	3.970 6.011	3.297	p<0.01
	Post	Exp 1 Exp 2	41 34	38.10 35.85	6.564 6.946	1.436	

From the above table, the result indicated that the intervention led to improvements in several aspects of ICT proficiency and attitudes. Specifically, the attitude towards ICT improved from a pre-test mean of 139.39 to a post-test mean of 135.37 ($p < 0.01$), although the improvement was not statistically significant. Technical aspects of handling ICT showed a decrease in the mean score from 17.27 to 16.27, but this change was also not statistically significant ($p < 0.01$). The pedagogical utility of ICT improved significantly from 42.80 to 51.59 ($p < 0.01$), indicating enhanced perceived usefulness of ICT for teaching. Social and ethical aspects related to ICT saw a minor decrease from 30.66 to 29.41, which was not significant ($p < 0.01$). Lastly, professional use of ICT improved from 39.29 to 38.10, with the increase also being non-significant ($p < 0.01$). Overall, while some areas showed significant positive changes, others did not exhibit significant improvements.

$H_{9.3}$: There is no significant difference in Confidence across all dimensions from pre-data to Post-data with the TIC Intervention Package between Experimental Groups 1 & 2.

Table 4.28: Testing-wise M, SD, N and correlated t-values of Confidence in using ICT and its' dimensions separately of in-service Teachers

Variable	Testing	Groups	N	M	SD	Correlated t-value	Remark
Confidence in using ICT	Pre	Exp 1 Exp 2	41 34	33.56 32.71	8.972 9.107	0.408	p<0.01
	Post	Exp 1 Exp 2	41 34	41.68 38.94	7.157 8.294	1.537	
Handling ICT tools	Pre	Exp 1 Exp 2	41 34	13.54 13.47	3.515 3.527	0.081	p<0.01
	Post	Exp 1 Exp 2	41 34	16.76 15.62	2.922 3.294	1.585	
	Pre	Exp 1	41	10.22	2.920	0.463	p<0.01

Managing the use of ICT		Exp 2	34	9.91	2.800		
	Post	Exp 1	41	12.68	2.067	1.629	
		Exp 2	34	11.82	2.504		
Solving the issues that arise during the use of ICT	Pre	Exp 1	41	9.80	2.848	0.714	p<0.01
		Exp 2	34	9.32	2.972		
	Post	Exp 1	41	12.24	2.343	1.289	
		Exp 2	34	11.50	2.654		

From the above table, the result indicated that there was a significant improvement in participants' ICT skills and confidence following the intervention. Confidence in using ICT increased from a pre-test mean of 33.56 to a post-test mean of 41.68 (t-value = 1.537, $p < 0.01$), highlighting a notable boost in self-assurance. Participants also showed enhanced abilities in handling ICT tools, with scores rising from a pre-test mean of 13.54 to a post-test mean of 16.76 (t-value = 1.585, $p < 0.01$). Their proficiency in managing ICT use improved from a pre-test mean of 10.22 to a post-test mean of 12.68 (t-value = 1.629, $p < 0.01$), and their problem-solving skills for ICT issues increased from a pre-test mean of 9.80 to a post-test mean of 12.24 (t-value = 1.289, $p < 0.01$). These results collectively suggest that the intervention effectively enhanced participants' ICT-related skills and confidence.

CHAPTER 5: SUMMARY, FINDINGS AND IMPLICATIONS

5.1 Introduction

The details of this study have been presented in previous chapters. The present chapter is devoted to the presentation of this study in a nutshell. It has been given under captions, like, Rationale of the Problem, Statement of the Problem, Operational Definitions, Objectives, Hypotheses, finding of the study, Implications and recommendations.

5.2 Rationale of the Problem

The National Education Policy (NEP) 2020 of India embodies a progressive approach towards transforming the education system of the nation. An essential aspect of this policy is the incorporation of ICT into educational practices, which requires a substantial improvement in the skills and knowledge of teachers. The policy recognises the significant impact that technology can have on the transformation of teaching and learning methods and highlights the crucial role that teachers play in driving this progress. According to the NEP 2020, there is a specific requirement for teachers to receive thorough training and development in order to effectively use online educational platforms and resources. The emphasis here is not only on the integration of technology but also on the incorporation of learner-centric pedagogical approaches, which are crucial in the realm of education. The policy acknowledges the importance of a comprehensive understanding of technological tools and their integration into pedagogical practices to enhance student learning experiences in teaching.

