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Exploring the Role of Technology Integration on Teaching and Learning in Primary Schools in Scotland

By

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Declaration

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Acknowledgement

In the name of Allah, the Most Gracious, the Most Merciful.

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Abstract

This research explores the role of technology integration on teaching and learning in Scottish primary schools, addressing a critical gap in understanding technology's role in education by analysing perspectives of key stakeholders: parents/ carers, teachers, teaching assistants, and headteachers. Digital technology can support individual learning and engagement, but problems including the digital gap, socioeconomics, resource, and devices allocation still exist. This study examines how stakeholder attitudes, access, and pedagogical practices influence technology integration in primary classroom settings and home settings using a mixed-methods sequential explanatory approach.

A systematic review to assess the role of technology on learning outcomes is followed by quantitative surveys of parents/carers, teachers and teaching assistants and headteachers, to assess current practices, attitudes, and barriers; and subsequent qualitative, semi-structured interviews to provide deeper insights into barriers and enablers to effective technology integration. The online quantitative questionnaire was administered to 213 participants (157 parents/carers, 47 teachers and assistants, and 8 headteachers), and follow-up interviews were held with 14 stakeholders (including 5 parents/carers, 6 teachers and assistants, and 3 headteachers), ensuring a comprehensive representation of the key stakeholders in the primary education system.

Key findings indicate that technology has transformative potential, but barriers include training, devices, and resource availability inequalities. Teachers and parents voiced favourable opinions about technology while pointing out disadvantages, including a lack of specialist digital tools, poor training, and internet safety. Analysis drawing on numerous theoretical models (including the ecosystem, cognitive theory of multimedia learning, social cognitive, technological pedagogical content knowledge, and the technology acceptance models) emphasises the interaction between individual, institutional, and systemic factors in shaping technology integration in primary schools. This research contributes by advancing the understanding of the complex dynamics between demographic, efficiency, attitude, barriers, and challenges that influence technology integration in education. Implementation recommendations are made for policymakers, educators, and designers to promote digital literacy, bridge the digital divide, and improve resource allocation, to promote fair, effective, and sustainable use of technology in primary education, ensuring better learning outcomes to prepare students for a digitally connected future.

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List of Abbreviations

ANOVA	Analysis of variance
CfE	Curriculum for Excellence
CI	Confidence interval
CK	Content knowledge
CPD	Continuous professional development
df	Degree of freedom
ECE	Early childhood education
EST	Ecological systems theory
GIRFEC	Getting It Right for Every Child
HT	Headteacher
ICEA	International Council of Education Advisers
ICT	Information and communication technology
LMS	Learning management system
P/C	Parent/carer
PCK	Pedagogical content knowledge
PEOU	Perceived ease of use
PK	Pedagogical knowledge
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
PU	Perceived usefulness
RCT	Randomised controlled trial
SCT	Social cognitive theory
SD	Standard deviation
SIMD	Scottish Index of Multiple Deprivation
STEM	Science, technology, engineering, and mathematics
T&L	Teaching and learning
TA	Teaching assistant
TAM	Technology acceptance model
TCR	Teacher
TIPS	Technology integration in primary schools
TK	Technological knowledge
TPACK	Technological pedagogical content knowledge
TPB	Theory of planned behaviour
TRA	Theory of reasoned action
WM	Weighted mean

PART I: INTRODUCTION, THESIS OUTLINE, THEORETICAL FOUNDATION AND METHODOLOGY

Chapter 1
Introduction

1.1 Research Background

In our technology-driven world, preparing children for the digital age is crucial, both for themselves in their own lives and for succeeding generations. This goes beyond basic technology skills; it includes critical digital literacy. The broad concept of the digital age encompasses using technology effectively, understanding media and data, and navigating online interactions responsibly (UNICEF, 2017). In addition to improving digital literacy, technology is a potent facilitator of learning, enhancing the learning process by enabling personalised learning experiences, improving the curriculum with access to educational resources, facilitating student and educator engagement, and providing immediate feedback. Furthermore, technology is useful in the classroom and serves as a prerequisite for higher education and a crucial tool in everyday life.

Consequently, in today's schools, colleges, institutions, and workplaces, proficiency with digital tools and flexibility in embracing new technology are highly valued competencies (UNESCO, 2021). Ensuring equal access to technology for all students is crucial, as unequal access could exacerbate latent inequalities in educational institutions and systems. Therefore, bridging the digital gap is necessary to provide all students with the commensurate devices and resources necessary to develop digital literacy and technological proficiency, regardless of their socioeconomic backgrounds (UNICEF, 2017; UNESCO, 2021).

The world has seen massive disruptions in social systems during the Covid-19 pandemic and global lockdown. Education systems in most countries witnessed massive dysfunctions due to closures and social restrictions (Reich et al., 2020). Researchers noted that the stop of formal or informal learning because of the closedown of schools has irreversible and extensive social, cultural, educational, and economic repercussions on students, teachers, and parents alike (Reich et al., 2020;

OECD, 2020). These negative results designate the risks associated with disruption of teaching and learning during the Covid-19 crisis. For the first time educational systems, parents, and other stakeholders were alerted to the relatively poor preparedness of most systems to offer online support and digital learning solutions in a context where traditional classroom instruction was impossible.

Primary school environments present additional complexities for technology integration. In this setting, multiple actors, including students, teachers, parents, and community members, play critical roles (Ibrahim et al., 2022). Moreover, much of the available technology is not specifically designed for young children, who are rapidly developing both cognitively and physically (Selirowangi and Wajdi, 2022). Additionally, the strict pressures of the curriculum and the challenges of managing mixed-ability classrooms make the effective integration of digital technology even more challenging than in secondary or higher education environments.

Based on these considerations, this research, conducted post-lockdown, aims to address the issue of technological integration by exploring the role of technology in teaching and learning (T&L) within primary schools in Scotland. Scotland's educational system, recognised internationally for its strength and innovation, provides a uniquely appropriate context for examining these issues. With progressive digital policies and a firm commitment to equity and digital literacy, Scotland offers an exemplary case study for investigating how technology can be effectively integrated into primary education. (For more detailed justification, see Chapter 2, Section 2.2.)

1.2 Motivations

Primary schools today face the important challenge of delivering high-quality education while operating under strict time and resource constraints. As demands for improved learning outcomes increase, schools must devise strategies that meet the diverse needs of their students while adhering to rigorous educational standards (Keddie, 2017). Tracey and Francesca (2020) emphasise that future educational agendas should focus on developing effective methods for identifying and filtering the most valuable digital resources and learning approaches. Achieving effective learning requires making informed epistemological and methodological decisions, as well as forging robust partnerships among all stakeholders.

The integration of ICT and digital resources is vital in modern education. Morais et al. (2015) have observed that as educational resources evolve in tandem with societal transformations, there is a clear shift from traditional print-based materials to dynamic digital models. This transition is further confirmed by findings from the Children and Parents: Media Use and Attitudes Report (Ofcom, 2024), which show that both children and parents are navigating a rapidly changing digital landscape. In an increasingly information-rich world, learning tools and resources emerge from diverse cultural communities across the globe. Moreover, Livari et al. (2020) note that, over the past few decades, innovations in digital technology have led to remarkable transformations in teaching methodologies.

A further complication in primary education is that many digital technologies currently in use are not specifically designed for young children. As a result, these technologies often fail to meet the cognitive and developmental needs of primary-aged learners (Haleem et al., 2022). Children in these settings are rapidly developing both physically and cognitively, meaning the technology they need and can effectively use is subject to continuous change (House of Lords Select Committee on Communications, 2017). In addition, the pressures imposed by a standardised curriculum, particularly evident in contexts like England, leave teachers with little flexibility to tailor educational approaches to the needs of mixed-ability classrooms (Keddie, 2017).

The challenges extend to providing resources that are tailored to the specific needs of each community. Limited funding and standardisation constraints further exacerbate these issues, as confirmed by Valverde-Berrocoso et al. (2021). They argue that the lack of appropriately designed instructional digital materials severely limits the effectiveness of virtual learning environments and undermines the development of robust e-learning modalities. The OECD (2015) report on students, computers, and learning further illustrates that while digital technologies offer significant potential to enrich education, their success depends on thoughtful and contextually sensitive implementation.

Securing the best learning resources demands active participation from all stakeholders. Clark-Wilson et al. (2020) stress that integrating digital resources successfully into academic environments requires strong partnerships among parents, students, teachers, and affiliated institutions. Morais et al. (2015) similarly report that the context in which technology is used and the actors involved are decisive factors in determining whether students experience positive or negative outcomes from technology integration.

1.3 Problem Statement

There are increasing calls for considerably greater integration of technology into education, alongside a deeper understanding of the complexities surrounding children's everyday use of digital technology at home and in school, in order to give them better preparation for present and future challenges and opportunities (Selwyn, 2012). However, there are concerns regarding the potential risks children may encounter in digital environments that are challenging to regulate, as well as the possible consequences of excessive screen time per se on their development and well-being (Livingstone and Smith, 2014). Moreover, while many children are exposed to and engage with digital environments from a very young age, access to technology and technological experiences vary among different children in different socioeconomic and geographical contexts, and even for the same individual child at different times (Merchant, 2014).

Although such various factors are at play in children's engagement with digital technologies, socioeconomic characteristics continue to play the most important role in either enabling or inhibiting access to technologies (i.e., due to financial constraints preventing children from poorer households from achieving the same access), and parental mediation and styles of coaching their children with regard to digital environments. As Livingstone et al (2015) observed, socioeconomically privileged parents typically support more access to connective technologies for their children, including mobile phones. In this context, economic equity concerns have been raised by global financial institutions concerning the way in which socioeconomic characteristics influence technological device availability at home (OECD, 2015, p.125). This inequity is linked not only to economic circumstances, but also to disparities in the utilisation of technology and resources within different households (McPake, Plowman and Stephen, 2013; Marsh et al., 2015).

However, viewing technology access as a key concern for its own sake ignores the pedagogical dimension, and in many respects digital technologies often simply provide alternative approaches to carrying out tasks that individuals are already engaged in within educational contexts. Selwyn and Facer (2013, p. 9) argue that there is no predetermined “technology future” to which educational institutions must conform,

nor are there universal technological effects from which young individuals must be shielded. Mayer and Moreno (2003) stated that technology adoption can be counterproductive to the learning process, as students being exposed to inappropriate multimedia resources (or indeed overexposed to appropriate ones), this can lead to cognitive overload and distractions from learning. Consequently, educators should choose the most suitable resource systems to reduce cognitive overload among pupils and facilitate the achievement of learning goals. However, while educators typically acknowledge the potential benefits of modern technologies in educational service delivery, they the ways in which to achieve this practically are often unclear.

Over recent decades, there has been growing interest among researchers and designers to integrate technological tools and resources into educational programs (Zawacki-Richter and Latchem, 2018). As reviewed in detail in Chapter 5, extensive studies have reported numerous educational strategies and programs implemented in various curriculums for different learning populations, and highlight the challenges faced in applying such strategies, as well as the perceived educational outcomes (Korat, 2010; Hwang, Wu and Ke, 2011; Bakker, van den Heuvel-Panhuizen and Robitzsch, 2015;

Sarıca and Usluel, 2016; Hwang et al., 2017; Kiili and Ketamo, 2018; Huang, Kuo and Chen, 2020; Nizam and Law, 2020). However, there remains a notable gap, this research gap is particularly critical given the unique challenges in primary education, such as balancing curricular pressures in mixed-ability classrooms, overcoming resource limitations, and managing diverse stakeholder expectations from educators and parents to the learners themselves.

As a result, there is a need for studies that explore practical ways to integrate technology and educational resources into primary learning environments while addressing pedagogical challenges and ensuring cognitive efficiency and positive learning outcomes (Selwyn, 2012; Bereczki and Kárpáti, 2021).

The current research seeks to help address this gap by answering the research question and achieving the aim and objectives described below.

1.4 Research Question

What is the role of digital technology integration in shaping teaching and learning practices in primary schools in Scotland?

1.5 Aim and Objectives of the Research

This research aims to examine technology integration on teaching and learning outcomes in primary schools by achieving the following objectives:

Objective 1: To critically review and evaluate the role of technology integration on teaching and learning in primary schools.

Objective 2: To analyse stakeholder attitudes and behavioural influences on technology integration.

Objective 3: To identify barriers and challenges to technology integration in education.

1.6 Definition of Terms

The core concepts pertaining to this research are reflected in the terms operationally defined below.

Attitude: According to Ajzen (2001), “attitude represents a summary evaluation of a psychological object (the ‘attitude-object’), captured in such attribute dimensions as good-bad, harmful-beneficial, pleasant-unpleasant, and likeable-dislikeable” (p. 28).

Barriers or Factors: Barriers are obstacles that impede the successful integration of technology, such as lack of training, resources, or conflict to change. Factors can include various external and internal influences that affect technology adoption, including socioeconomic status and institutional support (Ertmer, 1999).

Behaviour: Refers to observable actions or responses of individuals toward certain stimuli or within specific contexts, which, in education, can reflect how students and teachers engage with learning materials and technologies (Bandura, 1986).

Digital divide: “refers to the gap between the ‘haves ‘and the ‘have nots‘ in society: between those who have access to ICT and those whose access is limited or non-existent. Sub-groups whose access to ICT is unequal may fail to reach their full potential in school and beyond” (Anderson, 2010, p. 11).

Information and communication technology (ICT): Kalas (2010) explains that “in early childhood education (ECE) literature, the concept of ICT including computer hardware and software, digital cameras, video cameras, the Internet, telecommunication tools, programmable toys, and various other devices and resources.”

Technology Integration (Tech-Int): Technology integration refers to the meaningful and effective incorporation of digital devices, and resources into teaching and learning processes. Tech-Int involves using technology in a seamless, meaningful, and pedagogically aligned manner that supports curriculum delivery, enhances student engagement, and addresses learners’ specific needs. As Chakabwata (2023) explains, effective technology integration concerns the proficient integration of technology within educational settings to enhance and support the process of teaching and learning. This research considers integration both in classroom settings and at home, involving key stakeholders such as teachers, and parents.

Technology: Refers to digital tools and systems used to support teaching and learning processes. This includes both hardware (e.g., computers, tablets, interactive whiteboards, and mobile devices) and software/digital resources (e.g., e-books, educational games, learning platforms, video content, and communication apps). The definition emphasises tools that facilitate interaction, access to information, and enhancement of educational experiences in both classroom and home learning environments.

1.7 Contributions of Research

This research is significant because of its comprehensive exploration of different types of learning resources and the technologies used for delivery, with the goal of examining how these technologies affect educational outcomes. This research offers a comprehensive perspective that instructs many factors fundamental to learning development in comparison with earlier studies that focus on different types. The findings can help stakeholders make informed decisions about the development of scientific methods within their curricula. The main contributions of this research can be summarised as follows:

1. Advancing knowledge in the field of computers and education by offering insights into the comparative effectiveness of different technology resources and devices.
2. Empower designers to discern the most impactful types of technological resources and devices for enhancing educational outcomes among primary school children.
3. Providing insights into the attitudes of parents and teachers towards the integration of technologies in education, thereby facilitating informed decision-making in educational settings.

4. Enhancing understanding of learning outcomes and motivational effects associated with the use of technology in primary education, thus informing future educational practices and strategies.

1.8 Thesis Structure

This thesis includes three main parts with constituent chapters, as described below.

PART I: INTRODUCTION, THESIS OUTLINE, THEORETICAL FOUNDATION AND METHODOLOGY

Chapter 1: Introduction

This chapter briefly presents the research background (including the research question, aim and objectives, and key terminology), the literature gap addressed by this research, and its intended contributions to addressing the research problem.

Chapter 2: Research Context

This chapter briefly describes the education system of Scottish primary schools, with more details on key educational policies, areas of responsibility for stakeholders, and educational policies' importance in Scotland.

Chapter 3: Technology Integration (Tech-Int): Theoretical Perspectives, Models, and Influential Factors in Educational Settings

This chapter explains the rationale for integrating technology in education in relation to prominent theoretical perspectives, models, and influential factors in educational settings. It presents the theoretical groundwork for the fundamental conceptual framework development. The chapter analyses the theoretical perspectives germane to the field of pedagogy and Tech-Int related to this thesis.

Chapter 4: Research Methodology

This chapter describes the methodology and methods used in this research to achieve its objectives. It presents the rationale for choosing a sequential explanatory mixed methods approach, outlines the data collection steps, including a systematic review, quantitative data collection (questionnaire), and a qualitative phase (semi-structured interviews), and explains the data analysis methods, including statistical analysis methods for quantitative data and qualitative thematic analysis in order to achieve the aim and objectives of this research.

PART II: EMPIRICAL INVESTIGATION OF TECHNOLOGY INTEGRATION

This part includes three phases investigating various aspects of Tech-Int in primary education:

Phase 1: A critical review of Tech-Int.

Phase 2: A questionnaire to explore the current state of Tech-Int in Scottish primary schools.

Phase 3: Semi-structured interviews to validate the findings from Phase 2.

Chapter 5: Impact of Tech-Int on Teaching and Learning (T&L) Outcomes in Primary Schools: A Systematic Review

This chapter explores the impact of Tech-Int on T&L outcomes in primary schools through a systematic review (phase 1). The chapter includes literature strategy, selected databases, inclusion criteria, PRISMA diagram, results, and discussions on the history, modern use, impacts, types of technology, challenges, and factors influencing technology enhanced learning.

Chapter 6: Questionnaire Analysis

This chapter investigates the current state of Tech-Int in Scotland primary schools and presents the extensive findings arising from the questionnaire analysis phase of this research (Phase 2), including descriptive and statistical analysis.

Chapter 7: Interview Analysis

This chapter presents and analyses the data emerging from qualitative, semi-structured interviews (Phase 3) conducted with key stakeholders to expand and confirm the findings from Phase 2.

PART III: DISCUSSION, AND CONCLUSION

Chapter 8: Discussion

This chapter discusses the major findings from the questionnaire and semi-structured interviews, providing an integrated analysis of the data collected.

Chapter 9: Conclusion

This chapter presents the key findings and implications of the research, acknowledges its limitations, and offers suggestions for practice and further research.

1.9 Summary of Chapter

This chapter has provided motivation and aim for research, defined the key conceptual terms, provided background details about the research problem, and outlined the aim and objectives of the research. It also notes the intended contributions of this research and the structured outline of this thesis. The following chapter explains the research context in more depth.

Chapter 2
Research Context

2.1 Introduction

Education plays a critical role in forming societies, with diverse stakeholders in every country developing their own systems with the aim of addressing their citizens' learning needs and societal goals (Grant, 2017). Scotland is one of the world's leading education pioneers, and it continues to make relentless efforts to ensure that its citizens receive the best learning services. The country's pioneering role in providing universal education for both sexes' dates to the 17th century, and the country has also implemented major reforms to guarantee the attainment of the highest quality of education. As a result, the country has gained recognition for its exceptional education system, which enhance children's abilities and empowers them to become effective citizens. Furthermore, Scotland's education system is employment-orientated (Mandavkar, 2021).

The development of this high-quality education system in Scotland has not been without challenges, and in recent decades there has been a series of reviews, debates, and discussions about the development of a successful system for the nation's schools. The 2002 National Debate on Education debated the future of how Scottish schools should be, the curriculum they should follow, and general tactics to improve education (Priestley, 2013). The outcomes of these discussions suggested enhancing students' decision-making abilities, refining assessment methods, minimising class sizes, enhancing school infrastructure, enhancing headteachers' ability to manage school budgets, implementing a collaborative teaching approach across primary and secondary schools, and involving parents in all crucial aspects of school management (OECD ,2021).

In response to the recommendations, Scotland introduced several policies and legislation aimed at improving school education delivery. The most recent policies focus on both children and young adults, and they emphasise learner-centred and outcome-orientated approaches to education. These strategies include the Getting It Right for Every Child (GIRFEC) (Scottish Government, 2022).

2.2 Justification for Selecting Scotland as the Research Context

Scotland's commitment to educational equity, innovation, and digital literacy made it a strategic choice for this research. According to OECD (2021), Scotland's education system is more advanced compared to other international peers. Furthermore, Scotland has proved its leadership in developing a national policy for Tech-Int in primary schools (TIPS). The rationale for the policy framework was to align the children's needs with the fast-growing technology, especially during childhood development (Hargreaves *et al*., 2015). The past few years have seen a growing commitment by scholars to focus on creating a strong ICT infrastructure for learners of all ages, which is also sensitive to practitioners' feedback and needs (UNICEF, 2021). The "Early Years Framework," a Scottish education policy, is based on the understanding that early learning significantly impacts adult life, ultimately leading to employability (Dunlop, 2015). This policy perception mirrors the 2002 "No Child Left Behind" legislation, which emphasised bridging the digital divide by enhance equitable technological literacy (Office of Educational Technology, 2001–2002; ERIC, 2022).

However, despite such policy-level developments, the concept of incorporating technology into the Scottish curriculum for classroom deployments is relatively new and is unfolding gradually. The concept of Scottish digital integration has garnered diverse perspectives from various countries. While the Scottish integrated digital curriculum is generally considered far more advanced compared to its international counterparts (Brown *et al*., 2021), a report by the Scottish Government's International Council of Education Advisers (ICEA) (Scottish Government, 2020) pointed out that there are still "students and teachers with insufficiently developed digital skills." This implies that there is a need to quintessentially address potential digital inequality, and fully exploit the contributions of interactive digital pedagogies, to make the curriculum more effective (Brown *et al*., 2021).

The important principle of GIRFEC is a cornerstone of Scottish educational policy, significantly shapes the daily decision-making processes of primary educators in Scotland (Children and Young People, Scottish Government, 2021). GIRFEC poses a notable challenge to Scottish teachers, as it requires a deep consideration of the broader context in which children operate when tailoring their instructional approaches. Bronfenbrenner's (1979) EST supports this concept by illustrating how individuals operate within a multitude of dynamic and interactive spheres of influence. This constructivist perspective emphasises the diverse environmental factors that affect children's behaviour and their developmental trajectories (Wilson *et al*., 2016). Consequently, educators must consider a wide range of environmental influences when adjusting their teaching methodologies, in addition to the physical and psychological well-being of children.

In this context, Scottish education has enticed researchers to investigate the idea and how to improve digital integration in primary schools. To examine the issues relevant to Tech-Int in Scottish education, the current research focuses on the primary school environments and home. The researcher believes that the primary/ elementary ages schools 5 to 12 years are the foundation for building strong childhood learning. Therefore, integrating technology at this early stage enhances children's learning development and makes it easier for stakeholders to explore the barriers to Tech-Int.

2.3 Educational System

Scotland is known for its distinctive universal public education system (General Teaching Council for Scotland, 2020). The political administration of education is the responsibility of the Scottish Parliament and the Government's Education and Lifelong Learning Department. The 32 Local Authorities across Scotland include educational authorities who directly administer state schools within their designated areas of authority, in which privately run schools also exist (Mandavkar, 2021). Two bodies conduct the inspections of education standards: the Care Inspectorate, which oversees care standards in preschools, and Education Scotland, which oversees standards in preschool, primary, high school, and community education (Siraj and Kingston, 2015).

Education is free for children in government-funded schools between the ages of 5 and 19 years. Education in Scotland takes place in two phases: primary school for students aged 5-12, and high school for children aged 12-18. The primary-one category includes children aged 7 years and under. Most learners join high school at the age of 11 or 12 for a compulsory four years (S1-S4), with a further two years (S5 and S6) being optional. Children usually attend school for 190 days annually (Smith, 2013; Kirk *et al*., 2018). Scottish education is based on the CfE, which ensures all schools offer a similar range of subjects at every stage of learning. The introduction of the CfE between 2010 and 2011 aimed to improve comprehension of the curriculum and offer a comprehensive general education from the early years to the senior phase of education.