In addition, it emphasises the importance of digitally competent teachers in modernising education. The policy advocates for comprehensive training programmes to develop teachers' digital competency and enable them to effectively use ICT in teaching practices. The policy focuses on the need to equip teachers with both basic ICT skills and advanced competencies in integrating technology with pedagogy. This holistic approach aims to create an educational environment that is adaptable, innovative, and aligned with the demands of the 21st century, ensuring a more innovative and adaptable educational environment.

For this reason, it is essential for teachers to consistently engage in training in order to remain up-to-date with the most recent developments in teaching methods and technological advancements. Teachers need to possess the necessary skills for teaching and consistently update their methods to align with current educational trends and technologies. According to NEP 2020 and Samarg Shiksha, 50 hours of capacity-building training programmes are required for teachers to become digitally competent.

In light of these objectives, the CIET at the NCERT is playing a pivotal role. It has initiated research that focuses on the development and evaluation of the effectiveness of the ‘Techno-Pedagogical Content Integration (TPCI) package, which aims at enhancing the digital competencies of inservice teachers at the secondary level. The TPCI package is composed of two levels: TPCI Level 1 for ICT '-Basics' and TPCI Level 2 for ICT-Pedagogy Integration’ in teaching, learning, and assessment. The package is designed to seamlessly integrate technology with pedagogy, thereby enhancing the overall quality of education.

This research is a testament to the commitment to not only equip teachers with the necessary digital tools but also to ensure these tools are used effectively in educational settings. To further empower these teachers, a series of online and offline training, including TPCI Level 1 'ICT: Basics' and TPCI Level 2 'ICT: Pedagogy Integration', is essential.

5.3 Statement of the Problem

The effective integration of technology into teaching practices remains a challenge for many in-service secondary school teachers. Despite the availability of digital tools and resources, there is often a gap in teachers' digital competencies, which impacts their ability to leverage technology to improve educational outcomes. This research aims to evaluate the effectiveness of a Techno-Pedagogy Content Integration (TPCI) package in enhancing the digital competencies of these teachers. Specifically, it seeks to determine whether the TPCI package can significantly improve teachers' skills, knowledge, and confidence in using technology in their pedagogical practices. In this context, the study has been undertaken and is entitled "*Effectiveness of Techno-Pedagogy Content Integration (TPCI) package on Development of Digital Competencies of Inservice Teachers at Secondary Level".*

5.4 Operational Definition

5.4.1 ICT

Information and Communication Technology (ICT) refers to the use of digital tools and systems to handle and exchange information. This includes devices like computers and smartphones, software programs, and communication systems such as the Internet and email (Smith, 2022). In this study, ICT refers to any hardware, software, process or combination of it to create, store, retrieve, manipulate, send and receive digital information.

5.4.2 Techno-Pedagogy Content Integration

In this study, Techno-Pedagogy Content Integration (TPCI) refers to the systematic approach of incorporating digital tools and resources into teaching practices and educational content. This process involves selecting suitable technology that aligns with instructional goals, integrating these tools into lesson plans and classroom activities, and applying effective pedagogical strategies to enhance student engagement and understanding. TPCI ensures that technology is not only used to support educational objectives but also effectively improves the learning experience. Continuous assessment and adaptation are key to refining the integration of technology to achieve better educational outcomes.

5.4.3 ICT Competencies

In this study, "ICT Competencies" refers to the competencies such as knowledge, confidence, and attitudes that teachers require to effectively integrate ICT into their teaching practices.

5.4.4 In-Service Teachers

According to (igi-global)In-service teachers are those who have already completed their basic training and are now teachers.In this study, In-service teachers refers to the teachers who are currently working in schools and are continuing to learn and improve their teaching skills while they are on the job.

5.4.5 Secondary Level

In this study, the secondary level refers to the stage of schooling that comes after primary education and typically includes students aged 12 to 18. It is divided into:Lower Secondary: Students in grades 6-8 or 7-9.Upper Secondary :Students in grades 9-12 or 10-12.

5.5 Variables of the study

5.5.1 Independent Variable:

The independent variable is the Techno-Pedagogy Content Integration (TPCI) package. This is the variable that is manipulated or introduced in the study to observe its effect on the dependent variable. In this case, the TPCI package is a specific program or intervention designed to integrate technology with pedagogical methods. The aim is to evaluate how this package impacts teachers' digital competencies, including their ability to use technology effectively in their teaching practices.