The CfE also supporters for a differed approach to learning, in line with government directives, to ensure effective instructional delivery at nursery, primary, secondary, college, and vocational training canters. This new approach aims to improve knowledge retention and mastery of skills through a coherent, flexible, and enriched curriculum that periods from ages 3 to 18 years. The expectation is for schools to cultivate students into four key roles: successful learners, confident individuals, valuable contributors, and responsible citizens. The Local Authorities and schools work collaboratively to plan school days and support the transition of children to young adulthood and finally to the work environment. After completing S4 and S5, the minimum school leaving age is 16 years, at which point students have the option to continue their education for higher or advanced qualifications.

The method of assessment at the high school level includes a significant element of continuous assessment, according to each school’s internal procedures. This continuous assessment helps to promote students to subsequent classes. For lower high school levels, assessments follow the school’s testing and reporting policies, while senior high school students undertake national qualifications known as the Scottish

Qualifications Certificate. In addition to continuous assessment, exams evaluate high school students. Universities typically award degrees after four years, and students can join them at the end of S5. However, most students prefer to remain up to S6 before joining Scottish universities (OECD, 2021). Table 2.1 summarises the configuration of the Scottish education system.

Table 2.1: Configuration of Scottish education system (UK)

Age (years)	ISCED	Education Level	Institutions
2/3–5	0	Early learning and childcare	Nursery
5–12	1	Primary: Seven years, P1 to P7 (compulsory)	Primary schools
12–15	2	Secondary: Three years, S1 to S3 (compulsory)	Secondary schools: comprehensive, mostly co-educational
15–18	3	Upper-secondary: Three years, S4 (compulsory) and S5-S6 (optional). General and vocational studies.	Secondary schools, colleges of further education, or independent training providers
17+	4	Further education (non-advanced courses: vocational and general studies)	Colleges
17+	5	Higher education: Higher National Certificate, Higher National Diploma, professional training courses, and postgraduate programs	Higher education institutions (universities and colleges)

Source: OECD (2021, p.21)

2.4 Responsibility and Provision of Education

Scotland has a history of managing its own education system independent to the rest of the UK. With devolved powers under the 1998 Scotland Act, they have had complete control over education. In today's government, the person responsible for education also serves as the Deputy First Minister. They work with other ministers who handle different aspects of education, and they receive support from organisations like the Learning Directorate (OECD, 2021, p. 28). The Scottish government, through Parliament, takes responsibility for pre-school to higher-level education. The Education and Lifelong Department is responsible for the implementation of educational policies.

Concerning the envisioned “Lifelong” aspect of education, it is worth noting that nursery or childcare education is optional in Scotland. Nevertheless, the government guarantees every Scottish child aged 3 and 4 years a nursery place, and education is entirely free. At preschool, learning entails hands-on activities, scaffolding, and play. These learning methods enable children to understanding essential knowledge and skills that they will use in the next education levels (Scottish Government, 2021). The preschool stage prepares children for primary education.

Early childhood education primarily focuses on the development of communication and language skills, physical, emotional, interpersonal, and social skills, movement, expressive and skills, as well as knowledge and a basic understanding of their surroundings. The area of residents known as the “catchment area” determines the high school that the children will attend after primary education. Each catchment area has a specific high school, but a parent may apply for placement if they prefer their children to learn outside their catchment area (Priestley and Minty, 2013).

In Scottish primary education (P1 to P7), the policy recommends one teacher per class and a co-educational approach to T&L. On the other hand, secondary education lasts between S1 and S6. The first four years, S1 to S4, are compulsory, while the subsequent years, S5 and S6, are optional. While secondary school is mandatory from the age of 12 to 18, it becomes optional beyond the age of 16. Consequently, we further divide the lower secondary, which spans from 12 to 16 years of age, into the first two years, S1 and S2, and the final two years, S3 and S4. The S1 and S2 periods consist of general education provided within the 12-14 program. The next two years are about specialisation and vocational education (Hargreaves *et al*., 2015).

Educational institutions have a requirement to provide students with a high standard of learning and are accountable to their local governing body. This includes developing yearly improvement strategies that align with objectives established in collaboration with the local authority. Schools have gained more autonomy in shaping their curricula to cater to students’ specific requirements through the enforcement of educational policies like CfE and the Empowerment Agenda in Scotland (OECD, 2021, p. 29).

2.5 Stakeholder Engagement with Curriculum for Excellence (CfE)

Stakeholder involvement is a central component of the CfE, providing a chance, when structured effectively, for collaborative ownership and competent leadership of CfE. Extensive stakeholder involvement was encouraged at various stages of CfE's development, encouragement strong support for its role in advancing Scottish education. However, there is a difference between the extent of stakeholder participation and the impact it has on achieving important improvements in CfE implementation. Stakeholders in curriculum policy include different groups (such as teachers, parents, school administrators, students, and politicians), as well as cooperative entities (such as the ministry of education, national agencies, local governments, and teacher unions) that are cooperatively involved in a curriculum.

Their involvement refers to the processes through which they get involved, believe responsibility, and communicate during all phases of the development and implementation of a curriculum in daily practice and evaluations (OECD, 2021, p. 72). A variety of governance committees, advisory groups, and other stakeholder interaction forums that further fill the ecosystem were created because of specific structures that also appeared around CfE (Paterson, 2018; OECD, 2021, p.72).

2.6 Technology in Scottish Schools

The increasing importance of ICT in everyday life over recent decades has transformed various industries, including the education sector. Education Scotland's "Digital Technology Report" highlighted the crucial role of ICT in enhancing learning, despite its limited use in delivering tasks or lessons (Scottish Government, 2015). ICT has huge potential to benefit learning by motivating students and connecting learners to their career ambitions, according to this report, which gathered from 40 schools. Importantly, a technological change regarding the use of digital technologies at school has only occurred modestly (Scottish Government, 2015). Scotland's adoption of ICT has advanced in comparison to its international peers. In addition, Scotland is still considered the pioneer of national ICT policy for primary schools (Assessment-Result, 2016).

Concerning the synergy between general industries and educational services, it is an important fact that children and young people nowadays require technology skills to develop their learning process, especially at the primary or foundational level (Prensky, 2008). The ICT skills that students should acquire include hardware and software competencies to collect, process, store, present, and share educational information in digital form. Multimedia technology is a principal part of ICT, and it entails processing and displaying information using diverse media formats such as digital text, audio, video, and others (Guan, Song and Li, 2018). In other words, technologies combine two or more formats to present information in the best way possible (Abdulrahaman *et al*., 2020).

Research on technology in explores the difference between simply introducing ICT tools and using them to effectively promote learning and curriculum goals (Guan, Song and Li, 2018; Abdulrahaman *et al*., 2020). Reinforcing this point, the Scottish Government (2015) emphasised the need for proper implementation methods to make technology-based education effective in primary schools. To achieve this, educational technology specialists, including practitioners, should contribute their knowledge and skills to tailor right technologies for classroom learning activities (Mayer and Moreno, 2003).

2.7 Key Educational Policies and Importance in Scotland

Scotland's education policies and priorities revolve around several key areas, all of which aim to enhance the quality of education and improve the well-being of its students.

Curriculum for Excellence: Founded in 2010, the CfE serves as the foundation for the Scottish education system. CfE's primary goal is to adopt the development of knowledge and skills, including effective learning and professionalism. CfE's four key components, successful learning, responsible nationality, effective contributions, and confident individuals, reflect this goal.

Getting It Right for Every Child: Presented in 2006, GIRFEC serves as a framework to ensure the holistic well-being of children and their early stages. In 2019, the Scottish Government adopted a non-statutory approach to promote and insert GIRFEC through partnerships with local delivery partners, emphasising practical support and guidance. GIRFEC is considered a fundamental element of inclusive education in Scotland, and it is currently undergoing revisions to improve collaboration between local partners and the government (Children and Young People, Scottish Government, 2021).

Early Childhood Care and Education: "Realising the Ambition: Being Me," available in February 2020, updates national practice guidance for the early learning and childcare sector. This guidance aligns with CfE and provides pedagogy and practice recommendations for professionals working with young children, informed by national and international early childhood research. It supports consistency with other policies, such as GIRFEC (Scottish Government, 2021, p. 39).

Scottish Attainment Challenge: Launched in May 2016, the Attainment Challenge aims to focus on the achievement gap between children and young people from the least and most disadvantaged communities. This initiative forms part of the government's aim to enhance literacy, numeracy, and well-being in schools and Local Authorities. This undertaking has received significant funding (GBP 750 million over five years), and progress reports show a reduction in the attainment gap based on performance and evaluations (Scottish Government, 2021, p. 46).

Teacher and Leadership Policies: In 2010, a significant review of teacher education emphasised the importance of teaching quality and leadership in Scotland's educational goals (Donaldson, 2010, p. 25). This resulted in an increased emphasis on enhancing teacher professional development and the significance of career strategies to facilitate teacher recruitment and retention. The review also highlighted the growing frequency of master's studies for educators at various professional levels. In response to recruitment challenges in specific subjects and remote areas, Scotland introduced various initial teacher education programs.

The development of teacher career pathways, which were instructed between 2017 and 2020, has faced delays due to the COVID-19 crisis, theoretically affecting the original implementation timeline set for August 2021 (Scottish Government, 2021, pp. 60-61). Nevertheless, the Scottish Government has ranked educational leadership development, offered expanded professional development, and introduced the Standard for Leadership, a new qualification for school leaders. The Scottish College for Education Leadership handed over the responsibility for enhancing educational leadership in Scotland to Education Scotland and its Professional Learning and Leadership Directorate in 2018. Education Scotland has launched an evaluation process to improve professional learning chances in collaboration with Regional Improvement Collaboratives, Local Authorities, and the Learning Directorate (Scottish Government, 2021, p. 59).

2.8 Summary of Chapter

This chapter set the scene for the investigation unpacked in this thesis by reviewing the salient features of the Scottish educational system. The CfE, GIRFEC, Early Childhood Care and Education, and Scottish Achievement Challenge are among the primary educational policies and issues examined in Scotland. The chapter also examined teacher policies and leadership, emphasising leadership initiatives, career trajectories, and professional development. The chapter gave crucial background knowledge needed to understand Scotland’s educational system and the research’s areas of interest.

Chapter 3

Technology Integration (Tech-Int): Theoretical Perspectives, Models, and Influential Factors in Educational Settings

Scholarly investigations into the use of technology within educational contexts, particularly in the realms of pedagogy and Tech-Int, are constantly supported by one or more theoretical frameworks. These theories and models provide valuable insights into the determinants that influence the acceptance and proficient use of technology in T&L environments. Important factors that influence the adoption and use of technology in educational settings include the technology's perceived utility, compatibility with existing practices, and complexity of use for both educators and students. This chapter explores the rationales for Tech-Int in education, examines established models and theories, and discusses their significance in understanding how technology can affect T&L in classroom settings.

3.1 Rationales for Tech-Int in Education

The education sector has an important concern about staying aligned with society's use of technology in education (Ghavifekr and Rosdy, 2015). Besides this, various economic and educational justifications need to be considered to understand the stakeholders involved in Tech-Int in education (Timotheou *et al.*, 2023). The term "digital natives" was formulated to describe how confident young learners are in using technology due to their constant display of it in their daily lives (Prensky, 2001). Related to this, the term of "learning styles" (such as visual, auditory) has also influenced how some teachers and parents approach digital tool use, although the concept is debated in the literature and not supported as a validated instructional model (Pashler et al., 2008). In this research, the term is referred to in the context of stakeholder perceptions, especially how some teachers and parents view individual learning needs, rather than as a validated instructional design principle. These perceptions continue to shape expectations around technology use, particularly when digital technology are believed to align with a child's "style" of learning.

Researchers agree that children are naturally attracted to technology (Miller, 2018), which contributes to the convincing reasons for making technology itself an essential part of the education curriculum, as argued by both external and internal rationales (relative to the education sector) (Ertmer, 1999; Selwyn, Potter and Cranmer, 2010).

Kozma (2008) described internal rationales as those involving elements of technology use that can enhance educational practices, while external rationales stem from societal pressures outside of the education sector, emphasising the need for young learners to learn *through* technology in order to be able to deploy prerequisite skills for real-world needs. These reasons represent the main goals for using technology and create pressure to include it in education (Chen, Looi and Chen, 2009). Keeping up with children's technology use, meeting public expectations about the purposes and methods of technology use in education, and aligning with educational policy objectives are among these goals. Additionally, teachers and students need technology to engage young learners and ensure technology safe use (Selwyn, Potter and Cranmer, 2010).

3.1.1 External Rationales for Tech-Int in Children's Education

The external justifications for revolve around the societal and economic reasons for Tech-Int. From an economic perspective, governments are encouraged to support the use of technology in education by apportioning resources, funding, and policy support to prepare technologically proficient employees skilled in meeting the requirements of the "Information Age" (Kozma, 2008). This is particularly important in developed nations, where traditional areas of mass employment (e.g., manufacturing) are disappearing, underscoring the importance of advancing towards a knowledge-based economy driven by technology adoption and skills to use it (Selwyn, 2011).

In many developed countries, comprehensive "educational technology strategies" have been put in place, with the key aim of Tech-Int in T&L practices in schools. National policies on technology in education have been implemented in countries such as the USA, Europe, and the UK (including Scotland) (van der Vlies, 2020). Subsequently, there is a necessary need to provide young learners with an educational framework that includes technology, confirming they can meet the requirement for tech-understanding individuals who will form future employees (Koul and Nayar, 2021). The introduction of technology in children's education can be seen as a first stage in preparing young learners for the economic situation they will meet as they progress through their educational trajectory, training them with skills that can be further developed at higher educational levels.

3.1.2 Internal Rationales for Tech-Int

Internal justifications for Tech-Int in children's education, as indicated by Selwyn (2011), include obvious primary rationales, and additional advantages relating to practitioner preparation and administrative tasks. Furthermore, as Selwyn (2011) points out, technology can have a profoundly transforming impact on young children's learning and development processes. Educators who support constructivism and believe that technology can enhance children's cognitive development by serving as a social tool for active learning, particularly in problem-solving real-world scenarios, could potentially spearhead these reforms (Selwyn, 2011). Alternatively, practitioners, parents, and even the students themselves may seek the dynamic and collaborative problem-solving tasks that technology education can provide within the educational setting (Kim and Hannafin, 2011).

However, it is important to distinguish between the rationales for technology use, whether they come from external or internal sources, and the personal motivations of teachers who deliver technology in children's learning. Teachers' pedagogical knowledge, attitudes, and comprehension influence their motivations. While these rationales shed light on the broader reasons for the importance of technology use by young learners, they do not delve into the specific methods for comprehensively integrating technology into children's education in real classroom settings involving diverse stakeholders.

3.2 Theoretical Foundation: Development of Fundamental Conceptual Framework

Various psychological and social factors influence the interaction between individuals and technology (Taiwo and Downe, 2013). Given the complexity of predicting human behaviour, researchers have introduced numerous models and theories by which they have sought to comprehend factors in the acceptance of technological innovations (Alomary and Woollard, 2015). Researchers have extensively used these models and theories to forecast and explain users' acceptance of emerging technologies. Each model incorporates distinct constructs and moderators, resulting in variations in their influence on users' intentions and behaviours. Understanding Tech-Int in educational contexts requires drawing on several foundational theories that explain the complex dynamics of teaching, learning, and technology use.

Beyond the level of particular models, constructivism has been a central paradigm in many learning theories, particularly in the context of Tech-Int (Ouyang and Stanley, 2014). Two key constructivist learning theorists, Piaget (1970) and Papert (1990), viewed children as creators of their cognitive tools and of external facts. Their views hold that personal experience produces and constantly reconstructs knowledge and the world. Knowledge is more than a commodity that may be conveyed, encoded, remembered, and reapplied; it is a human experience that can be built through a process of cumulative and iterative learning (Papert, 1990).

According to this constructivist conceptualisation of "reality" as socially constructed, technology does not alter the process of knowledge generation; rather, it facilitates and improves it. Notable learning theories bolster the notion that technology may foster an active learning environment through discovery and problem-solving, and the constructivist and sociocultural perspectives underline the value of social interaction and knowledge creation within a community (i.e., social context) (Vygotsky and Cole, 1978; Bruner, 2009). Through social media platforms and applications, technology now significantly contributes to social discourse and community participation.

Social learning theory (SLT) bridges the gap between behaviourist and constructivist approaches by highlighting the influence of social interactions on learning. According to SLT, individuals learn by observing and imitating others, especially if they perceive favourable outcomes or rewards associated with the observed behaviour (Bandura, 1977). Observational learning, imitation, and modelling are fundamental principles of SLT that demonstrate the significance of social components in the learning process. When examining users' behavioural intentions, the theory of planned behaviour (TPB) (Ajzen, 1991) and the technology acceptance model (TAM) are particularly relevant. TPB advances in expecting the intention to use technology based on attitudes, perceived control, and subjective norms, while TAM focuses on how the way in which technology is perceived to be useful and easy to use drive technology adoption. Frameworks such as the Technological Pedagogical Content Knowledge (TPACK) Model in education extend these theories by emphasising the interplay between technology, pedagogy, and content knowledge. TPACK provides a comprehensive framework for understanding how teachers can effectively integrate technology into their teaching practices.

Cognitive science supports the notion that multimedia-based content, including images, words, and audio, can facilitate the establishment of mental constructs and enhance learning. Mayer's cognitive theory of multimedia learning emphasises the importance of integrating added information with prior knowledge to optimise learning outcomes (Mayer, 2005). By effectively using multimedia elements, such as sound, pictures, and animations, learners can reduce cognitive load and make meaningful associations between content, resulting in improved learning effects. Bronfenbrenner's (2005) ecological systems theory (EST) provides a comprehensive framework for understanding the impact of technology on a child's learning environment.

The theory emphasises the interconnection of various systems, from techno-subsystem to macro-systems, and how they influence Tech-Int in education (Johnson and Puplampu, 2008). Within this theory, the role of parents, teachers, and peers is crucial in creating congruent expectations and helping effective socialisation. Tech-Int in education relates to theories of learning and cognitive science, offering opportunities for active learning, knowledge construction, and meaningful engagement. Understanding the connection between ecological systems and effective learning principles can enhance the use of technology in learning environments, leading to improved educational outcomes for students. The following discussion explores many of these key theories in detail, focusing on how they specifically support the development of the research framework for understanding Tech-Int in education.

3.2.1 Ecological Systems Theory (Bronfenbrenner, 1979)

The primary construct of ecological theory shows that transitions are the social embodiment of individual participants rather than personal experiences. Urie Bronfenbrenner, a renowned American psychologist, pioneered the EST to prove how the social environment principally influences children's development, which provides "a unified but highly differentiated conceptual scheme for describing and interrelating structures and processes in both the immediate and more remote environment as it shapes the course of human development" (Bronfenbrenner, 1979, p. 11).

Based on this, Bronfenbrenner sought to prove how the social environment principally influences children's development (Guy-Evans, 2020). As such, the theory denotes the need for children to be assessed in multidimensional environments, or rather, in holistic ecological systems, to better understand their developmental process. The EST places children in the middle of the five-level concentric environmental model (see Figure 3.1), thus revealing the context within which everyone effectively interacts (Dockett and Perry, 2021). According to Bronfenbrenner (1979) a child's learning environment is made of a series of structural arrangements that can be ordered in a manner showing how they impact the child. He referred to these structural arrangements as "microsystems," "mesosystems," "ecosystems," "macrosystems," and "chronosystems," arranged from the smallest to the broadest interaction level. Guy-Evans (2020) summarised the Bronfenbrenner ecological model as follows:

Micro-system: It was suggested by Bronfenbrenner as the smallest level and the most immediate student environment. Examples of microsystems include home, school, peer group, community sphere, or daycare centres.

Meso-system: This level of interaction entails diverse microsystems where children live, and includes linkages between home and school, peer group and family, or to a broader extent family and community.

Exo-system: In Bronfenbrenner's ecological system, this level of interaction includes perceived linkages that could appear in more than one setting. This could not directly contain the developing child but impact the all the same. From the theorist, places or individuals with which children might not interact directly still hold significant influence on the child's life. The eco-system could include parents' workplaces, extended family, and the neighbourhoods.

Macro-system: This refers to the largest and most elaborate group of people and places in Bronfenbrenner's model relative to the child, and they still have a remarkable impact on them. Besides, this ecological system comprises the cultural dimensions, values, and prevailing beliefs not to mention the political and economic patterns.

Chrono-system: This is a unique assemblage of the time factor in Bronfenbrenner's theoretical model. It denotes both change and status quo in the child's environment. Changes such as family structure, physical address, parent's employment, and broader societal economic cycles or calamities include the aspect of the chrono-system.

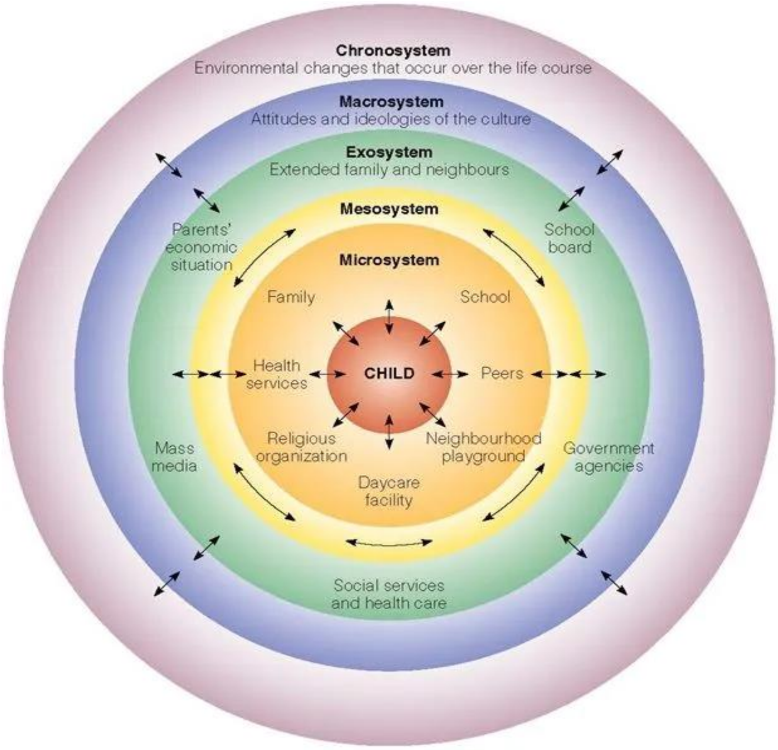

Figure 3.1: Pedagogy in Bronfenbrenner's (1977) micro-system

Source: Guy-Evans (2020)

3.2.2 The Ecological Techno-Subsystem (Johnson and Puplampu, 2008)

This theory extends Bronfenbrenner's (1977) original ecological systems model by emphasising the role of technology as a fundamental component of a child's developmental environment. The Ecological Techno-Subsystem presents how digital tools and resources interact with various systems that influence a learner's development (Figure 3.2).

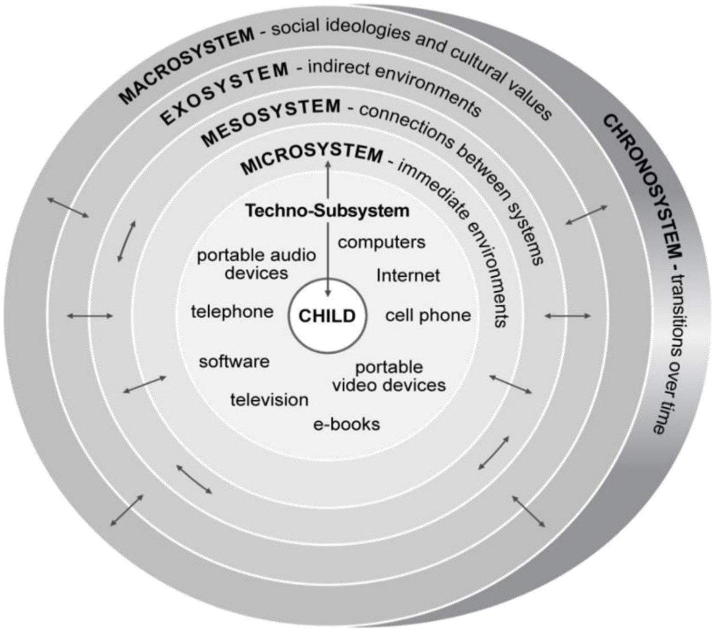

Figure 3.2: Ecological techno-subsystem

Source: Johnson and Puplampu (2008)

Ecological systems: The ecological systems approach offers a strong framework to understand how the techno-subsystem is influenced by the surrounding systems and how subsequent relationships affect the teacher and parents, the technological field, and the school setting where the child develops. Moreover, the macro-system pervades the school policy and children's access to assistive technology (Johnson and Puplampu, 2008). In this research, Bronfenbrenner's multifaceted approach helps us figure out what teacher, parent/carer, school environment (including headteachers' influence), and outside factors play in how stakeholders use technology (see Figure 3.3). Furthermore, this research suggests that the techno-subsystem concept fits seamlessly into this framework.