5.5.2 Dependent Variable:

The dependent variable is the digital competencies of in-service teachers. This variable measures the skills, knowledge, and confidence that teachers have in using technology as part of their teaching. It includes their ability to effectively apply digital tools and resources, manage and communicate information using technology, and adapt to new technological advancements. The study evaluates how the Techno-Pedagogy Content Integration (TPCI) package influences these competencies.

5.5.3 Intervening Variables:

Age, teaching experience, and prior exposure to technology affect how well teachers use the Techno-Pedagogy Content Integration (TPCI) package. Age can influence how easily teachers adapt to new technology, with older teachers possibly finding it harder. Teaching experience matters because more experienced teachers might be set in their ways and find it challenging to change. Prior exposure to technology is also important; teachers who have used technology before are likely to handle the TPCI package better than those who haven’t. These factors can explain why some teachers may benefit more from the TPCI package than others.

5.6 Objectives of the Study

1. To assess the impact of the Techno-Pedagogy Content Integration (TPCI) package on the development of digital competencies among in-service teachers at the secondary level.
2. To evaluate the changes in Knowledge, Attitude, and Confidence regarding digital tools and technologies among in-service secondary school teachers after the implementation of the TPCI package.
3. To compare the levels of digital competencies among in-service secondary school teachers before and after the implementation of the TPCI package.
4. To determine the effectiveness of the TPCI package in enhancing the integration of technology into pedagogy among in-service secondary school teachers.

5.7 Hypotheses

To undertake a meaningful analysis, the following hypotheses were proposed. There are hypotheses which were clubbed under three broad hypotheses as given below:

H1: There is no significant difference in Knowledge, Attitude, and Confidence across all dimensions from pre-data to mid-data with the ICT Basic Intervention Package in a face-to-face mode among in-service teachers.

$H_{1.1}$: There is no significant difference in Knowledge across all dimensions from pre-data to mid-data with the ICT Basic Intervention Package.

$H_{1.2}$: There is no significant difference in Attitude across all dimensions from pre-data to mid-data with the ICT Basic Intervention Package.

$H_{1.3}$: There is no significant difference in Confidence across all dimensions from pre-data to mid-data with the ICT Basic Intervention Package.

H2: There is no significant difference in Knowledge, Attitude, and Confidence across all dimensions from mid-data to post-data with the ICT Pedagogy intervention in an Online mode among in-service teachers.

$H_{2.1}$: There is no significant difference in Knowledge across all dimensions from mid-data to post-data with the ICT Pedagogy intervention.

$H_{2.2}$: There is no significant difference in Attitude across all dimensions from mid-data to post-data with the ICT Pedagogy intervention.

$H_{2.3}$: There is no significant difference in Confidence across all dimensions from mid-data to post-data with the ICT Pedagogy intervention.

H3: There is no significant difference in Knowledge, Attitude, and Confidence across all dimensions from pre-data to post-data with the TIC intervention in an Online mode among in-service teachers.

$H_{3.1}$: There is no significant difference in Knowledge across all dimensions from pre-data to post-data with the TIC intervention.

$H_{3.2}$: There is no significant difference in Attitude across all dimensions from pre-data to post-data with the TIC intervention.

$H_{3.3}$: There is no significant difference in Confidence across all dimensions from pre-data to post-data with the TIC intervention.

H4: There is no significant difference in Knowledge, Attitude, and Confidence across all dimensions from pre-data to mid-data with the ICT Basic Intervention Package in an Online mode among in-service teachers.

$H_{4.1}$: There is no significant difference in Knowledge across all dimensions from pre-data to mid-data with the ICT Basic Intervention Package.

$H_{4.2}$: There is no significant difference in Attitude across all dimensions from pre-data to mid-data with the ICT Basic Intervention Package.

$H_{4.3}$: There is no significant difference in Confidence across all dimensions from pre-data to mid-data with the ICT Basic Intervention Package.

H5: There is no significant difference in Knowledge, Attitude, and Confidence across all dimensions from mid-data to post-data with the ICT Pedagogy intervention in an Online mode among in-service teachers.

$H_{5.1}$: There is no significant difference in Knowledge across all dimensions from mid-data to post-data with the ICT Pedagogy intervention.

$H_{5.2}$: There is no significant difference in Attitude across all dimensions from mid-data to post-data with the ICT Pedagogy intervention.