Techno-subsystem: As a present extension of the ecological model, the techno-subsystem emphasises incorporating technology into students' environments, reflecting how digital tools and resources affect their learning within primary school settings.

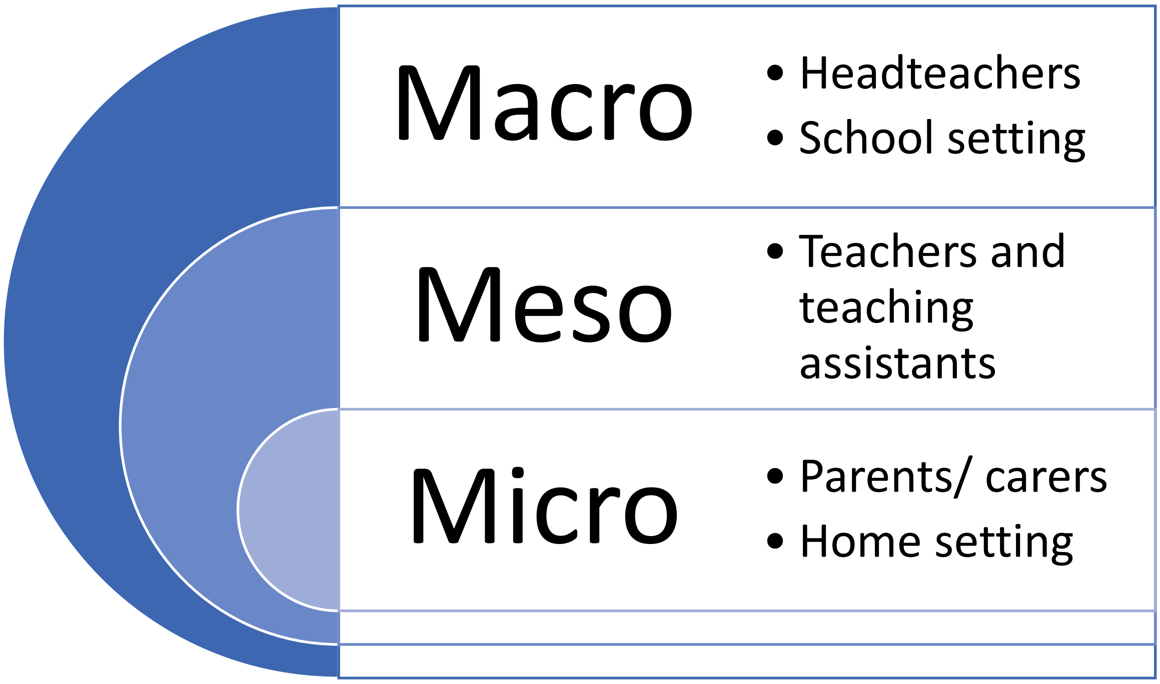

Figure 3.3: Ecological techno-subsystem: teachers, parents, and the dynamics of educational Tech-Int

Source: Author

Ecological theory confirms the intricate and evolving relationships between micro-, meso-, and macro-systems, and emphasises the complexity of Tech-Int within educational ecosystems. Zhao and Frank (2003) argue that schools use as eco-systems overlapping within broader community contexts that are themselves part of larger systems, such as local education authorities and national curricula. They propose an ecological framework as a strong approach to understanding the complex processes involved in ICT integration, finding barriers within pedagogical practices, school cultures, and the rapid pace of technological advancement, which often outpaces the skills of educators. Tearle (2003) similarly recognised the influence of macro- and eco-system forces on ICT integration, particularly in terms of external pressures, such as mandated curriculum requirements. However, her analysis primarily focused on how these external forces affect the meso-system without fully addressing the bi-directional nature of interactions between systemic levels.

This research suggests the significance of multiple systemic levels in shaping access to and use of technology within educational contexts (Figure 3.3). The macro-system, represented by headteachers and school settings, and the meso-system involves teachers and teaching assistants, who play important roles in influencing Tech-Int in schools. Additionally, the elements of microsystems, including parents and carers, must be aligned with the child's needs to advance efficient socialisation in the home setting. On the other hand, different elements or conflicting messages may lead to challenges in promoting the requested values and behaviour regulation (Bronfenbrenner, 1979; Campos-Gil, Ortega-Andeane and Vargas, 2020).

3.3 Theories Integration of Ecological Systems

The integration of the techno-subsystem in educational theories, particularly within the framework of EST, brings forth an intricate web of influences on how individuals learn and develop. While the EST primarily emphasises the role of social and environmental systems, including the digital and technological ecosystem, it is essential to connect this with contemporary learning theories, such as behaviourism and cognitivism theories, to expand a more complete understanding of the educational aspects.

3.3.1 Cognitive Theory of Multimedia Learning (Mayer, 2002)

This theory emphasises how individuals process information and learn through multimedia. It is based on the idea that people actively engage with content and integrate it into their existing knowledge. According to Mayer (2005), CTML works on the core principles explained below.

- **Dual channels for learning:** "The idea that people process visual and auditory information through separate channels" (p. 60). This principle suggests that presenting information using both visual and auditory cues enhances individuals' ability to engage it, thus enhancing the learning process.
- **Limited capacity:** "The concept that each cognitive channel has a limited capacity for processing information at any given time" (p. 60). This principle confirms the

idea of designing instructional materials to prevent overloading learners and thus enable them to concentrate on crucial information.

- **Active processing:** “the understanding that learning involves actively organising and integrating new information with existing knowledge” (p. 60). This process helps learners build meaningful connections, ultimately leading to better memory and comprehension.

This theory is particularly relevant to this research because it aligns with how technology (specifically, technological resources), can help learning by reducing cognitive load and enhancing engagement. Additionally, this framework is complemented by the techno-subsystem, which underscores the importance of technology in affecting students’ educational environments. Figure 3.4 displays the cognitive theory of multimedia learning.

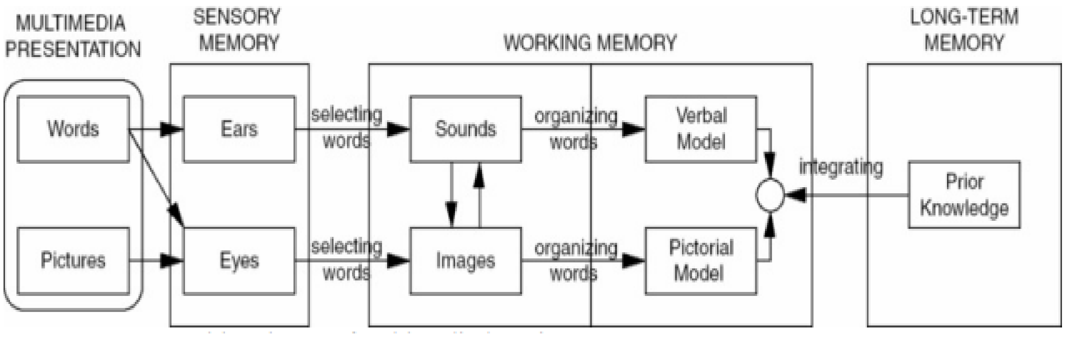

Figure 3.4: Cognitive theory of multimedia learning

Source: adapted from Mayer (2014)

3.3.2 Social Cognitive Theory (SCT) (Bandura, 1986)

Albert Bandura originally introduced the SCT in 1977, grounding it in the field of social psychology (Bandura, 1986). SCT highlights two primary constructs that influence behaviour: “outcome expectations” and “self-efficacy” (Compeau and Higgins, 1995). Bandura (1986, p391) defined self-efficacy as:

> “people’s judgements of their capabilities to organise and execute courses of action needed to reach designated types of performances. It

> is not concerned with the skills one has, but with judgments of what one can do with the skills one owns."

This theory shows four key constructs that shape self-efficacy: "personal mastery experiences," "vicarious experiences," "verbal persuasion," and "emotional arousal" (Alshahrani and Rasmussen Pennington, 2018). In the context of this research, SCT is relevant due to its ability to expect behaviour, particularly about how individuals engage with technology relative to their environment and behaviour, all of which mutually interact, as displayed in Figure 3.5.

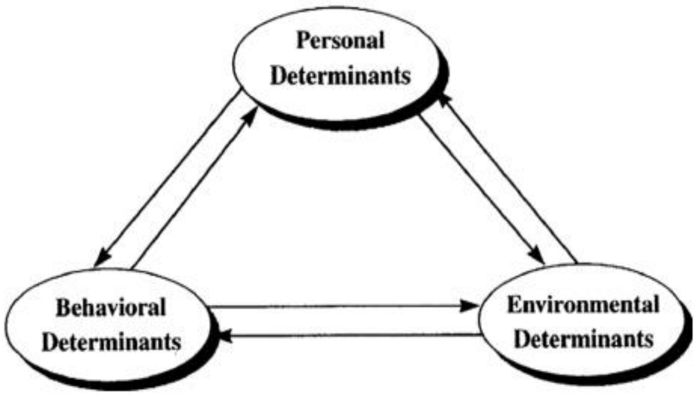

Figure 3.5: Social cognitive theory of learning

Source: Bandura, 2012

3.3.3 Theory of Planned Behaviour (TPB) (Ajzen, 1991)

The TPB, an extension of the Theory of Reasoned Action (TRA), sheds light on individuals' intentions and actions concerning specific behaviours. It includes three key components, as defined below according to Ajzen (1991):

- **Attitude toward behaviour:** "The degree to which a person has a favourable or unfavourable evaluation or appraisal of the behaviour in question" (p. 188).
- **Subjective norm:** "the perceived social pressure to perform the behaviour or not" (p. 188).

- **Perceived behavioural control:** "the perceived ease or difficulty of performing the behaviour, and it is assumed to reflect experience as well as anticipated impediments and obstacles" (p. 188).

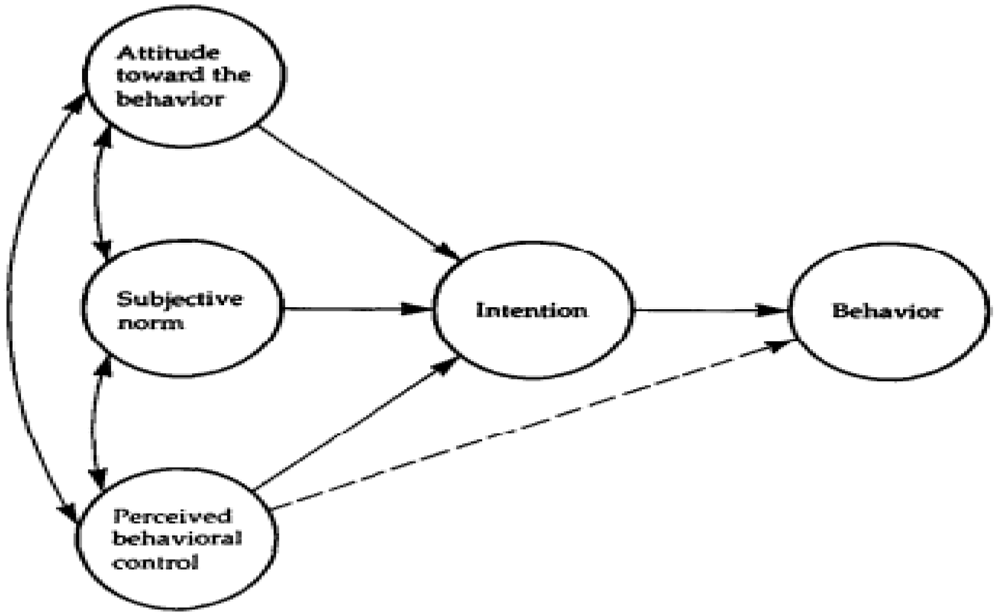

Figure 3.6: Theory of planned behaviour

Source: Ajzen (1991)

According to the TPB (Ajzen, 1991; Ajzen *et al.*, 2018), attitude is considered a broad concept made up of three distinct dimensions, which include various subcomponents that collectively shape an individual's attitude toward a particular behaviour. One of these dimensions, "perceptions of behavioural attributes," relates to the beliefs and emotions a person associates with a specific behaviour. This theory is suited for this research because it provides insight into users' behavioural intentions about the acceptance and use of technology.

3.3.4 Technology Acceptance Model (TAM) (Davis, Bagozzi and Warshaw, 1989)

The TAM is founded on two key constructs, as shown in Figure 3.7 and explained below, as defined by Davis, Bagozzi and Warshaw (1989).

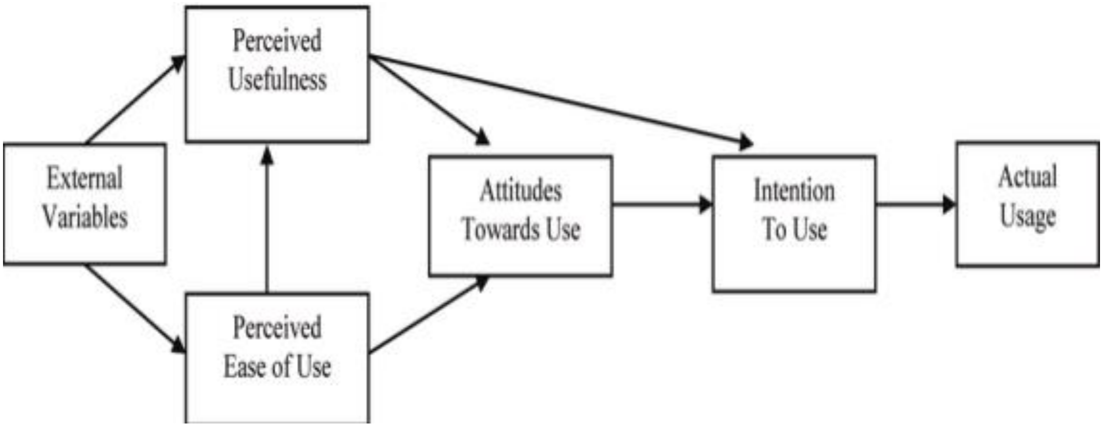

Figure 3.7: Technology acceptance model (TAM)

Source: Davis, Bagozzi and Warshaw (1989)

- **Perceived usefulness (PU):** "the extent to which an individual believes that using a specific system will improve their job performance" (p. 26).
- **Perceived ease of use (PEOU)**: "the extent to which an individual believes that using a specific system will require little physical and mental effort" (p. 26).

This model is relevant to this research as it evaluates users' intentions to integrate technology, aligning with the focus of this research. It is important to note that there is a revised version of this model, known as TAM2.

3.3.5 Technological Pedagogical Content Knowledge (TPACK) Model (Schmidt et al., 2009)

Schmidt et al. (2009) developed the TPACK framework, which expands on the concept of pedagogical content knowledge (PCK) first introduced by Shulman (1986). The model emphasises the intersection of three primary forms of knowledge: technology, pedagogy, and content, illustrated in Figure 3.8.

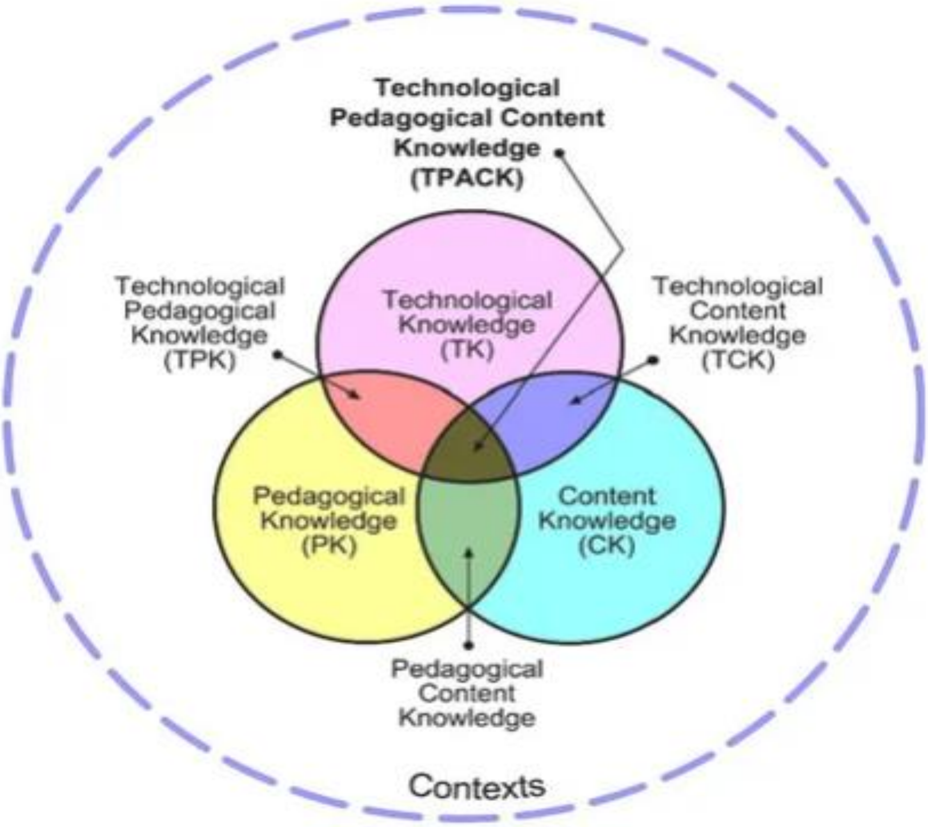

Figure 3.8: Technological pedagogical content knowledge (TPACK)

Source: Schmidt et al. (2009)

This framework is defined by the following constructs:

- **Technological knowledge (TK):** The understanding of various technologies, tools, and resources that can be used to enhance T&L.
- **Pedagogical knowledge (PK):** The knowledge of teaching methods and practices, including how to effectively engage and assess learners.
- **Content knowledge (CK):** The mastery of the subject matter being taught, involving both content's breadth and depth.

This research primarily relates to this model because it offers a thorough framework for examining how educators can successfully integrate technology into their pedagogical practices, ensuring that content delivery is both relevant and engaging for learners.

3.4 Key Findings Regarding Significant Theoretical Frameworks

The conceptual roadmap presented in Figure 3.9 was developed following a detailed synthesis of the theoretical foundations reviewed in this chapter. These include the Theory of Planned Behaviour (Ajzen, 1991), Ecological Systems Theory (Bronfenbrenner, 1979), Social Learning Theory (Bandura, 1986), Cognitive Learning Theory (Mayer, 2005), and educational technology perspectives from Selwyn (2011) and Kozma (2008).

While Figure 3.9 helped to conceptualise the theoretical relationships and guided the early stages of framework development, it served as a transitional framework bridging the literature review and developing a more focused model. Following further refinement and alignment with the study's aims and the specific context of primary education, the final conceptual model, Figure 3.10, presented in next section 3.5, was developed.

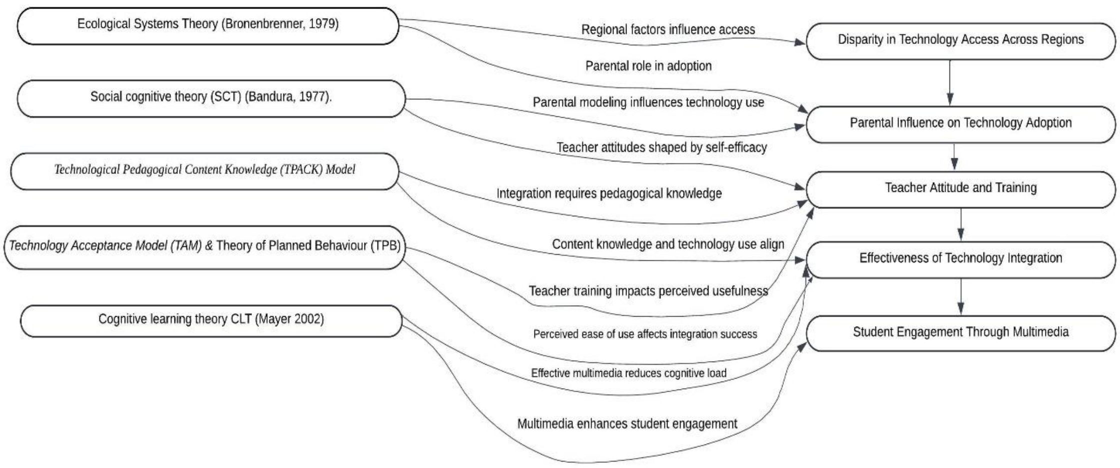

Figure 3.9: Conceptual map of theoretical framework

Source: Author

3.5 Developed Fundamental Conceptual Framework

The conceptual framework for TIPS developed in this research, as shown in Figure 3.10, outlines the key constructs influencing successful technology integration in educational environments. This framework draws from a range of educational and technology-related theories, including the Ecological Techno-Subsystem, CTML (Cognitive Theory of Multimedia Learning), SLT (Social Learning Theory), TAM (Technology Acceptance Model), TPACK (Technological Pedagogical Content Knowledge), and TPB (Theory of Planned Behaviour). These theories were selected for their complementary strengths in addressing the cognitive, social, behavioural, and contextual dimensions relevant to primary school settings.

The selection process was guided by the specific aims of this study and the unique characteristics of the primary education context. CTML explains how multimedia elements affect learning processes and outcomes, while SLT highlights the role of social interaction and modelling in learning environments. TPB and TAM were used to understand stakeholders' attitudes, beliefs, and behavioural intentions toward technology use. The Ecological Techno-Subsystem, a layer of Bronfenbrenner's broader ecological systems theory, was essential in contextualising technology use within the broader home, school, and policy environments. TPACK added a crucial educational perspective, emphasising the intersection of technological knowledge, pedagogical strategies, and content expertise necessary for effective integration.

Other frameworks, such as Connectivism (Goldie, 2016), were also considered during the development of the framework. Connectivism is often recognised as a learning theory suited to the digital age, especially in its focus on networked knowledge and informal, self-directed learning through digital platforms. However, it was excluded from the final model due to its limited applicability to the structured, teacher-led environments typical of primary education, where learners are still developing core cognitive and social capabilities. Furthermore, critiques of connectivism highlight concerns regarding its theoretical clarity and limited empirical foundation. Despite its exclusion, some of its broader ideas, such as the importance of socially mediated, technologically enriched learning, are reflected in this research through the inclusion of SLT and the Ecological Techno-Subsystem.

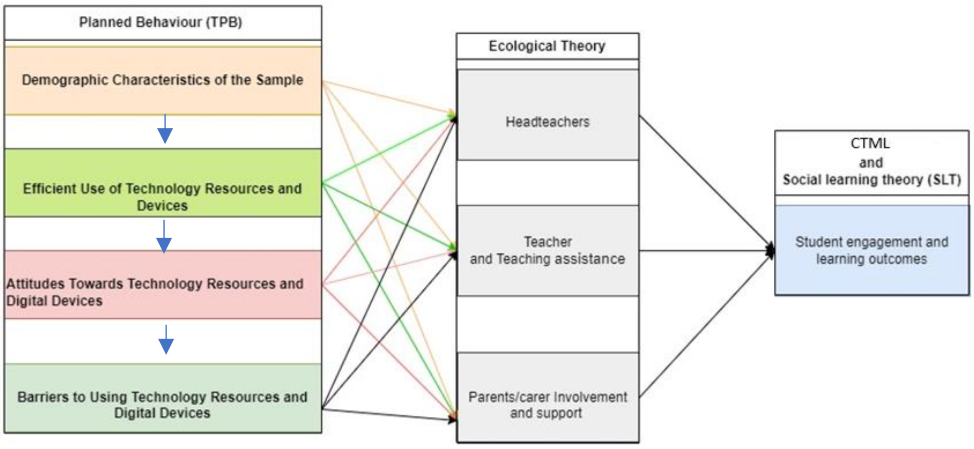

Figure 3.10: Technology integration in primary school (TIPS)

Source: Author

Demographics

Age, gender, socioeconomic level, and education affect technology acceptance and use, and these elements support EST (Bronfenbrenner, 1979), which shows how environmental levels affect children's development. A family's socioeconomic condition or parents' education (part of the micro-system) affects children's technological access.

Efficiency

The TAM highlights that the PU and PEOU of technology significantly impact teachers' and students' efficiency in integrating it. Technology is more likely to be accepted if it improves teaching efficacy and is easy to use, resulting in efficient educational outcomes. Teachers and parents are more likely to use technology if they think they can.

Attitude and Belief

Attitude and belief focus on how perceptions, norms, and individual motivations influence the use of technology. The TPB confirms the importance of attitudes toward technology, subjective norms, and perceived control as determinants of intention to use technology. Both teachers' and parents' attitudes towards Tech-Int are critical. Positive attitudes can motivate greater technology usage in learning environments.

Barriers and Challenges

Barriers and challenges refer to barriers that hinder effective Tech-Int in education. The TPACK framework identifies a lack of training in combining technological, pedagogical, and content knowledge as a key challenge, limiting teachers' ability to use technology effectively. Similarly, the TAM framework highlights how insufficient resources, poor infrastructure, and poor training reduce the perceived ease of use (PEOU) and perceived usefulness (PU) of technology, discouraging Tech-Int. The TPB framework points to perceived behavioural control, where low confidence and limited institutional support can reduce the intention to use technology, even if attitudes are positive.

3.6 Summary of Chapter

To fully understand TIPS, one must combine theories and models on multi-level processes, interactions, ecological considerations, and educational transformation. This research employs Bronfenbrenner's EST to examine the factors influencing the use of technology in primary schools and the various stakeholders at the micro, meso, and macro levels. It focusses on the interactions between individuals, the system, and technology. The "Fundamental Conceptual Framework" developed based on the above analysis incorporates insights from several pertinent theories and models to account for the multidimensional influences on how parents and educators use technology in the techno-subsystem of primary schools. This chapter outlines the components of the theoretical framework, thus structuring the investigation.

Chapter 4
Research Methodology

4.1 Introduction

This chapter details the mixed-method approach used in the research presented in this thesis. The chapter also provides a detailed justification of the selected methods and describes the development of data collection instruments, sampling techniques, recruitment procedures, data analysis strategies, ethical considerations, and measures to ensure trustworthiness. This research aims to answer the following research question:

- What is the impact of Tech-Int on T&L in primary schools in Scotland?

To achieve this, the research focuses on the following objectives:

Objective 1: To critically review and evaluate the role of Tech-Int on T&L in primary schools.

Objective 2: To analyse stakeholder attitudes and behavioural influences on Tech-Int.

Objective 3: To identify barriers and challenges to Tech-Int in education.

To achieve these objectives, this research employs a mixed-method approach, beginning with a systematic review to address objective one Chapter 5, followed by a sequential explanatory strategy. This methodological design is guided by a pragmatic philosophy, which provides the ontological, epistemological, and methodological foundation to explore the complex issue of technology in education. Pragmatism enables the integration of quantitative and qualitative methods, where quantitative data is collected through online surveys to address the second and third objectives, for more details, Chapter 6. Finally, qualitative semi-structured interviews were conducted to further investigate, validate, and deepen understanding of the key findings as presented in Chapter 7.

4.2 Research Philosophy

Defining the research philosophy is critical when undertaking social science research. The philosophical assumptions and paradigms underlying the research influence the methodological approach and knowledge generation process (Saunders et al., 2009).

This research study is guided by a pragmatic philosophy that focuses on the research problem and uses mixed approaches to derive knowledge about the problem (Creswell, 2014). Pragmatism directs the researcher to examine both objective and subjective points of view to fully understand the research topic.

The ontological orientation of pragmatism acknowledges that both singular and multiple realities exist. In this research, the reality of Tech-Int on education is shaped by the unique perspectives of various stakeholders like teachers, parents, and headteachers. However, there are also observable facts and quantifiable data around technology usage and academic outcomes. A pragmatic approach allows examining the topic through both lenses.

The epistemological stance recognises that knowledge can be generated by practical action and intervention, in addition to abstract reasoning. This aligns with the study's mixed methods approach, where survey data is integrated with insights from interviews.

Methodologically, pragmatism opens the door to mixed approaches. The combination of quantitative and qualitative methods provides a real-world, practical understanding of the research problem.

Finally, the pragmatic philosophy guidance this research provides the ontological, epistemological, and methodological grounding to fully investigate the complex issue of Tech-Int in education. It allows obtaining practical and socially relevant findings to inform stakeholders.

4.3 Research Approach

The research approach adopted in this research is focused on testing existing theoretical frameworks and is generally categorised as either deductive or inductive. The deductive approach is typically employed to develop a theory, formulate hypotheses, and design a research strategy to test these hypotheses (Saunders, 2019). Conversely, the inductive approach involves collecting data to generate a theory based on the analysis of the outcomes (Azungah and Kasmad, 2018). In this context, deductive research collects data to test existing theoretical frameworks, while inductive research generates theory from the analysis of data. Saunders (2019) further explains that the inductive approach aligns with interpretivism, while the deductive approach is associated with positivism.

In the deductive approach, theory plays a central role at the outset of the research process. The theoretical framework is first proved before any attempts are made to test the hypotheses or concepts derived from it. As such, theoretical principles guide the data collection and analysis process (Bryman, 2016). In contrast, the inductive approach is designed to develop theoretical concepts based on the findings of the research. This method is more flexible, allowing theoretical insights to appear organically from the data as it is analysed and refined (Bryman, 2016).

Although the distinctions between these two approaches appear strict, many research studies adopt a more flexible approach by combining elements of both methodologies at different stages of the research process (Saunders, 2019). Anderson et al. (2015) argue that selecting the most proper approach, whether deductive, inductive, or a combination, should be guided by the research objectives and the specific nature of the research topic.

In this research, a mixed-methods approach was adopted. The research began with a deductive process by proving a fundamental conceptual framework (see Section 3.5) followed by developing hypotheses (see Section 5.6), which were tested using quantitative data collected through a questionnaire presented in Chapter 6. This was followed by an inductive phase, involving semi-structured interviews analysis presented in Chapter 7, where insights were drawn from participants to refine and enhance the understanding of the quantitative findings. This combination allowed the research to integrate theory-driven insights with data-driven discovery, aligning with the research's objectives.

4.4 Research Design

This research employed a mixed method design, which enables the researcher to gather data either simultaneously or sequentially to reach an in-depth understanding of the research problem. Both quantitative instruments and qualitative instruments are used in mixed methods research (Tashakkori and Creswell, 2007). As stated by McDonnell, Scott and Dawson (2017), using more than one research method enables the researcher to effectively diagnose the research question from various perspectives. Schoonenboom and Johnson (2017) mentioned that mixed research methods serve five primary functions, including triangulation, complementarity, development, initiation, and expansion. Campbell *et al*. (2020) say that triangulation is a useful method in qualitative studies because it makes the study more trustworthy. Triangulation uses more than one way to collect and analyse data to check the validity and dependability of the results.

Data triangulation is a way to make sure that research data is correct, by cross-checking inferences with results from different sources. Moreover, triangulation verifies the consistency of the results and enhances the control of the research instrument, where the research can evaluate potential risks or factors that could affect the research's outcomes. Importantly, triangulation not only validates findings but also allows the researcher to examine the participants' responses in depth and more meaningfully.

Triangulation provides multiple perspectives about the data, enabling innovative conceptual framing for meta-interpretations. This research employed a mixed-methods approach to investigate and verify quantitative data (from online surveys) with qualitative data (semi-structured interviews). This combination of methods represents triangulation, as it integrates multiple data sources to cross validate findings and ensure greater reliability and depth of understanding.

4.5 Road Map and Research Instruments

This section outlines the empirical instruments used in this research to achieve its objectives. The research followed a sequential design, where each phase developed on the findings of the previous one. As illustrated in Figure 4.1, the study employed three main research instruments: a systematic review, a questionnaire, and follow-up semi-structured interviews.

Before these phases, a comprehensive literature review was conducted to examine relevant theories and existing conceptual models (see chapter3). This informed the development of the theoretical framework and shaped the overall direction of the research.

The systematic literature review was conducted to develop a foundation in existing knowledge and inform the development of hypotheses and survey questions. The questionnaire was designed to collect quantitative data, exploring stakeholder perspectives on Tech-Int. Follow-up semi-structured interviews provided qualitative insights, offering a deeper understanding of key findings from the survey. The next sections provide detailed descriptions of each method, outlining their design, implementation, and contribution to the research objectives.

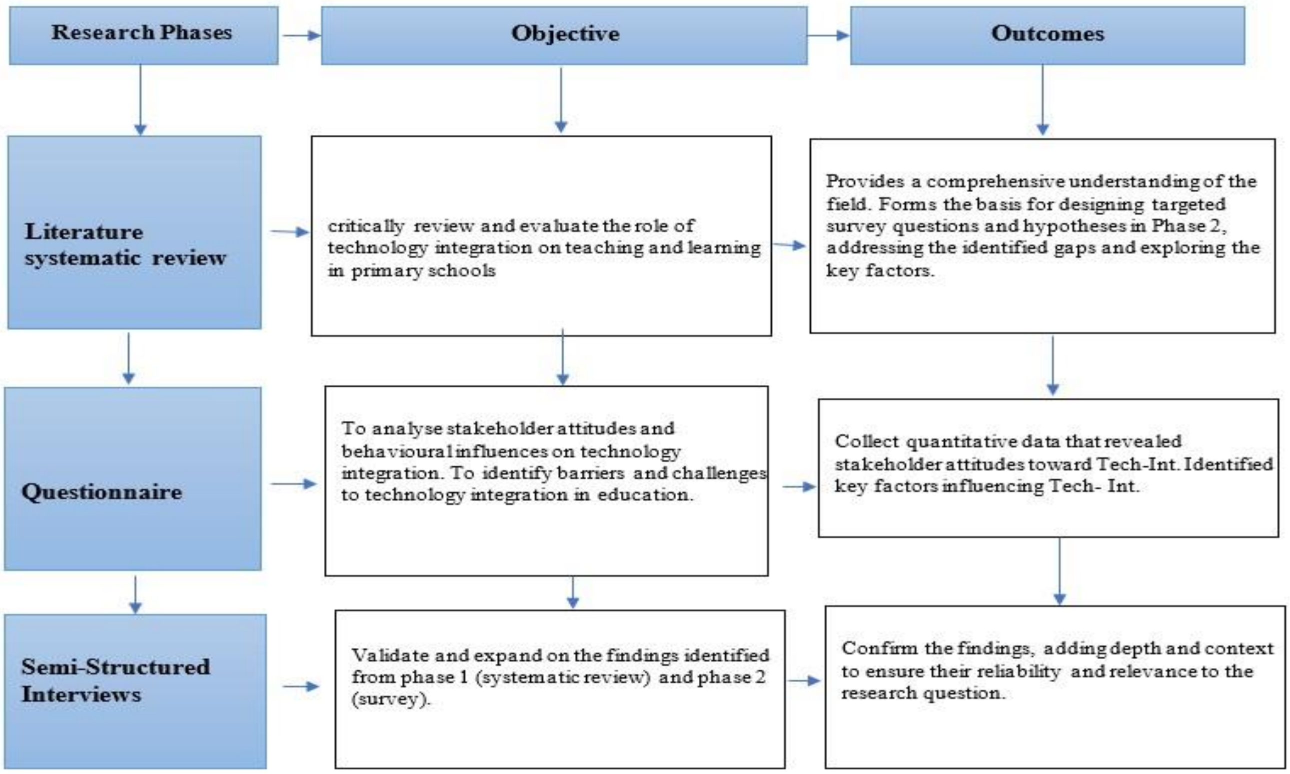

Figure 4.1: Road Map and Research instruments

Source: Author

4.6 Phase 1: Systematic Review

An integrative review is a distinct methodological approach used to synthesise existing empirical and theoretical literature, offering a comprehensive understanding of a particular phenomenon or issue. As outlined by Whittemore and Knafl (2005), this method allows for the inclusion of diverse sources and study designs, making it particularly suitable for exploring complex topics across different contexts. Although commonly applied in health and nursing research, its utility extends to educational research, where it can inform theory, policy, and practice.

In this research, the integrative review approach was adopted to address Objective 1: "To critically review and evaluate the role of technology integration on teaching and learning in primary schools." This phase aimed to explore how technology impacts learning outcomes and to identify the barriers and enabling factors influencing its integration in primary education.

This method was selected because it enables a nuanced exploration of both conceptual frameworks and real-world practices, supporting the study's broader focus on stakeholder perspectives and contextual challenges. The insights gained from this phase informed the development of the research model and hypotheses and guided the design of the survey instrument used in Phase 2 (Questionnaire) to address Objectives 2 and 3. This phased structure ensures continuity between the stages of the research and contributes to a cohesive and theoretically grounded investigation.

A systematic review is a meticulous, gold-standard methodology for synthesising scholarly evidence, integrating critical and responsible techniques to articulate the research topic under consideration effectively; this approach involves the coherent mix of relevant research identified and described through obvious, rigorous, and transparent methods (Gough, Thomas and Oliver, 2012). Systematic reviews, which were initially predominant in natural sciences like medical studies (Cook, Mulrow, and Haynes, 1997), have expanded across disciplines, and now involve social science, policy research and many other disciplines (Mallet *et al.*, 2012). This expansion underscores its flexibility and increasing relevance in different research views. The undertaking of a systematic review aims to combine relevant studies with research questions, applying correct methods to determine conclusive insights (Jahan *et al.*, 2016).

This includes a review protocol outlining the search and review phases. The correct execution of a systematic review is fundamental, with observance to specific criteria such as transparency and accuracy, ensuring the production of replicable and unbiased results (Greenhalgh *et al.*, 2005). Systematic reviews are instrumental for policymakers seeking strong, reliable, and evidence-based solutions to inform sound decision-making and justify public programs (Roberts *et al*., 2004). They serve as a substantial foundation for policy and educational innovation, particularly within empirical research that informs and improves educational practices. One prevalent synthesis method is meta-analysis, utilising statistical techniques to combine findings from different studies into a cohesive quantitative representation (Roberts *et al*., 2004).

Meta-analysis is particularly common in controlled trials focusing on healthcare and social interventions (Glass, McGaw and Smith, 1981; Gough, Oliver and Thomas, 2017). It is crucial to classify between different types of reviews, notably between aggregative and configurative reviews. Aggregative reviews combine similar data to make empirical statements. Such reviews are often used in interventions where combining similar studies ensures that statistical tests are important and valid. In contrast, configurative reviews discern patterns from heterogeneous studies, interpreting, and organising information to conceptualise phenomena (Barnett-Page and Thomas, 2009). A detailed overview of the systematic review process, including detailed steps, a PRISMA flow diagram, and paper selection criteria, is given in Chapter 5.

4.7 Phase 2: Quantitative Study

This phase employed an online questionnaire to address the following objectives:

Objective 2: To analyse stakeholder attitudes and behavioural influences on Tech-Int.

Objective 3: To identify barriers and challenges to Tech-Int in education.

The questionnaire method was selected to systematically gather quantitative data from a wide range of stakeholders. This data helped to capture insights into attitudes, behaviours, and challenges related to Tech-Int, which were key to achieving the objectives. By using a structured online format, the survey ensured that diverse stakeholder groups could provide their perspectives efficiently and consistently, allowing for comprehensive statistical analysis and meaningful comparisons, for generalisation among broader populations. This is one of the expedient advantages of online quantitative questionnaires, as highlighted by Hulland, Baumgartner and Smith

(2018), which supports their use in this. Specifically, electronic questionnaires offered the convenience of reaching individuals or groups through established online platforms, such as emails, which made them suitable for collecting extensive data in a cost-effective manner (Creswell, 2014). This method also minimised the logistical challenges that are typically associated with in-person interviews, such as scheduling and travel, therefore enhancing accessibility and efficiency (Saunders, Lewis and Thornhill, 2009).

4.7.1 Questionnaire Design

The questionnaire aimed to gather data and insights from teachers (TCRs), teaching assistants (TAs), headteachers (HTs), parents/carers (P/Cs) in primary schools. These groups were selected because represent key stakeholders involved in Tech-Int in the educational context. Further details on the roles and choice for these groups are provided in Section 2.5 and 3.2.2.

This information was formulated into the final version of the online questionnaire (Appendix A) to further explore, confirm, or expand upon the findings of the systematic review. Table 4.1 shows the divisions of the survey used in this research (as developed by the researcher, based on the reviewed literature).

Table 4.1: Summary of questionnaire parts

Survey Part	Aim/Objective	Question Types
Describe Your Job	Understanding diverse participant roles and perspectives.	Multiple-choice
	Customising follow-up questions based on roles.	
	Recognising that technology impact varies by educational roles.	
Part 1: Participant information	Collect demographic information about respondents. Include age, gender, years of experience, education level, etc.	Multiple-choice (categorical), numerical (age, income)
Part 2: *(Efficiency)* Technology Usage and Training	Investigate technology usage and training experiences. Cover training, resources of learning, frequency of use, device preferences, and observations of children's use	Multiple-choice (categorical), Likert scale (frequency, beliefs), open-ended.
Part 3: Attitude about Technology Usage	Explore respondents' perceptions and attitudes regarding the role of technology in education **For parents and carers:** Understand how parents and carers perceive the impact of digital technology on their child's academic and personal development. **For Teachers and Assistants**: Investigate teachers' and assistants' views on the educational environment enhanced by technology. **For Headteachers:** Explore how technology integration aligns with their strategic vision for primary education.	Likert scale (attitude statements)
Part 4: Barriers to Tech-Int	Assess respondents' agreement with statements about barriers to technology usage in schools	Likert scale (agreement statements)

"Describe Your Job"

This section serves as a critical component of the survey design, allowing us to understand the diversity of roles and perspectives among the participants. It is particularly important as it lays the foundation for tailoring subsequent questions to the specific roles of respondents, acknowledging that the impact and perceptions of technology may vary significantly based on their professional roles within the educational context.

Part 1: Participant Information

In the “Participant Information” section, demographic details of the respondents were collected. These details include the council area of the primary school, age, household income, gender, years of experience, current teaching level, and the highest level of education. This information serves as a foundational dataset for the research.

Council area: This information was collected from all participants (teachers, headteachers, parents/carers, and teaching assistants) to understand regional variations in Tech-Int and educational practices.

Age and gender: These demographic variables were collected from all participant groups. Age and gender are essential demographic variables that can influence technology usage and training preferences. Analysing these variables can help identify trends and differences.

Years of experience: This variable is specifically applied to educators (teachers, headteachers, and teaching assistants). The years of experience in the current role is critical for assessing the relationship between experience and technology adoption.

Current teaching level: This variable was gathered from teaching staff (teachers and teaching assistants) to provide insights into the grade levels being taught and how technology usage might differ among various age groups.

Highest education level: This was collected from both educators (teachers, headteachers, and teaching assistants) and parents/carers. Understanding the educational background of educators and parents/carers is vital as it can influence their perceptions and attitudes towards technology.

Child’s age and household income: For parents/carers, knowing the child’s age and household income helps contextualise their responses and allows for a more comprehensive analysis of technology use within households.

Part 2: Technology Usage and Training

This section delves into the participants' experiences and perceptions regarding technology in education. It includes specific questions about training and sources of learning for educators, in addition to frequency of technology use, device preferences, and observations of children's technology usage for both teachers and parents.

Training on technology use: This question for educators assesses the availability and effectiveness of training programs, which can significantly impact educators' competence and confidence in using technology.

Sources of learning: Identifying how teachers and teaching assistants learned about technology usage provides insights into their preferred learning channels, which can guide future training initiatives.

Frequency of technology resources use: Understanding the frequency of technology use in lessons among teachers and P/Cs helps gauge the integration level and potential areas for improvement.

Device preferences: Information about preferred devices for T&L among teachers and P/Cs is valuable for educational planning and resource allocation.

Observations of children's technology use: This question for both teachers and P/Cs allow for a comparison between educators' perceptions and the actual technology usage patterns of children, shedding light on any gaps in understanding.

Part 3: Beliefs About Technology Usage

This section investigates participants' perceptions of the educational environment created by technology resources and digital devices. This section features different Likert-scale questions specifically tailored to each participant group (parents and carers, teachers and teaching assistants, and headteachers) based on their unique roles and perspectives in the educational ecosystem. The findings from phase1, in turn, guided the design of the questionnaire to ensure that the questions addressed the distinct responsibilities, attitudes, and expectations of each group regarding Tech-Int.

This iterative process reflects the cyclical nature of the relationship illustrated in Figure 4.5, where insights from each phase influence the next.

Part 4: Barriers to Tech-Int

This section explores the extent to which participants agree with statements about the challenges associated with technology usage in schools. The same set of Likert-scale questions with five-point agreement scales was used for all participant groups. These questions were developed based on the initial theoretical framework and refined through insights gathered from the systematic review. This process ensures that the identified barriers are both theoretically grounded and reflect practical challenges found in the existing literature. This part is crucial for identifying potential obstacles to effective Tech-Int and can inform strategies for addressing these challenges.

The survey design presented here is a comprehensive framework for collecting data on technology usage, training, beliefs, and barriers in the context of primary education. The selected questions and sections were carefully designed by the researcher to provide a holistic understanding of the research topic. The data collected through this survey enables the analysis of the current state of Tech-Int in Scotland's primary education and in identifying areas for improvement and further research. Additionally, the demographic information collected will allow for the stratification of responses, enabling a more nuanced analysis and a deeper exploration of potential disparities or trends within the sampled population. The survey design is informed by a systematic literature review and a robust theoretical framework. The systematic review provided a foundation for designing the survey statements, ensuring alignment with established findings and identifying key areas of inquiry. This process was further guided by theories (see Chapter 3), where constructs from the Theory of Planned Behaviour (TPB), the Technology Acceptance Model (TAM), and the TPACK framework informed the inclusion of questions addressing attitudes, behavioural intentions, and technological efficiency. By integrating these theoretical and evidence-based foundations, the survey provides a strong basis for in-depth research into the role of technology in primary education.

4.7.2 Questionnaire Sampling for Teachers (TCRs), Teaching Assistants (TAs), Headteachers (HTs), and Parents/Carers (P/Cs)

The questionnaire utilised a convenience sampling method to recruit participants. Links to the online questionnaire were distributed through email outreach, social media platforms like Facebook, and Scottish Primary TCRs. Convenience sampling enabled efficient access to a large pool of potential respondents across various regions and demographics. The goal was to obtain a diverse sample that included TCRs, HTs, P/Cs, and TAs from primary schools across Scotland. No specific quota sampling targets were set, but efforts were made to maximise participation from all relevant groups through broad outreach channels. The final sample size obtained was 213 participants, comprising P/Cs (n = 157), TCRs and TAs (n = 47), and HTs (n = 8).

4.7.3 Questionnaire Data Collection

The questionnaire data was collected through an online survey hosted on Qualtrics after the researcher received ethical approval at the University of Strathclyde and under registration (Application ID: 2158). The questionnaire was active for three months, from May 1st to August 31st, 2023. Participants accessed the survey via links shared through social media like Facebook, aiming to reach key stakeholders involved in primary education, such as those described below.