$H_{5.3}$: There is no significant difference in Confidence across all dimensions from mid-data to post-data with the ICT Pedagogy intervention.

H6: There is no significant difference in Knowledge, Attitude, and Confidence across all dimensions from pre-data to post-data with the TIC intervention in an Online mode among in-service teachers.

$H_{6.1}$: There is no significant difference in Knowledge across all dimensions from pre-data to post-data with the TIC intervention.

$H_{6.2}$: There is no significant difference in Attitude across all dimensions from pre-data to post-data with the TIC intervention.

$H_{6.3}$: There is no significant difference in Confidence across all dimensions from pre-data to post-data with the TIC intervention.

H7: There is no significant difference in Knowledge, Attitude, and Confidence across all dimensions from pre-data to mid-data with the ICT Basic Intervention Package between face-to-face mode for Experimental Group 1 and online mode for Experimental Group 2 among in-service teachers.

$H_{7.1}$: There is no significant difference in Knowledge across all dimensions from pre-data to mid-data with the ICT Basic Intervention Package between Experimental Groups 1 & 2.

$H_{7.2}$: There is no significant difference in Attitude across all dimensions from pre-data to mid-data with the ICT Basic Intervention package between Experimental Groups 1 & 2.

$H_{7.3}$: There is no significant difference in Confidence across all dimensions from pre-data to mid-data with the ICT Basic Intervention package between Experimental Groups 1 & 2.

H8: There is no significant difference in Knowledge, Attitude, and Confidence across all dimensions from Mid-data to Post-data with the ICT Pedagogy Intervention Package in online mode for Experimental Groups 1& 2 among in-service teachers.

$H_{8.1}$: There is no significant difference in Knowledge across all dimensions from Mid-data to Post-data with the ICT Pedagogy Intervention Package between Experimental Groups 1 & 2.

$H_{8.2}$: There is no significant difference in Attitude across all dimensions from Mid-data to Post-data with the ICT Pedagogy Intervention Package between Experimental Groups 1 & 2.

$H_{8.3}$: There is no significant difference in Confidence across all dimensions from Mid-data to Post-data with the ICT Pedagogy Intervention Package between Experimental Groups 1 & 2.

H9: There is no significant difference in Knowledge, Attitude, and Confidence across all dimensions from Pre-data to Post-data with the TIC Intervention Package in online mode for Experimental Groups 1 & 2 among in-service teachers.

$H_{9.1}$: There is no significant difference in Knowledge across all dimensions from pre-data to Post-data with the TIC Intervention Package between Experimental Groups 1 & 2.

$H_{9.2}$: There is no significant difference in Attitude across all dimensions from pre-data to Post-data with the TIC Intervention Package between Experimental Groups 1 & 2.

$H_{9.3}$: There is no significant difference in Confidence across all dimensions from pre-data to Post-data with the TIC Intervention Package between Experimental Groups 1 & 2.

5.8 Research Design

The study employed a quasi-experimental design with a pre-test and post-test experimental group. This design is chosen for the reason that the quasi-experimental studies encompass a broad range of non-randomized intervention studies (Harris et al., 2006. (Needs to be revised) However, unlike a true experiment, a quasi-experiment does not rely on random assignment. Instead, subjects are assigned to groups based on non-random criteria. A quasi-experimental design is a useful tool in situations where true experiments cannot be used for ethical or practical reasons.

5.9 Delimitations

- The sample for this study was selected based on specific criteria.
- Both male and female teachers as well as teacher educators were taken for the study.

5.10 Findings of Study

The following are the findings of this study.

1. The intervention led to significant improvements in ICT knowledge across all tested dimensions, with notable increases in overall ICT knowledge and specific areas such as hardware, software, operating systems, word processing, image handling, audio and video, spreadsheets, internet browsing, and email.
2. The Findings showed a slight overall decline in attitudes towards ICT, with significant improvement in the pedagogical utility dimension, while technical and social/ethical aspects experienced minimal declines.
3. The Findings showed significant improvements in participants' confidence in using ICT, with notable gains in handling tools, managing use, and solving ICT-related issues, confirming the intervention's effectiveness.
4. The Findings indicated minor declines in overall ICT knowledge from mid-test to post-test, with slight reductions in specific areas like word processing and spreadsheets, but significant improvements in hardware/software and operating systems knowledge, demonstrating the intervention's overall effectiveness in maintaining or enhancing key ICT competencies.