Scottish primary TCRs: The survey link was shared in groups on Facebook specifically for Scottish primary TCRs, engaging educators directly involved in Tech-Int in the classroom. Visit the group here.

Scottish primary HTs: The survey link was also shared with school administrators, including HTs, who play a critical role in decision-making and implementing technology in schools. Visit the group here.

Design and technology coordinators for primary school teachers:

The survey link was shared in Facebook groups specifically for primary school design and technology coordinators. Visit the group here.

"Glasgow Mums and dads" Group: These groups consisted of parents actively participating in discussions about primary education in Glasgow. Sharing the survey link in these groups ensured that parents' perspectives, particularly from a local context, were well represented. Visit the group here.

"National Parents Forum of Scotland": The survey link was shared in this group to distribute the survey broadly to parents across Scotland, providing insights from a diverse range of regions and socioeconomic backgrounds. Visit the group here.

Respondents completed the survey anonymously online at their convenience. The survey included multiple choice, Likert scale, and open-ended questions focused on five key areas: participant background, technology usage, training, beliefs, and barriers. Participants who provided an email address were entered into a prize draw to win a £30 Amazon gift voucher, which helped incentivise participation. IP addresses were not collected, and data was exported from Qualtrics and stored securely with encryption and password protection to keep anonymity.

4.7.4 Questionnaire Data Analysis

The questionnaire survey data analyses using descriptive and inferential statistical techniques to address the study's research questions and hypotheses. Univariate analysis was conducted to describe the distribution of individual variables. Measures of central tendency (mean, median, mode) and dispersion (range, standard deviation) were calculated for numerical variables such as age and years of experience. Frequencies and percentages were reported for categorical data like education level, gender, and technology usage.

Bivariate analysis examined relationships between two variables through chi-square, correlations, t-tests, and analysis of variance (ANOVA) tests. The Chi-square test was used to analyse the interaction between categorical variables (e.g., children's age with the age of parents). Correlation analysis assessed associations between interval variables such as age. T-tests evaluated differences in interval variables across two groups, such as gender, and 1-way ANOVA was used to test for differences across three or more groups, such as teaching roles and beliefs about technology.

It is important to acknowledge that the use of parametric tests with 5-point Likert scale data presents methodological considerations. While individual Likert items technically produce ordinal data, this research follows the approach advocated by Norman (2010) who contend that parametric tests are sufficiently robust to handle 5-point Likert scale data, particularly when:

1. The sample size is suitable; 213 exceeds the minimum recommended limit.

2. The data distribution approximates normality (which was confirmed through preliminary analysis).

3. Multiple 5-point Likert items are combined to form composite scales (as was done in this study for measuring technology attitudes and perceived barriers).

This approach is further supported by empirical evidence from Mircioiu and Atkinson (2017), who demonstrated that parametric and non-parametric tests often provided similar results when applied to 5-point Likert scale data in educational research contexts. Additionally, the use of means and standard deviations with 5-point Likert scales facilitates more nuanced interpretation and comparison across groups than would be possible with purely ordinal approaches (Harpe, 2015). The equidistant presentation of the 5-point scale in this study (with clearly identified points ranging from “Strongly Disagree” to “Strongly Agree”) further supports regarding these measures as approximating interval-level data (Lantz, 2013).

While acknowledging the ongoing discussion in the field (Sullivan, 2013), the decision to employ parametric statistics was made after careful consideration of the research objectives, data characteristics, and precedent in educational technology research using similar 5-point measurements. The statistical analysis was conducted using IBM SPSS (v. 28), which provided comprehensive tools for managing, analysing, and visualising quantitative data. SPSS allowed efficient cleaning, coding, and recoding of survey variables for analysis. Outputs from SPSS, such as tables and models, helped summarise key findings and relationships to address the study's research aims and hypotheses.

4.8 Phase 3: Qualitative Study

The qualitative study in this phase was conducted to explore in greater depth the findings from the previous phases and to gain a more nuanced understanding of stakeholder perspectives on TIPS. To address Objectives 2 and 3, a triangulation approach was used, which involved gathering data from multiple methods to ensure a comprehensive understanding of the research topics. The aim was to delve deeper into the attitudes, experiences, and contextual factors influencing technology use in education, which could not be fully captured through quantitative data alone.

Investigating and understanding a central phenomenon is the goal of qualitative research. To gain insights into this phenomenon, researchers ask participants open-ended, broad questions, gather detailed responses in the form of words or images, and analyse the data to identify themes and descriptions (Creswell, 2002). This approach was critical in capturing rich, contextual insights that help explain the quantitative patterns observed earlier, thereby providing a comprehensive understanding of the factors affecting Tech-Int. In this research, semi-structured interviews were used as the data collecting method to investigate integration technology in Scottish primary schools. This strategy allowed the researcher to explore personal experiences, attitudes, perceptions, and barriers related to the research aim (DeJonckheere and Vaughn, 2019).

4.8.1 Data Instrument

To address the research question, data were gathered using a qualitative research approach. In this research, semi-structured interviews were conducted to collect the data.

Hofisi, Hofisi and Mago (2014) defined an interview as a purposeful conversation. Rowley (2012) explained that during an interview conversation, the interviewer questions a list of questions to the interviewees who provide their responses. Hofisi, Hofisi and Mago (2014) further illustrated that an interview entails a verbal discussion through face-to-face, telephone, or video platforms where the parties express their perceptions, attitudes, and beliefs on the matter being discussed. An interview can be simply defined as a conversation started between two or more people through face-to-face or any media such as telephone, social media, or digital platform to exchange ideas, information, or beliefs on a specific topic.

The interview is supported by researchers as an essential tool for collecting information, ideas, and attitudes from individuals. Additionally, interview schedules offer a suitable setting for comprehending the events and perspectives surrounding the phenomenon under investigation (Rowley, 2012). As a result of these benefits, an interview is a suitable tool for engaging in a productive research study. Hofisi, Hofisi and Mago (2014) categorise interviews based on their flexibility. In principle, there are three types of interviews, namely structured, unstructured, and semi-structured. Structured interviews are just like questionnaires except for the fact that, in addition, the interviewer engages in an interview, listens to, and observes the interviewee’s cues (Pickard, 2013). Kumar (2018) added that structured interviews produce uniform information, therefore enhancing data comparability. Besides, unlike other formats, structured interviews are simple to carry out as they require no special skills.

Conversely, unstructured interviews aim to capture the interviewee’s thoughts, feelings, perceptions, attitudes, and knowledge about the phenomenon under investigation (Pickard, 2013). In this type of interview, the researcher is not restricted by asking the specific type of questions or order of questions (Kumar, 2018). Unstructured interviews can be very useful when exploring critical issues that need further clarification or inquiry (Pickard, 2013).

Lastly, semi-structured interviews lie between structured and unstructured interview types. Therefore, semi-structured interviews have moderate flexibility. For example, the researcher might modify the list of questions they have to address an important issue or concern during the research (DeJonckheere and Vaughn, 2019). Researchers, especially for qualitative studies, prefer semi-structured interviews because they combine elements of both structured and unstructured interviews (DeJonckheere and Vaughn, 2019).

4.8.2 Interviewee Sampling

Purposive sampling was used to recruit interview participants from the pool of questionnaire respondents. The goal was to conduct approximately 8-15 semi-structured interviews with a diverse mix of TCRs, HTs, P/Cs, and TAs. Participants who provided rich, relevant insights in the open-ended survey questions were invited to take part in follow-up interviews to gain deeper perspectives. Maximum variation sampling was employed to capture a wide range of views related to the research questions. In this research, the technique involved selecting subgroups from the initial sample of participants, specifically those who agreed to participate in the second stage of interviews. This method allowed for a more accuracy understanding of the research topic, capturing differences within specific groups while ensuring a broader range of views.

4.8.3 Interview Data Collection

This research used semi-structured interviews to collect data from 14 participants recruited from the initial survey respondents who agreed to participate in follow-up interviews. The participants represented various regions of Scotland and included HTs (n = 3), TCRs and TAs (n = 6), and P/Cs (n = 5). The interview data was collected through audio-recorded, video-conferencing interviews, approximately 30-40 minutes in length. Interviews were conducted on the platform Zoom to enable participation from different geographic regions. On the day of the interview, participants received an information sheet via email (Appendix B), which provided a brief overview of the research, explained their rights, and included contact details for both the researcher and his supervisors. The researcher also emailed the participants an interview consent form (Appendix C) for their signature. The researcher received the signed consent form via email and then sent an invitation link to the Zoom meeting to start the interview.

The interviews consisted of open-ended questions that built on key questionnaire findings, allowing participants to elaborate on their experiences and perspectives. The final interview questions are provided in Appendix D. Each interview was recorded, and notes were taken during the sessions to ensure no critical information was missed. The researcher manually transcribed the recordings on the same day as the interviews. Additionally, the researcher utilised transcription tools like Zoom transcription and Microsoft Office's Online Word to aid in the process and redacted any identifiable information to safeguard participant confidentiality. The researcher verified the accuracy of the transcriptions by listening to the recording's multiple times. Finally, the researcher simultaneously listened to the audio and read through the transcriptions to confirm their accuracy.

4.8.4 Data Analysis

Thematic analysis was chosen as the method for analysing the interview data because it provides a flexible yet systematic approach to identifying and interpreting patterns across qualitative datasets (Braun and Clarke, 2006). Thematic analysis is particularly suited to this research because it allows for a detailed exploration of participants' experiences and perspectives on Tech-Int, making it ideal for understanding complex issues from multiple stakeholders (Nowell *et al*., 2017). Unlike other methods such as content analysis, which focuses primarily on frequency counts, or grounded theory, which aims to generate new theories (Glaser and Strauss, 2017), thematic analysis is well-suited for exploring pre-existing theoretical frameworks while still allowing themes to appear naturally from the data (Braun and Clarke, 2006). Thematic analysis is defined as "a method for identifying, analysing, and interpreting patterns of meaning (themes) within qualitative data" (Braun and Clarke, 2006, p. 79), which aligns with the aim of this research to explore stakeholder perspectives and uncover key themes related to Tech-Int in primary education.

Following the six stages outlined by Braun and Clarke (2006) and further elaborated by Maguire and Delahunt (2017), thematic analysis was conducted to identify patterns and sub-themes within the interview data. These steps included familiarising oneself with the data, generating initial codes, searching for themes, reviewing themes, defining and naming themes, and producing the final report.

The analysis began with a close reading of the interview transcripts to gain a comprehensive understanding of the content. During this familiarisation stage, open coding was employed to capture key concepts emerging from the data. These concepts were then organised into broader categories and themes, guided by predetermined codes aligned with the research's fundamental conceptual framework (see Section 3.5). Insights from the systematic literature review (Chapter 5) informed the development and refinement of these categories and themes. Coding was conducted manually (see Appendix G), ensuring close engagement with the data and linking the findings to constructs identified earlier in the study.

A combination of inductive and deductive reasoning was employed throughout the analysis. Initial codes emerged from the data (inductive), while the analysis was also informed by the key constructs from the conceptual framework and systematic literature review (deductive). This dual approach allowed both theoretical and emergent themes to surface, capturing a nuanced understanding of the research topic.

In the final stage, the themes and sub-themes were reviewed, refined, and organized into a cohesive structure, as presented in Chapter 7. This process enabled the qualitative findings to complement the quantitative results Chapter 6, deepening the understanding of statistical data and providing additional context for interpreting the overall research findings.

4.9 Ethical Considerations

Several measures were taken to ensure this research followed to ethical guidelines for research involving human participants, as described below.

4.9.1 Informed Consent

All participants were provided with information sheets outlining the purpose, risks, and benefits of the research. Their consent to participate was obtained through tick boxes on the online survey and written signature on interview consent forms. Participants were informed that involvement was entirely voluntary and that they could withdraw at any time.

4.9.2 Confidentiality and Anonymity

Ensuring confidentiality and anonymity was paramount. Names and any identifiable information were removed during transcription of interview data. All data was de-identified and stored securely with password protection. Only the lead researcher had access to the original data with identifiers. As the topic was not highly sensitive, there were minimal foreseeable risks to participants beyond those encountered in everyday life. The likelihood of participant harm was very low.

4.9.3 Ethical Review

Ethical approval was obtained from Ethics Committee in the Computer and Information Sciences Department at the University of Strathclyde and registered the Research Ethics Review Board prior to recruitment and data collection, as explained previously (Application ID: 2158). The research strictly followed to institutional and discipline-specific ethical guidelines. There were no major ethical dilemmas met during the execution of the research.

4.10 Summary of Chapter

This methodology chapter provides a detailed account of the mixed-methods approach employed to explore the impact of Tech-Int on T&L in primary schools in Scotland. The research addressed three key objectives using a combination of methods. Objective 1, which focused on critically reviewing and evaluating the impact of Tech-Int on T&L in primary schools, was addressed through a systematic review of existing literature. This review provided a theoretical foundation and identified key patterns and gaps in knowledge.

Objectives 2 and 3, which aimed to analyse stakeholder attitudes and behavioural influences on Tech-Int and identify barriers and challenges to Tech-Int in education, were addressed together through quantitative surveys, followed by semi-structured interviews.

Data was collected from 213 participants through surveys, with the qualitative insights from the consequent interviews ensuring a comprehensive understanding of the multifaceted realities of TIPS. The semi-structured interviews involved 14 participants recruited from the initial survey respondents who agreed to participate in follow-up interviews. These participants represented various regions of Scotland and included HTs (n = 3), TCRs and TAs (n = 6), and P/Cs (n = 5).

The integration of quantitative and qualitative methods allowed for the triangulation of findings, enhancing the research's methodological rigour and alignment with its objectives. This balanced approach ensured both empirical data and theoretical exploration were effectively captured, offering valuable insights into the complexities of technology use in primary education.

PART II: EMPIRICAL INVESTIGATION OF TECHNOLOGY INTEGRATION

Phase 1

Chapter 5
Impact of Tech-Int on Teaching and Learning (T&L) Outcomes in Primary Schools: A Systematic Review

5.1 Introduction

Part II explores the literature, research, and ideas surrounding the relationship between technology and digital learning in primary schools. This chapter presents a systematic review of recent research on the integration of technology in primary education. While the literature review in Chapter 3 provided a broad theoretical and contextual foundation examining multiple frameworks, conceptual models, and general developments in educational technology, the purpose of this systematic review is different. It adopts a structured, replicable methodology to critically analyse and synthesise recent empirical studies to address Objective 1: "To critically review and evaluate the role of technology integration on teaching and learning in primary schools."

The systematic review constructs directly on the theoretical insights identified in the literature review but moves farther them by focusing on peer-reviewed studies published in the last decade. This allows for a detailed, evidence-based understanding of how technology is currently being integrated in primary classrooms, its reported impact on teaching pedagogy and student learning outcomes, and the barriers and contextual factors affecting its implementation. Specifically, this systematic review aims to:

- Examines the types of technological devices and resources that are used in primary school education.
- Evaluates the effectiveness of Tech-Int in enhancing teaching pedagogy and its impact on the learning outcomes of primary school students.
- Identifies the barriers and challenges of technology in education and explore the factors influencing the effectiveness of technology-enhanced learning.

The chapter follows the integrative review methodology proposed by Whittemore and Knafl (2005), which allows for the inclusion of diverse study types and methodological approaches. A well-structured search strategy was used to identify and evaluate relevant studies, including clearly defined search terms, inclusion and exclusion criteria, and a transparent selection process. The next sections present the review methodology, data sources, and thematic findings from the included studies.

5.2 Method Approach

To conduct a systematic literature review, the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guideline was adopted to ensure clarity, transparency, and accuracy throughout the review process. Social sciences and educational research widely recognise PRISMA as a structured framework for reporting the steps involved in systematic reviews. The framework clearly outlines the various stages of data collection and analysis, guaranteeing comprehensive documentation of each step. Although PRISMA does not prescribe a specific search strategy, it helps articulate the resources used and the processes followed to finalise the list of included references. The application of PRISMA highlights the researcher's dedication to accurate reporting and reduces potential bias by promoting transparency in the review process (Attatfa, Renaud and De Paoli, 2020; Sarkis-Onofre *et al*., 2021). The PRISMA flow diagram for this review is displayed in Figure 5.1, and the constituent stages are described below. It depicts the systematic search strategy and stages used to screen and select relevant studies and presents the number of studies identified in each database, followed by the exclusion of duplicates, and details the progression through the screening of titles, abstracts, and (finally) full-text versions. For this review, the literature search was restricted to studies published in peer-reviewed journals in English between 2010 and 2023. This date range was selected because preliminary scoping searches identified no relevant or significant empirical studies specifically addressing digital technology integration in primary schools prior to 2010, a finding also supported by Connolly et al. (2012). This ensures the literature included reflects recent developments and aligns with the widespread emergence and adoption of modern digital tools in educational contexts.

Initially, 10,447 publications were identified, but after removing duplicates and irrelevant studies, 347 papers remained. Following a detailed screening process, 34 articles that met the inclusion criteria were selected. These studies provided data on the effects of digital technology in primary schools, addressing the research gap highlighted in previous work (Connolly *et al.*, 2012).

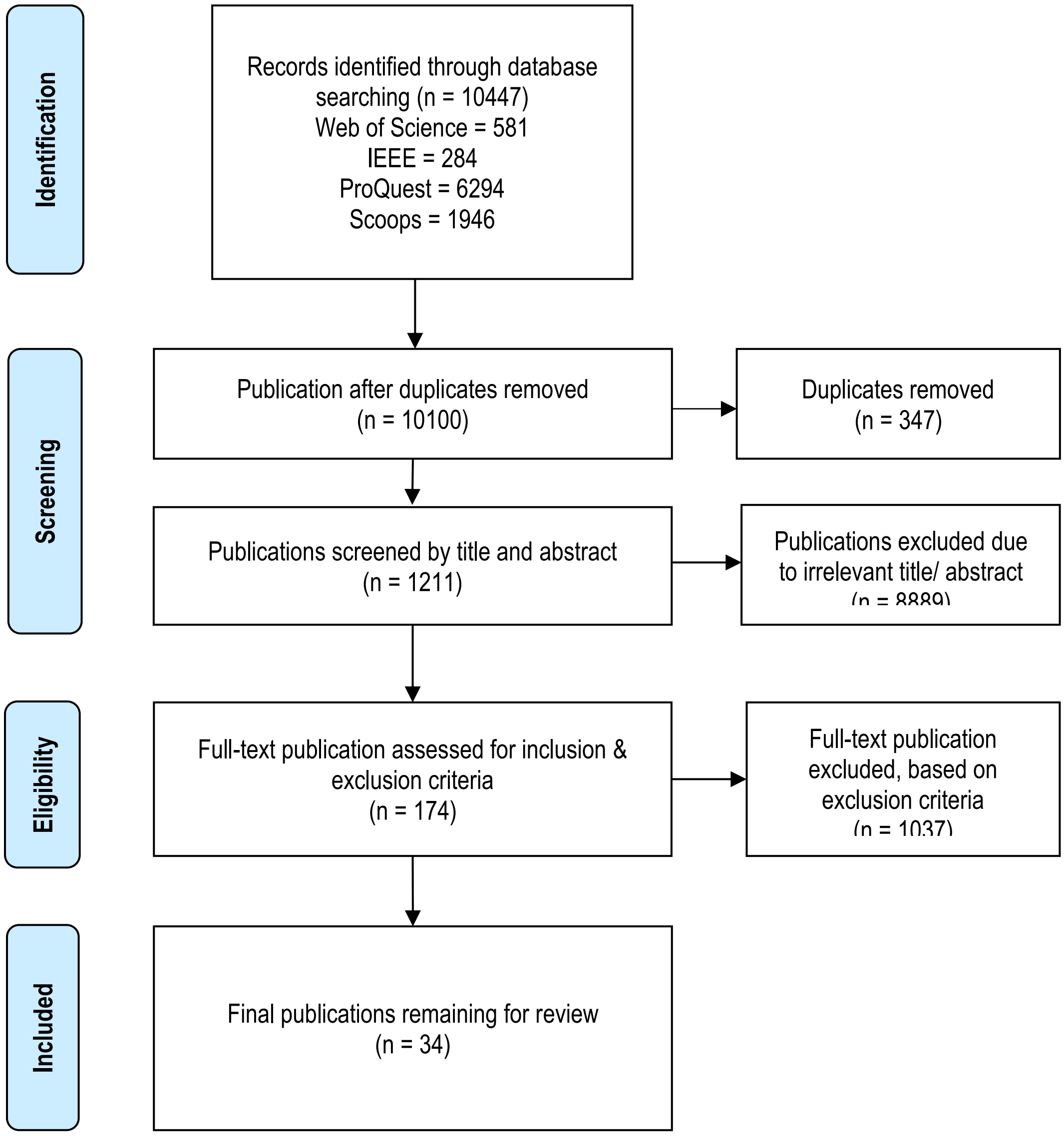

Figure 5.1: PRISMA flow diagram

5.2.1 Academic Database

To support a strong and inclusive review, literature was retrieved from major academic databases including ProQuest, Scopus, Web of Science, IEEE, and ScienceDirect. These databases were chosen for their wide coverage of peer-reviewed educational and technological research, their compatibility with systematic review methodologies, and their advanced filtering capabilities.

5.2.2 Concept Search Terms

The selection of search terms was guided by an initial scoping review, an analysis of terminology used in high-impact studies on digital learning in primary education, and iterative pilot searches to refine the balance between breadth and relevance. The search terms were designed to reflect three core conceptual elements relevant to this review: technology, digital content, and pedagogical application. These were defined according to Kumar Basak, Wotto, and Belanger (2018), who describe technology as tools or mechanisms for delivering content (including internet-connected hardware), digital content as instructional materials (from static files to interactive software), and digital education as the teacher-led pedagogical use of such tools.

Based on this framing, the final search strings included terms related to digital formats, multimedia tools, game-based learning, and measurable learning outcomes. The following search string is an example:

((“digital” AND “digital resources”) OR (“digital games” AND “games-based learning” AND “serious games” AND “computer games” AND “CMX” AND “MMORPG”) OR (“multimedia resources” AND “multimedia technology” AND “multimedia tools AND Education”) OR (“digital story” AND “digital narrative” AND “multimodal storytelling”) OR (“DIGITAL BOOK” AND “E-BOOK” AND “E-book learning”) OR (“Impact” AND “learning AND outcomes” AND “primary school” AND “elementary school”)).

5.2.3 Inclusion Criteria

- The intervention should have a clear target outcome to reflect cognition, affect, and/or student achievement outcomes for example CK.
- Only articles including the evaluation of a multimedia sources and teaching any aspect of subjects in a primary education context; each study should include statistical data such as sample sizes, means, and standard deviations.
- The study will select and examine literature published in peer-review journals, written in English, available via digital libraries, published during recent years (between 2010 to 2023).
- The study reports on an empirical or quasi-experimental investigation, with either between- or a within-subject design.

To be included as qualitative evidence:

- Studies including primary school samples (with children aged between 5 and 12 years).
- The study should involve interviews and/or open-ended survey questions and the analysis of qualitative data concerning parents' and educators' perceptions which contain statistic data in order to calculate the effect size.

5.2.4 Exclusion criteria

- This research excluded studies that did not focus on pedagogical uses of digital technology in primary education settings, including those primarily concerned with cultural issues, software design, or development-only studies without empirical testing. Studies focusing on secondary or higher education were also excluded.
- Furthermore, studies were excluded if they lacked quantitative or qualitatively coded outcome data related to learning, cognition, affect, or behavioural change necessary for evaluating learning impact or stakeholder perception in primary education.
- Only peer-reviewed journal articles were included; therefore, Ph.D. dissertations, technical reports, posters, book chapters, and systematic reviews

were excluded. Additionally, some studies were excluded due to age mismatches, particularly those involving children younger than 5 years (preschool or early childhood settings).

This methodical approach, guided by the PRISMA framework, ensured a robust and transparent review process, contributing to a clearer understanding of digital technology's impact on primary education.

5.3 Data Analysis

5.3.1 Coding of Papers

The 34 included articles were selected according to the inclusion criteria. The systematic review data extraction can be seen in Appendix E. Coding was done for papers using the following parameters, following the example of previous related studies (Connolly *et al*., 2012).

5.3.1.1 Categorisation of Technology Resources and Devices

The coding of the included papers was organised based on the types of technology resources and devices utilised in each study.

5.3.1.2 Categorisation of Effects of Technology

The current research focused on the positive outcomes of technology. The categories used for analysing the positive impacts of technology were as follows:

- Enhanced learning outcomes.
- Increased collaboration and communication.
- Challenges and barriers.
- Impacts on behaviours and attitudes.

5.3.2 Assigning Quality Indicators for Included Studies

According to Connolly *et al*. (2012), assessing the quality of the papers based on study design appropriateness, to what extent is the research design right for addressing the questions or sub-questions of this review (with a higher weighting for the inclusion of a control group). The quality of papers was coded using a three-point designation, where “3” indicates “high” quality (e.g., randomised controlled trials, RCTs), “2” refers to “medium” quality (e.g., a quasi-experimental controlled study), and “1” indicates (relatively) low-quality studies (e.g., case studies, single-subject experimental designs, and pre-test/post-test designs).

5.4 Results

5.4.1 Study Design Used in Papers

Table 5.1 summarises the number of papers that employed different study designs. Results are shown for all 34 papers, with specific counts provided in brackets for the higher-quality studies found. Among the 34 studies, the majority, 25 studies (74%), reported quantitative data, while 9 studies (26%) employed qualitative methods. Of the 25 quantitative studies, 4 (16%) used quasi-experimental designs, 14 (56%) used experimental designs, and 7 (28%) depend on surveys. Of the quantitative designs, 8 (32%) used between-group designs with randomisation (RCT), and 10 (40%) used within-group designs with control groups. The 9 qualitative studies primarily employed case study methodologies and interview.

Table 5.1: Description of studies, ranked by "appropriateness"

Study	Authors/Year	Research Design	Quality Score
High Appropriateness (Score = 3) – RCTs			
Reading electronic books as a support for vocabulary story comprehension	Korat (2010)	Experimental WITH RCT	3
The effects of two digital educational games on cognitive and non-cognitive math and reading outcomes	Vanbecelaere *et al*. (2020)	Quasi-experimental WITH RCT	3
Does "Measure Up!" measure up? Evaluation of an iPad app	Schenke *et al*. (2020)	RCT, experimental	3
Effects of playing mathematics computer games on primary school students' multiplicative reasoning ability	Bakker, van den Heuvel-Panhuizen and Robitzsch (2015)	RCT, experimental	3
The effect of game-based learning on academic achievement motivation of elementary school students	Partovi and Razavi (2019)	RCT, quasi-experimental	3
The interactive animated e-book as a word learning device for kindergartners	Smeets and Bus (2015)	RCT, experimental	3
To solve or to observe? The case of problem-solving interactivity within child learning games	Tetourová *et al*. (2020)	RCT, experimental	3
Comparing serious games and educational simulations: Effects on enjoyment, deep thinking, interest and cognitive learning gains	Imlig-Iten and Petko (2018)	RCT, experimental	3

Table 5.1: Description of studies, ranked by "appropriateness"

Study	Authors/Year	Research Design	Quality Score
Medium Appropriateness (Score = 2) – Quasi-Experimental or Experimental, no Randomisation)			
A digital game-based learning method to improve critical thinking skills	Hussein *et al*. (2019)	Quasi-experimental, no randomisation	2
Applying digital escape rooms infused with science teaching in elementary school: Learning performance, learning motivation, and problem-solving ability	Huang, Kuo and Chen (2020)	Quasi-experimental, no randomisation	2
Closing the gap: Efficacy of a tablet intervention to support the development of early mathematical skills in UK primary school children	Outhwaite, Gulliford and Pitchford (2017)	Experimental, no randomisation	2
An online game approach for improving students' learning performance in web-based problem-solving activities	Hwang, Wu and Ke (2011)	Experimental, no randomisation	2
Exploring the factors influencing learning effectiveness in digital game-based learning	Tsai *et al*. (2012)	Experimental, no randomisation group	2
Evaluating cognitive and affective outcomes of a digital game-based math test	Kiili and Ketamo (2018)	Experimental study, no randomisation	2
Assessing fraction knowledge by a digital game	Ninaus *et al*. (2017)	Experimental, no randomisation	2
Derivation of young children's interaction strategies with digital educational games from gaze sequences analysis	Nizam and Law (2020)	Experimental, no randomisation	2
Comparing electronic and paper storybooks for pre-schoolers: Attention, engagement, and recall	Richter and Courage (2017)	Experimental, no randomisation	2
Applying game learning analytics to a voluntary video game: Intrinsic motivation, persistence, and rewards in learning to program at an early age	Zapata-Cáceres and Martín-Barroso (2021)	Experimental, no randomisation	2

Table 5.1: Description of studies, ranked by "appropriateness"

Study	Authors/Year	Research Design	Quality Score
Low Appropriateness (Score = 1) – Case Study, survey or Qualitative			
Computer-game-based tutoring of mathematics	Ke (2016)	Case study	1
Digital games-based learning for children with dyslexia: A social constructivist perspective on engagement and learning during group game-play	Vasalou *et al*. (2017)	Case study	1
The effect of digital storytelling in improving the third graders' writing skills	Yamaç and Ulusoy (2016)	Interviews	1
Exploring the use of educational technology in primary education: Teachers' perception of mobile technology learning impacts and applications' use in the classroom	Domingo and Garganté (2016)	Questionnaire	1
Digital technologies in early childhood: Attitudes and practices of parents and teachers in Kosovo	Gjelaj *et al*. (2020)	Mixed method (interviews and online questionnaire)	1
Surveying in-service teachers' beliefs about game-based learning and perceptions of technological pedagogical and content knowledge of games	Hsu *et al*. (2017)	Questionnaire	1
Probing in-service elementary school teachers' perceptions of TPACK for games, attitudes towards games, and actual teaching usage: A study of their structural models and teaching experiences	Hsu *et al*. (2020)	Questionnaire	1
A quantitative approach to pre-service primary school teachers' attitudes towards collaborative learning with video games: Previous experience with video games can make the difference	Martín del Pozo *et al*. (2017)	Questionnaire	1
Elementary teachers' reflections on their use of digital instructional resources in four educational contexts: Belgium, Finland, Sweden, and US	Remillard *et al*. (2021)	Interviews	1
How and why digital generation teachers use technology in the classroom: An explanatory sequential mixed methods study	Li *et al*. (2015)	Mixed methods research	1
Understanding parents' conflicting beliefs about children's digital book reading	Kucirkova and Flewitt (2022)	Interview	1
Values education using the digital storytelling method in fourth grade primary school students	Ayten and Polater (2021)	Case study	1
Towards digitalisation in early childhood education: Pre-service teachers' acceptance of using digital storytelling, comics, and infographics in Saudi Arabia	Al-Abdullatif (2022)	Quantitative approach with descriptive correlational design	1

Table 5.1: Description of studies, ranked by "appropriateness"

Study	Authors/Year	Research Design	Quality Score
Integration of digital technologies into play-based pedagogy in Kuwaiti early childhood education: Teachers' views, attitudes and aptitudes	Aldhafeeri, Palaiologou and Folorunsho (2016)	Questionnaire	1
Technology integration and technology leadership in schools as learning organisations	Cakir (2012)	Questionnaire	1
Teacher beliefs and technology integration practices: A critical relationship	Ertmer *et al*. (2012)	Multiple case-study and interviews	1

5.4.2 Location of Studies

As shown in Table 5.2, the studies included in this review represent a various array of regions, reflecting the universal interest in the impact of technology on learning outcomes in children. Learners' perceptions and attitudes toward Tech-Int can vary across regions due to cultural and educational differences. Europe leads with 14 studies (41%), with the UK contributing 4 studies (13%), and other European countries, such as Belgium, Finland, Switzerland, and Spain, each contributing 2 studies (6%). Taiwan, which contributed 5 studies (16%), led Asia with 6 studies (6%). 5 studies (15%), including 4 from the US (12%), reflect North America's strong engagement with innovative teaching methods through technology. The Middle East accounts for 6 studies (18%), including research from Saudi Arabia, Kuwait, Turkey, and Iran, reflecting the region's growing interest in the integration of digital learning solutions.

Table 5.2: Number of papers by geographical region

Region	Countries	Number
Asia	Taiwan	5
	Malaysia	1
Europe	UK	4
	Belgium	2
	Finland	2
	Switzerland	2
	Spain	2
	Czech Republic	1
	Kosovo	1
North America	US	4
	Canada	1
Middle East	Saudi Arabia	1
	Kuwait	2
	Turkey	2
	Iran	1

5.4.3 Frequently Used Technological Devices

Several devices are frequently used in primary school technology interventions, each contributing to enhanced learning outcomes. Figure 5.2 shows that computers are the most used device at 36%, followed by tablets at 32%. Mobile phones account for 8%, while interactive platforms such as learning management system (LMS) make up 4%. This visual representation effectively illustrates the distribution of device usage and its contributions to enhancing learning outcomes in primary education.

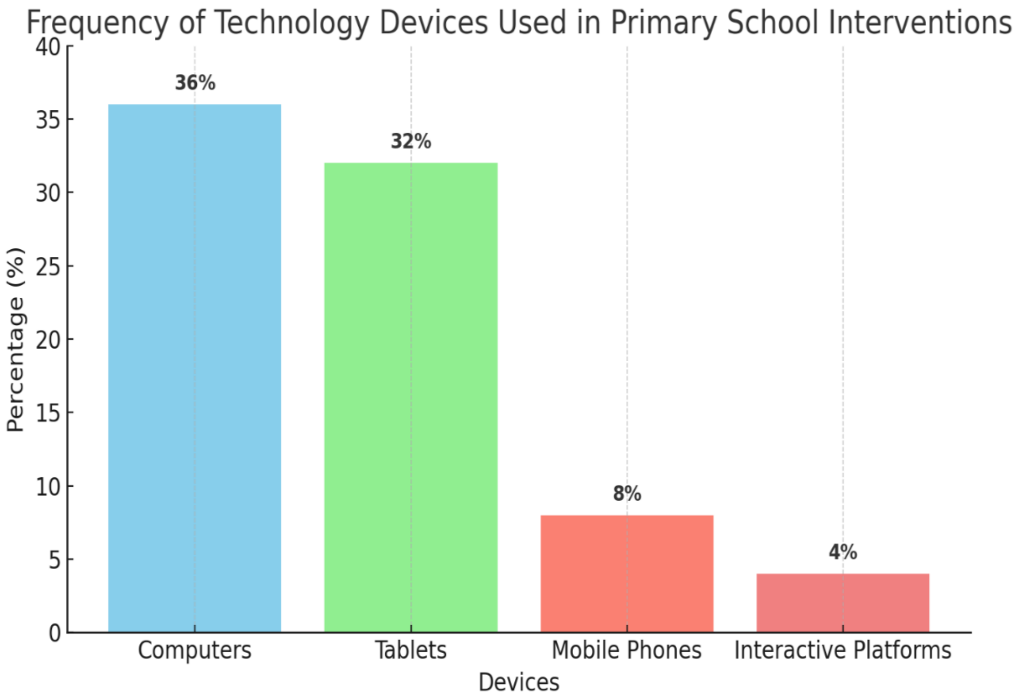

Figure 5.2: Frequently used technological devices

5.4.4 Frequently Used Technological Resources

Primary school technology interventions use multiple resources to improve learning across subjects. Figure 5.3 shows that digital games (e.g., game-based learning, and digital educational games) are the most popular resources, appearing in 41% of the studies. Digital storytelling comes in second with 18%, followed by e-books and educational app with 9% and web-based application with 6%. This visual representation effectively highlights the various resources used to enhance learning outcomes across subjects in primary education.

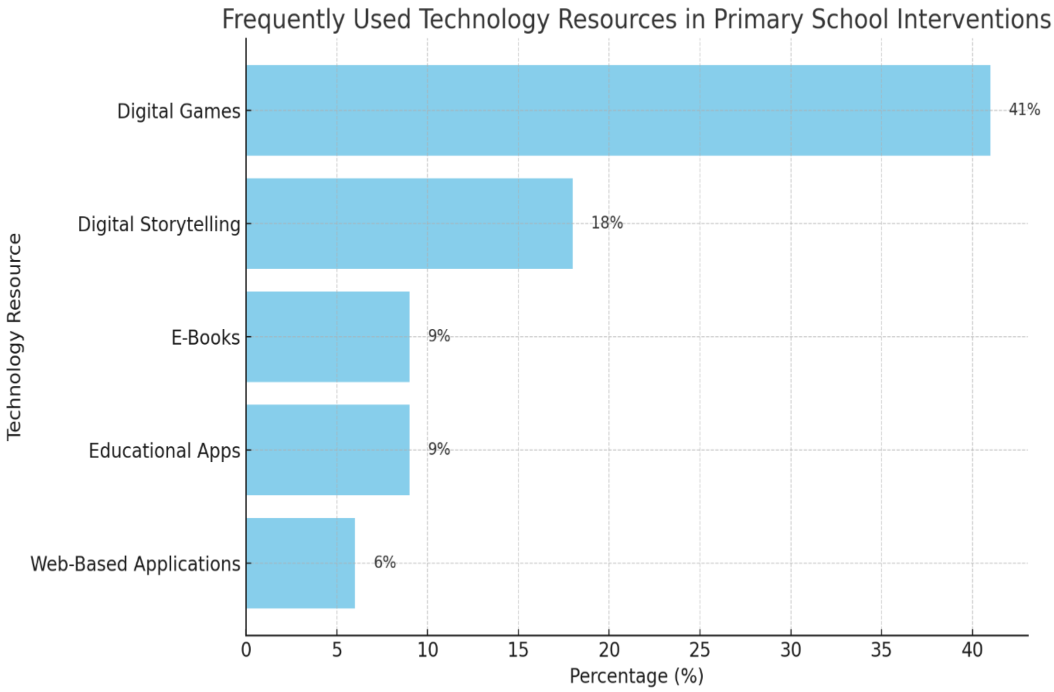

Figure 5.3: Frequently used technological resources

5.4.5 Frequency of Subjects in Primary Schools

Figure 5.5 shows that mathematics, reading, language, science, and values education are the subjects most frequently addressed in primary school technology interventions Mathematics emerges as the most prominent focus, appearing in approximately 36% of the studies. This confirms the effectiveness of digital resources, such as games and tablet apps, in enhancing students' multiplicative reasoning and overall mathematical skills, as evidenced by research like that of Bakker, van den Heuvel-Panhuizen and Robitzsch (2015) and Outhwaite, Gulliford and Pitchford (2017). Around 28% of the studies focus on reading, writing skills and language development, where e-books and digital storytelling play a crucial role in facilitating vocabulary acquisition, reading comprehension, and writing skills as evidenced by Korat (2010) and Yamaç and Ulusoy (2016). Approximately 20% of the studies reported that science education valued the use of game-based learning and interactive platforms to enhance students' understanding of scientific concepts and problem-solving abilities (e.g., Hwang, Wu and Ke, 2011; Hussein *et al*., 2019). About 4% of the studies focused on values education, exploring how digital storytelling methods can complement traditional approaches to instill important social values in primary school students (e.g., Ayten and Polater, 2021).

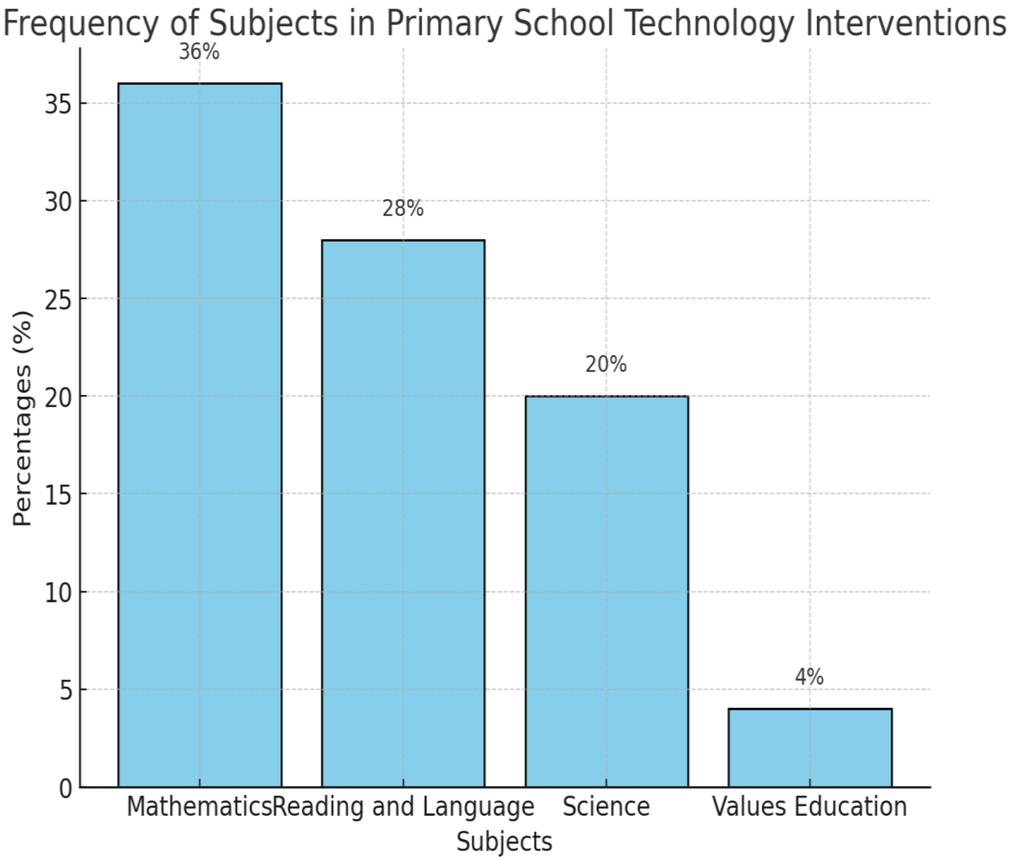

Figure 5.4: Frequency of subjects in primary schools

5.4.6 Educational Outcomes Across Digital Resources and Devices

According to the analysis of the included experimental studies (n = 25), the combined impact of resources and devices on learning outcomes in primary education is evident across various fields, including cognitive development, motivation, and engagement. The following summary includes specific findings from all referenced papers, importance the ways in which digital resources and devices influence educational outcomes.

5.4.6.1 Digital Devices: Computers, Tablets, and Interactive Platforms

Digital devices, such as computers and tablets, play a critical role in influencing learning outcomes by providing students with interactive, engaging, and personalised learning experiences. Reviewed studies focused on several critical impacts pertaining to the two core pedagogical objectives described below.

Cognitive skills: Devices support the development of mathematical reasoning, reading comprehension, and problem-solving abilities through interactive games and educational apps (Korat, 2010; Hwang,2011, Wu and Ke, 2011; Bakker, van den Heuvel-Panhuizen and Robitzsch, 2015). For example, computers enable students to engage in game-based learning, which enhance concepts through repetition, instant feedback, and adaptive learning paths (Ke, 2016).

Academic achievement: Studies consistently show that students who use educational software on computers or tablets tend to experience enhanced academic achievement in subjects like mathematics and literacy (Outhwaite, Gulliford and Pitchford, 2017; Partovi and Razavi, 2019). Devices offer rich, multimedia content that promotes deeper engagement and understanding, which contributes to improved performance.

5.4.6.2 Digital Resources: E-Books, Games, and Digital Storytelling

Digital resources, including e-books, educational games, and digital storytelling platforms, also have a profound impact on learning outcomes.

Language and literacy development: E-books and digital storytelling tools help students improve their writing, vocabulary, and reading comprehension by providing interactive and visually enriched content. These resources often incorporate audio support and visual aids, which are particularly beneficial for younger learners (Korat, 2010; Yamaç and Ulusoy, 2016). This combination of text, audio, and interactive features helps reinforce key literacy skills.

Mathematics proficiency: Digital games that focus on mathematics offer students an engaging way to practice and reinforce math skills. Games designed around multiplicative reasoning and fraction knowledge have been shown to significantly improve students' mathematical understanding and performance (Bakker, van den Heuvel-Panhuizen and Robitzsch, 2015; Ninaus *et al*., 2017).

Critical thinking and problem-solving skills: Game-based learning platforms also promote the development of critical thinking and problem-solving skills. When students are engaged in games that require strategic thinking or navigating complex challenges, they learn to apply critical thinking in a way that traditional instructional methods may not facilitate (Hussein *et al*., 2019).

5.4.6.3 Learning Management Systems (LMS)

LMS platforms provide a structured environment where educators can organise and deliver course materials, assignments, and assessments. The impact of LMS on learning outcomes is notable in two main areas.

Collaboration and communication: LMS tools enable greater collaboration and communication between students and teachers, supporting both independent and group learning activities. Through features like discussion boards and real-time feedback, LMS enhances student engagement and encourages active participation in the learning process (Hwang, Wu and Ke, 2011).

Self-learning: LMS platforms allow students to access content autonomously and at their own pace, which supports differentiated instruction and accommodates different learning speeds. This flexibility contributes to improved learning retention and understanding, as students can revisit challenging concepts as needed (Hwang, Wu and Ke, 2011).

5.4.6.4 Non-Cognitive Outcomes: Engagement and Motivation

A significant finding across multiple studies is the positive impact of digital resources and devices on student engagement and motivation.

Engagement: Game-based learning, e-books, and digital storytelling tools gain students' attention through interactive elements and multimedia, which keeps them engaged in the learning process. For instance, Nizam and Law (2020) found that children’s interaction strategies with digital games, as analysed through observe sequences, were crucial in maintaining focus and interaction, leading to deeper engagement in learning.

Motivation: Vanbecelaere *et al*. (2020) and Partovi and Razavi (2019) both confirmed the motivational promote provided by educational games. Gamified elements like challenges, rewards, and progress tracking encourage students to stay engaged while also enhancing academic motivation. These findings are particularly relevant in improving learning outcomes in math and reading through fun, interactive experiences.

5.5 Discussion

5.5.1 Theories of Learning

The papers included in the systematic review reflect various learning theories that inform the use of technology interventions in educational settings. Many interventions, such as that tested by Vanbecelaere *et al*. (2020), showed how digital educational games align with Piaget’s (1970) constructivist theory, promoting independence and allowing children to construct knowledge through active engagement and feedback. The study’s focus on game-based learning also reflects Mayer’s (2005) cognitive theory of multimedia learning (Section 3.3.1), which confirms how multimedia elements like graphics and sounds can enhance cognitive processing and support significant learning. The use of games to provide instant feedback aligns with Mayer’s principles of dual-channel processing, supporting learners in understanding complex concepts.

A change toward constructionism is evident in the study by Outhwaite, Gulliford and Pitchford (2017), where tablet interventions helped children develop early mathematical skills. This approach confirmed hands-on learning, in line with Piaget’s (1970) theory, and provided personalised feedback to support the learner’s progress. Particularly, the interventions allowed students to work at their own pace, proving the child-cantered nature of constructionist learning.

Bakker, van den Heuvel-Panhuizen and Robitzsch (2015) used the Ecological Techno-Subsystem framework to look at how contextual factors affect learning outcomes and showed that the right educational environment is important for Tech-Int successfully. Yamaç and Ulusoy (2016) represent Bandura (1986) SLT, where peer collaboration plays a crucial role in the writing intervention, promoting social interaction and learning through shared experiences. Domingo and Garganté (2016) reflect the TPB, showing that educators' beliefs about mobile technology significantly influence their practices and the role of attitudes in technological acceptance. Additionally, Hsu *et al*. (2017) and Hsu *et al*. (2020) both focus on the relevance of TPACK, as they confirmed the need for teachers to integrate technology effectively with pedagogical strategies and CK to enhance learning outcomes.