5. The Findings showed minor but statistically significant declines in attitudes towards ICT from mid-test to post-test across various dimensions, including technical handling, pedagogical utility, social and ethical aspects, and professional use, indicating that the intervention led to slight reductions in perceptions, though the overall impact on attitudes was modest.
6. The Findings revealed significant improvements in confidence in using ICT from mid-test to post-test, with increases in overall confidence, handling ICT tools, managing ICT resources, and solving ICT issues, indicating that the intervention effectively enhanced participants' competence and assurance in these areas.
7. The intervention significantly improved overall ICT knowledge and digital competencies across all dimensions, with substantial gains in hardware/software, operating systems, word processing, image handling, audio/video, spreadsheets, internet browsing, and email skills.
8. The findings revealed that the overall attitudes towards ICT decreased slightly, with notable reductions in technical, social, and professional aspects, but significant improvement in the perceived pedagogical utility of ICT.
9. The Findings revealed significant improvements in participants' confidence in using ICT across all dimensions, with notable increases in overall confidence, handling tools, managing ICT use, and solving issues, demonstrating the intervention's effectiveness in enhancing their skills and assurance.
10. The finding showed that from pre-test to mid-test, ICT knowledge improved significantly in all areas, including Hardware & Software, Operating Systems, Word Processors, Images, Audio and Video, Spreadsheets, Internet Browsing, and Email.
11. The Findings showed a slight overall decline in attitudes towards ICT from pre-test to mid-test, with reductions in technical aspects and social/ethical awareness, but notable improvements in the pedagogical utility and a modest increase in professional use, indicating a mix of enhanced perceptions and minor declines in specific areas.
12. The Findings revealed significant improvements in confidence in using ICT from pre-test to mid-test, with notable increases in overall confidence, proficiency in handling tools, managing ICT resources, and problem-solving capabilities, indicating the intervention's effectiveness in enhancing participants' ICT skills and self-assurance.
13. The findings revealed that from mid-test to post-test, ICT knowledge generally improved, especially in hardware/software, operating systems, word processing, and audio/video skills, but there were small declines in spreadsheet skills and internet browsing.
14. The findings revealed that from mid-test to post-test, attitudes towards ICT improved overall, especially in technical skills, teaching use, and social/ethical aspects, while professional use stayed the same.
15. The findings showed that from mid-test to post-test, there were clear improvements in confidence using ICT, especially in handling tools, managing ICT, and solving problems.
16. The findings showed major improvements in ICT knowledge from pre-test to post-test, with significant increases in scores across all areas, including hardware/software,

operating systems, word processing, image handling, audio/video, spreadsheets, internet browsing, and email usage.

17. The findings from the analysis revealed a slight overall decrease in attitudes towards ICT, with minor reductions in technical handling and social/ethical aspects, a significant improvement in the pedagogical utility of ICT, and a small increase in professional use, indicating mixed outcomes in participants' perceptions of ICT from pre-test to post-test.
18. The findings showed significant improvements in participants' confidence in using ICT, with notable gains in their overall confidence, ability to handle tools, manage resources, and solve problems.
19. The findings showed that Experimental Group 1 exhibited greater improvements in ICT knowledge from pre-test to mid-test compared to Experimental Group 2, with notable gains in most dimensions including Hardware & Software, Operating Systems, and Internet & Browsing, indicating more substantial overall progress in Experimental Group 1.
20. The findings revealed that Group 1 had more positive attitudes towards ICT than Group 2 at both pre-test and mid-test, especially regarding its educational and professional use, though both groups were similar in technical and social/ethical views.
21. The comparative findings revealed that Experimental Group 1 significantly improved in ICT confidence compared to Group 2. By the mid-test, Group 1 showed notable increases in confidence, handling ICT tools, managing ICT use, and solving ICT-related issues, demonstrating more substantial gains in these areas.
22. The findings showed that Experimental Group 1 consistently outperformed Group 2 in ICT knowledge, scoring higher in most areas including overall ICT knowledge, Hardware & Software, and Internet & Browsing, both at the mid-test and post-test.
23. The findings showed that Experimental Group 1 consistently scored higher than Group 2 in attitudes towards ICT, with significant advantages in pedagogical utility and professional use of ICT. However, differences in technical handling and social/ethical aspects were not significant between the two groups.
24. The findings revealed that the Experimental Group 1 consistently outperformed Group 2 across all dimensions of Confidence in Using ICT, Handling ICT Tools, Managing the Use of ICT, and Solving Issues During ICT Use, with significant differences observed at various testing phases.
25. The findings revealed that Group 1 demonstrated significant improvements in overall ICT knowledge and several dimensions compared to Group 2, including Hardware & Software, Operating System, Internet, Web Browser & Browsing, and Working with Spreadsheet, while other dimensions showed non-significant differences.
26. The findings revealed that the intervention led to significant improvements in the pedagogical utility of ICT, while attitudes towards ICT, technical aspects, social and ethical considerations, and professional use showed changes that were not statistically significant.
27. The findings revealed that the intervention significantly improved participants' ICT skills and confidence, with notable increases in self-assurance, handling ICT tools, managing ICT use, and solving ICT issues, all statistically significant.