5.5.2 Factors Influencing the Effectiveness of Tech-Int

The discussion shows how complicated Tech-Int in primary school is, especially when it comes to the various factors that affect how well it works. Researchers found attitudes, beliefs, and existing knowledge and skill levels as the most significant barriers preventing teachers from using technology (Ertmer *et al*., 2012; Tondeur *et al*., 2017). Other factors include teachers' demographic characteristics and access to digital resources (Davies and West, 2014; Drossel, Eickelmann and Gerick, 2017).

However, the studies included in this review offer insights into the types of leadership strategies and technological interventions implemented, along with common challenges related to infrastructure, teacher training, and leadership support (Cakir, 2012). Research by Zheng *et al*. (2016) highlights leadership as a key factor that positively influences the successful implementation of Tech-Int in schools. For this transformation to be successful, policy support and leadership must include a clear vision for the use of digital technologies in education, offering guidance to students and parents, logistical support, and comprehensive teacher training (Conrads *et al*., 2017). Condie and Munro (2007) confirmed the importance of school principals' excitement as a source of inspiration, cultivating a culture of innovation, and proving sustainable digital change.

To achieve these goals, leaders must build capacities for both learning and leadership, promote professional development, and establish strong support systems and structures (Ipsos, 2019). Despite the vital role of leadership, training for school leaders is still insufficient; notably, only a third of education systems in Europe have implemented national strategies that explicitly address the training of school principals (Ipsos, 2019). Several researchers report the influence of internal and external factors on the effective implementation of various technologies in classrooms (Johnson *et al*., 2016). Li *et al*. (2015) defined external and internal barriers as “first- and second-order barriers,” which can significantly impede the success of technological integration. The following sections explain the external and internal factors.

5.5.2.1 External Barriers

5.5.2.1.1 Technological Infrastructures

Research indicates that the physical and technological environment of educational institutions significantly influences the facilitation or obstruction of technology use in classrooms (Martín del Pozo *et al*., 2017). Ipsos (2019) underscores that for technology to be effective in education, educators and learners must have uninterrupted access to technical resources, highlighting the necessity for sufficient infrastructure. Drossel, Eickelmann and Gerick (2017) similarly confirms that the lack of critical resources in many schools, such as modern computers and interactive whiteboards, can be a significant obstacle to the integration of digital technology into educational methodologies. The lack of critical technological infrastructure could make teachers and students unsatisfied, which would lower the quality of the learning experience overall. Additionally, poorly constructed school infrastructure might limit access to resources particularly in remote regions where schools often have insufficient power supply to support modern equipment (Building the 21st Century Classroom, 2018).

The issue of insufficient technology is closely related to infrastructure issues. Many schools face challenges in getting the latest educational technologies due to budget constraints and a lack of funding (Harrell and Bynum, 2018). The high costs of purchasing and maintaining technological resources often discourage schools from fully integrating them into their curricula (Harrell and Bynum, 2018). Schools in developing countries, or in less wealthy areas within developed countries, may struggle to keep up with technological advancements, exacerbating this problem. Because of this, teachers may only be able to use traditional instruments that do not meet the needs of today's students, which makes it even harder for them to use technology successfully in the classroom (Ipsos, 2019).

5.5.2.1.2 Effective Professional Development

Although the term "teaching quality" is often used interchangeably with other concepts in research, practice, and policy, Burić, Butković and Kim (2023) clarify that teaching quality is a distinct element of teacher effectiveness. A teacher's effectiveness consists of three components: (a) inputs, such as their qualifications and personality; (b) processes, or their teaching methods, sometimes referred to as "teaching quality"; and (c) outcomes, or the effects on student achievement, engagement, and social and emotional health. Teachers must receive technology-integrated professional development, as many of them struggle to use technology due to a lack of technical skills and knowledge.

Teachers' characteristics and their professional development play a crucial role in the effective use of digital technologies in education. Cheok and Wong (2015) found a link between teachers' characteristics, such as anxiety and self-efficacy, and their satisfaction and engagement with technology. Bingimlas (2009) reported that a lack of confidence, resistance to change, and negative attitudes toward new technologies are significant factors that impede teachers' engagement with ICT. However, the same study also noted that providing technical support, motivational (such as awards and sufficient planning time), and training on the educational benefits of technology can help overcome these barriers to Tech-Int, increasing their comfort and familiarity with innovative solutions.

In this regard, Archer *et al*. (2014) confirmed that teachers' comfort level with technology is key predictors of successful Tech-Int, encouraging training and ongoing support to ensure teachers feel confident using ICT in the classroom. Additionally, Hillmayr *et al*. (2020) found that training teachers in ICT significantly enhances student learning outcomes. However, studies also caution that simply providing professional development training does not automatically lead to successful Tech-Int in classrooms. Teachers achieve success when they get the necessary knowledge, skills, ability, support, and experience to effectively use technology in ways that enhance the delivery of curriculum content to enable students to achievement learning objectives (Harrell and Bynum, 2018).

Teachers need to understand not only *how* to use technology, but also *when* and *why* to use it, in order to maximise its impact on student learning (Hollebrands, 2020). Currently, schools generally do offer technology-related teacher training and development. However, although Tech-Int is the second most common topic in teacher professional development programs, only 67% of teachers report receiving such training (Rotermund, DeRoche and Ottem, 2017). Furthermore, 59% of teachers who attended these programs received eight hours or less of training time. This leaves many teachers to independently select the most suitable technologies to enhance their T&L.

5.5.2.2 Internal Barriers: Attitudes and Perceptions

According to Ajzen (2001), attitude "represents a summary evaluation of a psychological object (the 'attitude-object'), captured in such attribute dimensions as good-bad, harmful-beneficial, pleasant-unpleasant, and likeable-dislikeable" (p. 28). It pertains to "self-efficacy," a perceived ability to perform a behaviour, as an example of an internal factor. An individual's attitude can shape their intention to engage in a particular behaviour, which is believed to influence its actual performance (Ajzen, 1991).

5.5.2.2.1 Teachers' Attitudes

Many teachers, perhaps accustomed to traditional instructional methodologies, may experience frustration when transitioning to a new paradigm based on 21st-century technologies. This is because many teachers may not have sufficient digital literacy, and face pressure to incorporate the new technologies. They must weigh factors like the required effort, practicality, and the new technologies' values when deciding whether to use them or not (Hayak and Avidov-Ungar, 2020). Harrell and Bynum

(2018) reiterated such concepts, noting that teachers' readiness, or lack thereof, significantly influences their self-efficacy, thereby finding their use of these technologies.

Some teachers may also have negative feelings towards the technologies due to their implementation time, classroom management practices, and attention demands. Therefore, some teachers may choose to stick to the status quo. Teachers' perceptions, their digital skills, and their ability to integrate various digital tools significantly influence the quality of instructional planning and delivery. It is worth noting that negative beliefs about the impact of technology on children have discouraged the development of effective digital instruction. For example, some claim that digital resources harm instructional content (Morgan, 2010).

Alotaibi *et al*. (2020) also reported a common belief that digital content limits children's interaction and physical activity, leading to emotional problems and antisocial behaviours. Furthermore, Plowman, McPake and Stephen (2010) emphasised the necessity for teachers to undergo a cognitive transformation to reshape their beliefs and willingness to offer the most professional services to facilitate digital learning solutions. However, even where educators are willing to facilitate e-learning solutions in their classes, they are often unable to do so due to external barriers, such as a lack of resources, inadequate instructor training, inadequate teacher experience, and poor planning of digital instructions, all of which can impede positive transformation and lower the quality of multimodal learning (Aubrey and Dahl, 2014).

5.5.2.2.2 Parents' Attitudes

Parental attitudes toward technology play a critical role in finding how children interact with digital tools, as shown by many studies. Research continued shows that positive parental attitudes and support significantly influence children's engagement with digital technology. Hollingworth *et al*. (2011) found three main themes in parents' perceptions of technology: (1) the existence of a "digital gap" among different families; (2) concerns about the potential risks and harms of technology for children, and (3) the idea of a "generational divide" between parents and their children. Fidan and Olur (2023) and Gjelaj *et al*. (2020) found that when parents support a positive outlook and enhance a supportive environment, children are more likely to develop and safe technology habits. In contrast, negative attitudes or a lack of parental involvement can limit children's interactions with digital media, thus restricting opportunities for learning and the development of essential skills (Gjelaj *et al*., 2020).

These themes offer important insights into how parents view Tech-Int with their children's education at home. According to Osorio-Saez, Eryilmaz and Sandoval-Hernandez (2021), parents are more likely to become involved in their children's education when schools provide well-structured technological tools and when parental attitudes are influenced by external factors, such as the opinions of other parents, teachers, children, and the broader public. Conversely, when parents perceive technological tools as difficult to use or beyond their own knowledge and skills, they tend to undo. Furthermore, Osorio-Saez, Eryilmaz and Sandoval-Hernandez (2021) noted that male parents are generally more involved in their children's education than female parents.

Despite the benefits of technology in education, the debate surrounding its integration into childhood curricula remains contentious (American Academy of Paediatrics [AAP], 2011; Teichert and Anderson, 2014). This debate has left parents uncertain about the role of technology in their children's lives. One side encourages parents to help their children in getting digital literacy, while on the other, they are warned against allowing excessive use of digital technology, which are often seen as distracting and potentially harmful. For instance, Aldhafeeri, Palaiologou and Folorunsho (2016) pointed to research by paediatric occupational therapist Cris Rowan, who argued that parents should limit their children's use of digital tools, especially for children under 12. Rowan cited concerns such as sleep deprivation, delayed development, and potential mental health issues. These warnings have contributed to negative parental attitudes toward children's use of digital technology.

The AAP (2011) further cautioned parents about allowing children under the age of two to use iPads and tablets, citing the potential for long-term negative consequences.

In additional, Sosa (2016) also raised concerns that children who play with electronic toys may engage less with their parents, potentially resulting in limited language development and poor communication skills. Some critics argue that digital technology may negatively affect children's cultural and social development. For instance, Aldhafeeri, Palaiologou and Folorunsho (2016) suggested that frequent use of digital devices could lead children to deviate from their family and social culture.

These concerns, expressed by paediatricians, parents, and educators alike, highlight the need for serious consideration of the health and educational impacts of e-learning on children's holistic development. Researchers such as Marsh and Bishop (2014) and Lupton (2014) recommend that teachers, parents, and technology developers take collective responsibility for guiding children toward appropriate and responsible digital literacy. By encouraging an environment where children can get digital knowledge, skills, and content in a balanced approach, they can obtain the benefits of technology while mitigating its potential risks.

5.5.2.3 Low Level of Self-Efficacy

Self-efficacy has been defined as the notion that an individual can execute a task diligently to achieve the intended goals. Self-efficacy was a critical concept in Bandura's (1986) SCT, whereby he claimed that the idea shaped how a person interacts with society and their environment. In the field of education, self-efficacy is commonly used to describe teachers' performance, indirect experience, influence, and physiological wellbeing (Pan and Franklin, 2011; Howardson and Behrend, 2015; Wilson *et al*., 2016). Researchers have noted a significant relationship between teachers' motivation to integrate technology in classrooms and their level of self-efficacy (Li *et al*., 2015).

As student achievement and educational accountability become increasingly important metrics of effective learning, teachers who believe that classroom technologies can enhance learning are more likely to implement them. Contrastingly, if teachers perceive that these technologies will not significantly help learning, they are less inclined to use them (Pearson, 2015). Additionally, the fact that a large percentage of elementary students (62%) believe they are more technologically literate than their teachers may potentially reduce teachers' perceived self-efficacy (Pearson, 2015). Furthermore, parental awareness and self-efficacy in digital parenting play a crucial role in shaping children's digital experiences and supporting their development. Parents' confidence in safely and effectively using digital tools is important for guiding their children in today's digital world (Bassi *et al*., 2020). By enhancing their self-efficacy, parents can better provide the support and guidance necessary for their children's healthy development and wellbeing (Fidan and Olur, 2023). Therefore, it is essential for parents to be knowledgeable about digital parenting and to effectively guide their children in this digital age (Bassi *et al*., 2020).

5.6 Systematic Review Key Findings and Hypothesis Development

This research aims to explore Tech-Int in educational primary settings by looking at various factors that influence Tech-Int and perceived barriers. The model was developed using established theories and models such as the EST, SLT, TPB, TAM, and TPACK. By integrating the TPACK model, the research acknowledges the importance of stakeholders' knowledge of the intersection of technology, pedagogy, and content, which is critical for effective Tech-Int in educational practices. Additionally, the research integrates demographic factors such as gender, education level, and income to improve the model's explanatory power within the context of educational technology. Nine hypotheses were developed based on the reviewed literature, as presented in Table 5.3 and further explained below.

Table 5.3: Hypotheses

Hypothesis	Description	Target Group
H1	There is a negative correlation between the role of tech-based learning environments and the perceived barriers to Tech-Int. Higher ratings on tech-based learning environments will correlate with lower perceived barriers to Tech-Int.	P/Cs, TCRs, TAs, HTs
H2	The role of tech-based learning environments differs among groups with positive, negative, and medium perceptions of technology's impact.	P/Cs, TCRs, TAs, HTs
H3	There are significant differences in technology integration across teaching levels, influenced by educational qualifications.	TCRs, TAs
H3a	Headteachers with higher levels of formal education are more likely to promote or support technology integration within their schools.	HTs
H4	Higher income levels are associated with fewer perceived barriers to Tech-Int.	P/Cs
H5	There is a relationship between income levels and the role of tech-based learning environments in education.	P/Cs
H6	Educators with higher education levels report fewer barriers to Tech-Int.	TCRs, TAs, HTs
H7	There is a significant difference between genders in their perceptions of the role of technology in educational environments.	P/Cs, TCRs, TAs, HTs
H8	There is a significant difference between genders in their perceptions of barriers to Tech-Int.	P/Cs, TCRs, TAs, HTs
H9	There is a significant relationship between parents'/carers' age and the age group of their children, reflecting generational differences that may shape perceptions of how parents manage technology use.	P/Cs
H9a	The age of TCRs and TAs is associated with the level of technology integration in classroom practice, with younger teachers more likely to use digital tools frequently.	TCRs, TAs

The hypothesis suggests a negative correlation between the role of tech-based learning environments and perceived barriers and Tech-Int (**H1**). The hypothesis posits that as educators and parents perceive technology's effectiveness increasing, the barriers to its integration are likely to decrease. The TPACK framework further explores this relationship, emphasising that effective Tech-Int involves not only the tools themselves, but also educators' ability to integrate these tools with pedagogical strategies and CK to overcome challenges. This framework shows the role of perception toward technology in educational settings as a critical factor influencing its integration. The TPB framework suggests that positive attitudes towards technology, shaped by beliefs about its usefulness and ease of use, will significantly influence the intention to integrate technology into educational practices.

The TPACK model further supports this by emphasising that perceptions are not only based on the technology itself but also on how well educators can support it with pedagogical and CK. As such, the research hypothesises that different levels of perception positive, medium, and negative will result in varying levels of technology adoption and integration (**H2**). This hypothesis indicates that these perceptions have a direct impact on how educators and parents engage with technology. In this model, gender plays a role in shaping perceptions of technology. The research uses literature and the TPACK framework to suggest gender differences in technological comfort and confidence. It also suggests that men and women view technology differently (**H7**). Additionally, this hypothesis has been expanded to explore the potential influence of gender disparities on perceived barriers to Tech-Int (**H8**).

Educational level is another important factor in the hypothesised model. The research examines the relationship between educators' education levels and their perceived barriers to Tech-Int. The research suggests that higher education levels, particularly in areas such as technology, pedagogy, and CK, may contribute to a reduction in perceived barriers (**H6**). In addition, the research looks at whether education level affects how teachers teach at different levels (**H3**). According to the TPACK framework, teachers with more education use more effective methods, which may or may not directly lower perceived barriers.

Additionally, the model incorporates income level as a determinant of Tech-Int among parents and carers. According to previous research, socioeconomic status affects both access to and attitudes towards technology. The research hypotheses that higher income levels are linked to fewer perceived barriers to Tech-Int (**H4**) and a more positive role for tech-based learning environments (**H5**). However, empirical evidence and the TPACK framework challenge these assumptions, suggesting that non-financial factors, such as parental involvement and communication with schools, play a more significant role in shaping perceptions and engagement with technology.

The research also considers the age factor, hypothesising that generational differences between parents and their children influence perceptions and management of technology use (**H9**). The concept posits that parents belonging to different age groups may possess diverse attitudes toward technology, thereby influencing their supervision and guidance of their children's digital tool usage.

Finally, the model addresses the role of age and teaching level among educators (**H9.a**), hypothesising that the average age of teachers may vary across different teaching levels. Examining this demographic factor to understand its potential impact on the adoption and Tech-Int in educational environments, particularly considering the potential interactions between age and educators' technological, pedagogical, and CK, as outlined in the TPACK model.

5.7 Limitations of the Systematic Review

While this systematic review followed a structured and transparent process using the PRISMA framework, several limitations should be acknowledged:

Age Range of Participants: Only studies focused on learners aged 5 to 12 years were included, aligning with primary education classifications. As a result, studies involving slightly younger children, such as Cheng (2013), which included participants starting from age 4, were excluded although thematic relevance.

Database Scope: The review focused on five major databases: ProQuest, Scopus, Web of Science, IEEE, and ScienceDirect. While comprehensive, Taylor and Francis was not searched directly due to overlap with Scopus and limitations in institutional access. This may have led to the exclusion of relevant studies found exclusively in Taylor and Francis.

Search Term Selection: Terms such as "technology integration" and "Techint" were excluded after pilot testing revealed a large number of irrelevant or secondary-level studies. Similarly, terms like “playful learning” and “creative learning” were not included due to their stronger association with early childhood education and general pedagogy, rather than digital technology with measurable outcomes. While these choices improved search precision, they may have excluded some relevant studies.

These limitations are acknowledged to inform future updates and reviews that aim to build on this research. Expanding search terms, age ranges, database access, and source types could enrich future findings.

5.8 Summary

This chapter examines the impact of Tech-Int on learning outcomes in primary schools, emphasising the effective use of technology to enhance T&L. Using the PRISMA framework, the systematic review started with 10,447 studies and finally narrowed it down to 34 articles, which were systematically reviewed in detail in order to provide understanding of the impacts of digital technology, attitudes towards it, barriers to its integration, and the factors instrumental in its effectiveness. This chapter categorises technology resources and devices, highlighting positive outcomes like enhanced learning, increased collaboration, and improved student attitudes. A quality assessment was conducted, classifying studies based on research design quality, from RCTs to qualitative case studies.

It also discussed frequently used devices, such as computers and tablets, and resources like digital games and storytelling that contribute to improved learning outcomes, noting differences in their effects on skills like problem-solving, literacy, and motivation. Additionally, the chapter presented external barriers (e.g., infrastructure) and internal barriers (e.g., teacher attitudes) to Tech-Int, stressing the importance of effective leadership and professional development, and the key instrumental role of concerning stakeholders with regard to classroom implementations and outcomes.

Phase 2

Chapter 6
Questionnaire Analysis

6.1 Descriptive Analysis

This chapter presents the findings from the data collected through an online questionnaire, beginning with a descriptive analysis of the sample demographics and key variables to understand the complex dynamics surrounding Tech-Int in educational environments. Emphasis is placed on the demographic differences between the various groups within the educational ecosystem, examining their efficiency, attitudes, and barriers faced when using technology in Scottish primary schools. The chapter then progresses to part 6.2 a statistical analysis, including reliability checks and hypothesis tests.

6.1.1 Response Rate

The questionnaire was distributed to 32 council areas across Scotland, as detailed in Section 4.6.3 (Questionnaire Data Collection) of Chapter 4. A total of 308 responses were received, including 212 (57%) complete and 96 (43%) incomplete responses. Consequently, the actual usable size of the sample in this research was 212 participants. The majority of participants were from Glasgow City Council (n = 46). The general guidelines proved by Roscoe’s (1975) rules have been utilised extensively to calculate sample sizes in behavioural research. He recommended that studies on psychology should include anything from 30 to 500 individuals. He also mentioned that the margin of error will rise if the sample size was extended to more than 500.

6.1.2 Demographic Groups

Because education is a collaborative effort involving multiple stakeholders, this research gives special consideration to a comprehensive analysis of various significant groups. The following findings highlight demographic differences among the groups.

6.1.2.1 Council Distribution

Respondents were categorised based on their jobs (educational roles) and the council with which they are associated, as illustrated in Table 6.1. The analysis reveals a diverse composition of respondents across different roles and locations. Among the identified groups, the majority were P/Cs (n = 157, 74.1%). This substantial representation underscores the significance of engaging with the parent community in educational matters. TCRs (n = 31, 14.6%), play an essential role in the educational process, contributing to the overall dynamics of the learning environment. TAs (n = 16, 7.5%), contribute to the support structure in educational settings. While their numbers are comparatively smaller, their role in assisting TCRs and students is noteworthy. HTs (n = 8, 3.8%) form a smaller but influential subset of the participants. Their leadership positions suggest potential impacts on the overall management and direction of educational institutions.

Table 6.1: Participant groups by local council area

Local Council	Total N = 212	Group			
		TCR N = 31	HT N = 8	P/C N = 157	TA N = 16
Aberdeen City	12 (5.7%)	2 (6.5%)	0 (0.0%)	10 (6.4%)	0 (0.0%)
Fife	13 (6.1%)	0 (0.0%)	0 (0.0%)	12 (7.6%)	1 (6.5%)
Glasgow City	46 (21.7%)	7 (22.6%)	1 (12.5%)	35 (22.3%)	3 (18.5%)
North Lanarkshire	12 (5.7%)	2 (6.5%)	0 (0.0%)	10 (6.4%)	0 (0.0%)
Renfrewshire	11 (5.2%)	0 (0.0%)	0 (0.0%)	9 (5.7%)	2 (12.5%)
South Lanarkshire	11 (5.2%)	1 (3.2%)	0 (0.0%)	10 (6.4%)	0 (0.0%)
Other council areas	107 (50.4%)	19 (61.2%)	7 (87.5%)	71 (45.1%)	10 (62.5%)

6.1.2.2 Age Distribution

In addition to the overall demographic details outlined in Table 6.2, the survey participants (n = 212) were categorised into different age groups, providing insights into the distribution within each. The median age for the entire sample was 41 years, with a range from 22 to 76 years (Q1 – Q5: 35.0 – 49.0).

Table 6.2: Participant groups by age

	Total N = 212	Group			
		TCR N = 31	HT N = 8	P/C N = 157	TA N = 16
Age (years)					
Median (Q1-Q5)	41 (35.0-49.0)	37 (30.5-51.5)	48 (40.5-54.0)	42 (37.0-48.0)	35.5 (27.0-52.0)
Min.-Max.	22-76	23-64	44-56	24-76	22-68
Age categories (years)					
20-29	19 (16.96%)	7 (22.6%)	0 (0.0%)	7 (4.5%)	5 (31.3%)
30-39	69 (32.54%)	11 (35.5%)	0 (0.0%)	53 (33.8%)	5 (31.3%)
40-49	72 (33.96%)	3 (9.7%)	4 (50.0%)	64 (40.8%)	1 (6.3%)
50-59	41 (19.33%)	8 (25.8%)	4 (50.00%)	26 (16.6%)	3 (18.8%)
60+	11 (5.18%)	2 (6.5%)	0 (0.0%)	7 (4.5%)	2 (12.5%)

6.1.2.3 Gender Distribution

The survey participants, totalling 212, were classified into different gender categories across various educational roles. The overall gender distribution showed a balanced representation, with 91 respondents (42.9%) identifying as male, and 121 (57.1%) as female.