5.11 Implications of the Study:

1. **Enhanced Engagement and Practical Application:** From the findings of the study, it was noted that face-to-face training may provide a more engaging and practical learning environment for in-service teachers. The interactive nature of in-person sessions allows for real-time feedback, hands-on activities, and immediate clarification of doubts, which can significantly enhance the understanding and application of ICT integration in the classroom.
2. **Collaborative Learning Opportunities:** Face-to-face training provides opportunities to facilitate collaboration among participants, fostering a sense of community and shared learning. This interaction can lead to an exchange of ideas which may not be as easily achieved in an online setting. In-person sessions also allow the teachers to present their opinions, suggestions and real-time feedback. This dynamic exchange will enhance the critical thinking, problem-solving, and creative means of integrating ICT in the classroom. Also, face-to-face interactions foster professional networks and relations that can promote further collaboration and support among educators even after the end of training. These connections are very important in sharing resources, solving challenges, and promoting continuous professional growth.
3. **Tailored Instruction and Support:** Face-to-face training allows for tailoring the sessions according to the needs and skill levels of the participants. This also allows the trainer to assess the unique backgrounds, experiences and learning styles of the participants. Furthermore, the immediate availability of trainers during in-person sessions fosters an environment where participants feel comfortable asking questions thus leading to a deeper level of understanding. In-person sessions also build participant's confidence by providing practical exercises, real-time demonstrations and guidance. This hands-on approach ensures that all participants, regardless of their initial proficiency levels, can achieve a baseline competency in digital skills, empowering them to effectively integrate technology into their classrooms.
4. **Technical Challenges in Online Training:** The study indicates potential limitations in online training, such as technological barriers, lack of engagement, and difficulties in maintaining participant motivation. These challenges can hinder the effective transfer of skills and competencies.

5.12 Recommendations:

1. **Blended Learning Approach**: To leverage the strengths of both face-to-face and online training modalities, a blended learning approach could be implemented. This would combine the interactive, hands-on benefits of in-person sessions with the flexibility and accessibility of online learning.
2. **Enhanced Online Engagement Strategies:** To improve the effectiveness of online training, it's crucial to incorporate interactive elements such as live webinars, discussion forums, and peer-to-peer collaboration opportunities. Gamification and multimedia resources can also enhance engagement and retention of knowledge.
3. **Professional Development for Trainers:** Trainers should receive specialized training to effectively deliver content in both face-to-face and online formats. This includes

strategies for engaging participants, providing constructive feedback, and utilizing technology to its fullest potential.

4. **Continuous Support and Follow-Up:** Providing continuous support and follow-up sessions after the training can help reinforce learning and assist teachers in overcoming any challenges they encounter while integrating ICT in their classrooms. This could include online discussion groups, mentoring programs, or additional workshops.
5. **Addressing Technological Barriers:** To ensure that online training is accessible to all participants, steps should be taken to address technological barriers. This could involve providing technical support, ensuring that all participants have access to the necessary devices and internet connectivity, and offering tutorials on using the online learning platforms.
6. **Evaluation and Feedback Mechanisms:** Implementing robust evaluation and feedback mechanisms can help assess the effectiveness of the training programs and identify areas for improvement. Feedback from participants can provide valuable insights into their experiences and inform future training initiatives.

By considering these implications and implementing the recommended strategies, educational institutions and policymakers can enhance the effectiveness of Techno-Pedagogy Content Integration (TPCI) training programs, thereby better equipping in-service teachers with the necessary digital competencies to integrate ICT in the classroom.

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