Table 6.3: Participant groups by gender

Gender	Total N = 212	Group			
		TCR N = 31	HT N = 8	P/C N = 157	TA N = 16
Male	91 (42.9%)	16 (51.6%)	3 (37.5%)	65 (41.4%)	7 (43.8%)
Female	121 (57.1%)	15 (48.4%)	5 (62.5%)	92 (58.6%)	9 (56.3%)

6.1.2.4 Years of Experience By Role

As shown in Table 6.4, the respondents were categorised based on their roles in education. A dynamic pattern is explained by looking at the years of experience of educators in Scotland’s primary schools about Tech-Int. There are three different roles among the 55 participants in the survey: TCRs (n = 31), TAs (n = 16) and HTs (n = 8). These results show the varied backgrounds and years of experience of those who support the teaching profession by indicating differences in experience levels across various roles within the educational context.

Table 6.4: Participant groups by years of experience

Years of experience	Total N = 55	Group		
		TCR N = 31	HT N = 8	TA N = 16
1-5	16 (29.1%)	10 (32.3%)	0 (0%)	6 (37.5%)
6-10	9 (16.4%)	6 (19.4%)	0 (0%)	3 (18.8%)
11-15	9 (16.4%)	5 (16.1%)	3 (37.5%)	1 (6.3%)
16-20	10 (18.9%)	6 (19.4%)	3 (37.5%)	1 (6.3%)
>20	11 (20.00%)	4 (19.9%)	2 (25.0%)	5 (31.3%)

6.1.2.5 Children Age and P/C Age

Table 6.5 presents a nuanced distribution of children's ages, highlighting the range within the surveyed population. The percentages across different age categories are as follows: This breakdown is important because it shows how varied parental/carer age configurations are related to different developmental stages of childhood.

Table 6.5: P/C and child ages

Child's age (years)	Total N = 157	P/C age categories		
		<30	30-40	>40
4-5	32 (20.4%)	5	16	11
6-7	41 (26.1%)	1	24	16
8-9	28 (17.8%)	0	14	14
10-11	37 (23.6%)	0	15	22
12	19 (12.1%)	0	6	13

6.1.2.6 Current Teaching Level

The provided Table 6.6 outlines the distribution of educators across different teaching levels, categorised into two groups: TCRs (n = 31) and TAs (n = 16).

Table 6.6: Teaching level

Level teaching	Total N = 52	Group	
		TCR (n = 31)	TA (n = 16)
P1	12 (23.07%)	7 (22.58%)	5 (31.25%)
P2	9 (17.30%)	8 (25.80%)	1 (6.25%)
P3	8 (15.38%)	1 (3.22%)	7 (34.75%)
P4	3 (5.76%)	2 (6.45%)	1 (6.25%)
P5	7 (13.46%)	5 (16.12%)	2 (12.5%)
P6	6 (11.53%)	6 (19.35%)	0
P7	7 (13.46%)	6 (19.35%)	1 (6.25%)

6.1.2.7 Total Household Income for P/C

In Table 6.7 the median value indicates the overall household income distribution's central tendency, showing that a sizable portion of respondents fall into higher income categories. The range provides information about the distribution of income categories, with most people falling into higher categories, which go between £30,001 to £40,000 to over £40,001. For context, the median annual earnings in Scotland were £38,315 in 2024 (Office for National Statistics, 2024). Meaning that a significant part of the sample reported incomes above the average for the country.

Table 6.7: P/C household income

Total household income (GBP p.a.) Median = 5, Min-Max (4 -5)	**Frequency**	**Percent**
<10,000	0	0%
10,001-20,000	0	0%
20,001-30,000	0	0%
30,001-40,000	25	15.9%
>40,001	99	63.1%
Prefer not to say	33	21.1%
Total	157	100.0%

6.1.2.8 Educational Level

All survey participants (n = 212) were categorised based on their highest level of education across different educational roles. Table 6.8 outlines the distribution of educational attainment, offering insights into the respondents' academic backgrounds. These findings show a diverse range of educational backgrounds among the surveyed population, with a notable proportion holding advanced degrees, particularly among HTs. Understanding the educational attainment of participants is crucial for contextualising their perspectives on Tech-Int in primary education and provides valuable insights into the potential influence of educational background on their views and practice.

Table 6.8: Participants' level of education

Highest level of education	Total N = 212	Group			
		TCR N = 31	HT N = 8	P/C N = 157	TA N = 16
Some college credit, no degree	1 (0.47%)	0 (0%)	0 (0.0%)	1 (0.6%)	0 (0.0%)
Technical/vocational training	3 (1.4%)	0 (0.0%)	0 (0.0%)	3 (1.9%)	0 (0.0%)
Associate degree	22 (10.37%)	1 (3.22%)	0 (0.0%)	20 (12.73%)	1 (6.25%)
Bachelor's degree	15 (7.07%)	2 (6.45%)	0 (0.0%)	11 (7.0%)	2 (12.5%)
Master's degree	20 (9.43%)	2 (6.45%)	0 (0.0%)	12 (7.6%)	6 (37.5%)
Professional degree	17 (8.011%)	5 (16.12%)	3 (37.5%)	9 (5.7%)	0 (0.0%)
Doctorate degree	91 (42.92%)	13 (41.93%)	3 (37.5%)	72 (45.85%)	3 (18.75%)
Prefer not to say	43 (20.28%)	8 (25.80%)	2 (25.0%)	29 (18.47%)	4 (25.0%)

6.1.3 Efficiency in Using Technology

Efficiency in the use of technology is a crucial metric since it directly affects how successful instructional strategies are. This section discusses how each group uses technology.

6.1.3.1 Training on Technology Use

Table 6.9 provides information on the training experiences that TCRs and TAs have had in using technology for teaching. The vast majority of these 47 teaching staff (n = 37, 78.7%) reported that they had received technology-related training, indicating an increasing focus on professional growth in this field. However, a closer look shows a possible divide between the professional groups.

Table 6.9: Training on technology

Have you received any training on how to use technological device and resources in education teaching?	Yes	No	Total
TCR	27 (87.1%)	4 (12.90%)	31
TA	10 (62.5%)	6 (37.5%)	16
Total	37 (78%)	10 (21.27%)	47

6.1.3.2 How Did You Learn About the Use of the Technology in Education?

Table 6.10 provides a summary of the types of training that TCRs and TAs employ to integrate technology into their teaching, with a particular focus on the technological devices and resources used in Scotland's primary schools.

Table 6.10: Resources for learning about technology in education

Learning about technology	Self-learning (%)	Seminars/ conferences/ workshops (%)	Professional training courses (%)	School training (%)
Technological devices (computer, laptop, tablet etc.)	35 (74.5%)	14 (29.8%)	13 (27.7%)	14 (29%)
Technology resources (game-based learning, digital story, E-book etc.)	33 (70.2%)	16 (34.0%)	9 (19.1%)	15 (31.9%)

6.1.3.3 Do You Use Technological Devices (Computer, Laptop, Tablet etc.) and Resources (Game Based Learning, Digital Story, E-Book etc.) for Children Educational Purposes?

The frequency of technology use in home and school learning environments is displayed in Table 6.11. It shows how frequently the various groups of TCRs, TAs, and P/Cs use technological devices and resources for their children's education. This difference highlights how the two groups' usage patterns differ from one another. The findings highlight differences in the frequency of Tech-Int in different environments, suggesting possible differences in strategies for Tech-Int in children's learning environments. When taken as a whole, these observations highlight the necessity of understanding these differences to successfully use technology in the educational contexts.

Table 6.11: Frequency of using technological devices and resources for children's education

Do you use technological devices and resources for children's educational purposes?	Group	
	TCR+TA	P/C
Median (Q2.4) Min.-Max	Median = at least once a day 1-5	Median = at least once a week 1-5
All lessons	25.5%	2.5%
At least once a day	40.4%	36.3%
At least once a week	12.8%	27.4%
Frequently	19.1%	29.9%
Never	2.1	3.8%
Total	100%	100%

6.1.3.4 Which Technological Devices Do You Prefer Using for Teaching Children?

To illustrate the differences between the home and school contexts, Table 6.12 shows the preferred technology used by P/Cs, TCRs, and TAs to teach children, to compare preferred technological devices for teaching children between home and school settings. In schools and homes, tablets are the most favoured device among participants.

Table 6.12: Participant groups' preferences for technological devices

Which technological devices do you prefer using for teaching children?	**Group**	
	TCR+TA	**P/C**
Computer	30.1%	16.0%
Tablet	37.0%	48.8%
Laptop	24.7%	22.0%
Smartphone	5.5%	12.4%
Others	2.7%	0.8%
Total	100%	100%

6.1.3.5 Based on Your Observations, Which Technological Devices Do Children Commonly Use for Learning?

Table 6.13 shows the devices children usually use for education in different learning environments at home and school. Tablets are the most used device in both groups, according to 47.6% of TCRs and TAs, and 45.6% of P/Cs. Furthermore, considering device comprehension, it is important to investigate any differences in how technological resources are used for the education of children. By exploring these subtleties, parents and TCRs can change their strategies to help children most effectively in their educational goals.

Table 6.13: Devices commonly used for learning by children

Based on your observations, which technological devices do children commonly use for learning?	Group	
	TCR+TA	P/C
Desktop	13.%	13.1%
Tablet	47.6%	45.6%
Laptop	20.2%	20.8%
Smartphone	16.7%	19.8%
Others	2.4%	0.7%
Total	100%	100%

6.1.3.6 Which Technology Resources Do TCRs and Children Prefer for Learning in Class and At Home?

According to TCRs and P/Cs, the Table 6.14 shows how different technological resources are used to teach in classrooms and focuses the resources children prefer to learn from, both at home and in the classroom. The most popular technological resource among TCRs and children for both classroom and home learning is games-based learning. These findings show the importance of using various kinds of technological resources in the classroom to meet the needs of children and improve their learning outcomes at home and school more effectively. Additionally, they highlight to answer which subject's children are interested in using technology for learning.

Table 6.14: TCRs' and P/Cs' preferences for technological resources for T&L

Resources	Group		
	TCR+TA: prefer use in class	Children's Tech Preferences in class: TCRs' Report	Children's Tech Preferences in home: P/C Report
Games based learning: educational video games, gamified learning apps	34.7%	42.4%	42.4%
Digital story: interactive storybooks, digital storytelling	11.2%	23.2%	20.5%
E-book: electronic versions of textbooks or reading materials, interactive e-books	23.5%	15.2%	9.8%
Online learning platform: educational websites, LMS	28.6%	18.2%	26.3%
Other	2.0%	1.0%	1.0%

6.1.3.7 For Which Subjects Would Children Like to Use Technology for Learning?

Table 6.15 provides comprehension of the subjects that children prefer to learn using technology, as reported by both TCRs, TAs, and P/Cs. Among TCRs and TAs, "mathematics" and "science" appear as the most preferred subjects for technology-assisted learning, with 70.2% and 68.1% of respondents showing preference, respectively. This suggests a strong interest in employing technology to enhance learning in these main subjects. "Reading" also garners significant attention, with 40.4% of TCRs and TAs reporting it as a preferred subject for technology-based learning.

Conversely, P/Cs report slightly different preferences among children. While "mathematics" is still the top choice, preferred by 82.2% of respondents, "science" and "reading" also rank high, with 59.9% and 53.5% agreement from P/Cs (respectively), expressing a preference for technology-assisted learning in these subjects.

Table 6.15: Subjects students prefer to learn with technology according to TCRs and parents

Subjects	Group	
	Report: TCR+TA	Report: P/C Report
Math	70.2%	82.2%
Science	68.1%	59.9%
Reading	40.4%	53.5%
Geography	31.9%	38.2%
History	34.0%	37.6%
Learning languages	44.7%	57.3%
Others	17.0%	7.6%

6.1.3.8 How Do You Perceive the Impact of Technology on Teaching Outcomes?

Table 6.16 provides information on the different groups' opinions on how technology affects teaching outcomes, including HTs, TCRs and TAs, and P/Cs. These results point to a generally optimistic view of how technology is affecting learning outcomes for all groups involved, with HTs showing the highest degree of optimism, followed by P/Cs and TCRs and TAs.

Table 6.16: Impact of technology on teaching outcomes

Impact of technology on teaching outcomes	Group		
	HT	TCR+TA	P/C Report
Negative	37.5%	4.3%	1.3%
Medium	37.5%	36.2%	50.6%
Positive	75.0%	59.6%	47.8%

6.1.4 Attitude to Used Technology

Investigating the viewpoints and overall attitudes of various stakeholders, this part examines the perspectives of P/Cs, TCRs and TAs, and HTs regarding the role of Tech-Int in environmental educational settings. The aim is to understand their attitudes on Tech-Int in the learning environment. Considering the differences in how the term "attitude" is defined, especially in research on attitudes towards the use of technology in education, Ajzen (1991) and Ajzen *et al*. (2018) presented The TPB as the foundational theoretical model of attitude and its relationship to behaviour, as mentioned in Chapter 3. This part of the questionnaire was measured using a five-point Likert scale, with responses ranging from 1 = "strongly disagree" to 5 = "strongly agree."

6.1.4.1 P/Cs

Table 6.17 presents data related to the impact of technology resource-based education and digital devices on children's development and learning. The table also provides the total mean, standard deviation (SD), and weighted mean (WM) for all items (3.91, 0.87, and 74.44, respectively). The total mean refers to the average value calculated by summing all the scores and dividing by the number of observations. The weighted mean accounts for the relative importance of each item, with different weights assigned to each based on their significance in the analysis. Overall, the data suggests that respondents generally agree with the positive impact of technology resource-based education and digital devices on children's development and learning, with the highest agreement related to the idea that technology can make learning fun and useful. However, there are also some moderate levels of agreement with concerns about the design and effectiveness of digital content.

Table 6.17: Parental perspectives on the impact of technological resources-based education and digital devices

As a P/C, I think that technological resources-based education and digital devices provide an environment in which:					
Item	M	SD	WM	Interpretation	Rk
1. Children can develop and learn	4.30	0.71	86.00	Agree	1
2. Children can explore first-hand experiences while also assisting them in developing and learning via play	4.19	0.74	83.8	Agree	3
3. Children are actively involved, and self-motivated	4.12	0.85	82.4	Agree	4
4. There is increased understanding and ability to solve problems and understanding	3.98	0.80	79.6	Agree	7
5. Children's interactions are increased, enabling them to acquire new skills	4.10	0.87	82.00	Agree	5
6. Children can re-enact real-life events for educational objectives	3.89	0.87	77.8	Agree	9
7. Complex topics can be more easily understood for children	3.97	0.97	79.4	Agree	8
8. Teachers should encourage the use of technology source-based education and digital devices in educational process	4.02	0.84	80.52	Agree	6
9. Using educational technology at home, in my opinion, is a combination of fun and utility	4.29	0.76	85.8	Agree	2
10. I believe that digital contents limit children's interaction and physical activity, leading to emotional problems and behaviours	2.89	1.17	57.8	Moderate	10
11. I believe that digital contents are an ineffective way of teaching	2.31	1.05	42.6	Moderate	12
12. Its design is not in line with the educational content, which causes children to not pay attention to the educational content	2.52	1.039	50.4	Moderate	11
13. I believe that is good way for entertainment	3.98	0.72	79.6	Agree	7
All items	3.91	0.87	74.44	Agree	

M: Mean; SD: Standard deviation; WM: Weighted mean; Rk: Ranking

6.1.4.2 TCRs and TAs

It is important to investigate behavioural beliefs to understand the emotional and cognitive effects of behaviour. Examining the opinions of TCRs and TAs on the usage of technology in the classroom provides environment. Table 6.18 presents results, providing a categorised set of items that further explains the perspectives of TCRs. It also provides the total mean, SD, and WM for all items (3.77, 0.69, and 75.4, respectively). Overall, the data suggests that respondents generally agree with the positive impact of technology resource-based education and digital devices on the learning environment, with the highest agreement related to the idea that children's interactions are facilitated, enabling them to acquire new skills (item no. 6). However, there are also some moderate levels of agreement with concerns about the design, effectiveness, and potential limitations of digital content.

Table 6.18: TCR and TA attitudes toward technological resources-based education and use of digital devices

Technological resources-based education and digital devices provide an environment in which:					
Item	M	SD	WM	Interpretation	Rk
1. Children can explore first-hand experiences while also assisting them in developing and learning via play	4.02	0.821	80.4	Agree	4
2. Children are actively involved, and self-motivated	4.09	0.996	81.8	Agree	3
3. Classroom engagement is increased, providing unique learning experiences	4.09	1.018	81.8	Agree	3
4. Physical, cognitive, emotional, and social skills are activated through technology resource-based education and digital devices	3.87	0.947	77.4	Agree	7
5. Understanding and ability to solve problems is increased	3.80	0.980	76.0	Agree	8
6. Children's interactions are facilitated, enabling them to acquire new skills	4.90	0.880	98.0	Strongly agree	1
7. The classroom atmosphere is more enjoyable than traditional methods	3.91	0.996	78.2	Agree	6
8. Technology resource-based education and digital devices establish an atmosphere in which children can re-enact real-life events for educational objectives	3.98	0.872	79.6	Agree	5
9. Complex topics can be made easier to understand for children	4.13	0.687	82.6	Agree	2
10. I believe that policy makers should consider introducing technology resource-based education and digital devices in educational process	4.02	0.897	80.4	Agree	4
11. Digital contents limit children's interaction and physical activity, leading to emotional and behavioural problems	3.11	0.173	62.2	Moderate	9
12. Digital resources harm instructional content	2.79	0.161	55.8	Moderate	11
13. Digital contents are an ineffective way of teaching	2.98	0.181	59.6	Moderate	10
14. Design is not in line with the educational content, which causes students to not pay attention to the educational content	3.11	0.170	62.2	Moderate	9
All items	3.77	0.69	75.4	Agree	

M: Mean; SD: Standard deviation; WM: Weighted mean; Rk: Ranking

6.1.4.3 HTs

Table 6.19 presents data related to respondents' agreement or disagreement with various points about the educational philosophy of their primary school, particularly concerning Tech-Int. The table also provides the total mean, SD, and WM for all items (3.64, 1.86, and 72.8, respectively). Overall, the data suggests that respondents generally agree with positive statements about Tech-Int in their primary school but have more moderate agreement regarding potential challenges and discomfort related to technology use among HTs.

Table 6.19: HTs' attitudes on the impact of technological resources-based education and digital devices

To what extent do you agree or disagree to the following points about the educational philosophy of your primary school?					
Item	M	SD	WM	Interpretation	Rk
1. TCRs and children prefer to use technology resources to teach and learn	3.62	0.91	72.4	Agree	7
2. Technology resources and device are only appropriate for use in your primary school if it reflects the curriculum requirements	3.87	0.83	77.4	Agree	5
3. TCRs must attend technology training to become more effective when teaching using technology	3.37	1.06	67.4	Moderate	8
4. The majority of the teaching staff can use technology resources comfortably	3.25	1.16	65.00	Moderate	9
5. The high cost is the primary barrier to using technology in your primary school	4.25	0.46	85.00	Agree	3
6. The use of technology resources and devices comes with remarkable benefits and is highly encouraged across the primary education continuum	3.62	0.91	72.4	Agree	7
7. Keeping pace with the fast-changing technology is cumbersome and unnecessary for teachers in your primary school	2.75	0.88	55.00	Moderate	12
8. Children in your school generally receive technology resources positively	4.75	0.46	95.00	Strongly agree	1
9. Children are more likely to use technology at home than in school	4.37	1.06	87.4	Agree	2
10. The adoption of technology in this school is supported by the children's parents	3.12	1.126	62.4	Moderate	10
11. The use of technology resources in this school makes TCRs uncomfortable	2.87	0.83	57.4	Moderate	11
12. Most of the TCRs in your school feel more positive about using technology in teaching	3.75	0.88	75.00	Agree	6
13. New TCRs majorly prefer using technology in teaching	4.12	1.24	82.4	Agree	4
14. Education, in the future, will be primarily based on technologies	3.25	1.28	65.00	Moderate	9
All items	3.64	1.86	72.8	Agree	

M: Mean; SD: Standard deviation; WM: Weighted mean; Rk: Ranking

6.1.5 Barriers and Factors to Technology Learning

This section explores the views of different groups (P/Cs, HTs, TCRs, and TAs) on the barriers and factors influencing Tech-Int in Scottish primary schools. This part of the questionnaire was measured using a five-point Likert scale in which 1 = “strongly disagree” and 5 = “strongly agree.”

6.1.5.1 P/Cs

The Table 6.20 provides the total mean, SD, and WM for all items (3.15, 0.73, and 63.06, respectively). Overall, the data suggests that respondents generally agree with the statements about barriers they face when using technology in their home, with the highest agreement related to the high cost of technology and unavailability of designs, and the lowest agreement related to their own experience in using technology for teaching. These barriers are seen as moderate challenges in Tech-Int effectively into education.

Table 6.20: Barriers and factors to Tech-Int – perspectives of P/Cs

P/Cs					
Item	M	SD	WM	Interpretation	Rk
1. Unavailability of designs according to the curriculum content	3.32	1.04	66.42	Moderate	2
2. I don’t have enough experience to using to teach	2.58	1.01	51.67	Moderate	5
3. Negative beliefs about the impact of technology on children have discouraged developing effective digital instructions	3.06	1.06	61.23	Moderate	4
4. The high cost of designs and devices affected their use in the classroom and home	3.58	1.07	71.54	Agree	1
5. Lack of courses in technology-related subjects	3.31	0.96	66.11	Moderate	3
All items	3.15	0.73	63.06	Moderate	

M: Mean; SD: Standard deviation; WM: Weighted mean; Rk: Ranking

6.1.5.2 TCRs and TAs

Table 6.21 provides the total mean, SD, and WM for all items (3.52, 0.85, and 71, respectively). Overall, the data suggests that respondents generally agree with the statements about barriers they face when using technology in their school, with the highest agreement related to the high cost of designs and devices. These barriers are seen as significant challenges in Tech-Int effectively into education.

Table 6.21: Barriers and factors to Tech-Int – perspectives of TCRs and TAs

TCRs and TAs					
Item	M	SD	WM	Interpretation	Rk
1. Unavailability of designs according to the curriculum content	3.55	0.80	71	Agree	3
2. I don't have enough experience to using to teach	2.64	0.98	52.8	Moderate	5
3. Negative beliefs about the impact of technology on children have discouraged developing effective digital instructions	3.43	0.95	68.6	Moderate	4
4. The high cost of designs and devices affected their use in the classroom and home	4.13	0.76	82.6	Agree	1
5. Lack of courses in technology-related subjects	3.85	0.78	77	Agree	2
All items	3.52	0.85	71	Agree	

M: Mean; SD: Standard deviation; WM: Weighted mean; Rk: Ranking

6.1.5.3 HTs

Table 6.22 provides the total mean, SD, and WM for all items (4.04, 0.90, and 81.76, respectively). Overall, the data suggests that respondents generally agree with the statements about barriers they face when using technology in their school, with the highest agreement related to the lack of courses in technology-related subjects. These barriers are seen as significant challenges in Tech-Int effectively into education.

Table 6.22: Barriers and factors to Tech-Int – perspectives of HTs

HTs					
Item	M	SD	WM	Interpretation	Rk
1. Unavailability of designs according to the curriculum content	4.40	0.76	85.8	Agree	2
2. I don't have enough experience to using to teach	3.40	0.53	68.6	Moderate	5
3. Negative beliefs about the impact of technology on children have discouraged developing effective digital instructions	3.60	1.67	77.2	Agree	4
4. The high cost of designs and devices affected their use in the classroom and home	4.40	0.78	88.6	Agree	3
5. Lack of courses in technology-related subjects	4.43	0.78	88.6	Agree	1
All items	4.04	0.90	81.76	Agree	

M: Mean; SD: Standard deviation; WM: Weighted mean; Rk: Ranking

6.2 Statistical Analysis

In the comprehensive analysis of the role of technology in educational environments, the mean scores for scales part 3 of survey (Attitude Tech-Int, see 6.4.1) and part 4 of survey (Barriers to Tech-Int, see 6.1.5) were calculated by taking the average of all questions within each respective scale. This methodological approach provided a consolidated view of each respondent's overall perception and experience, allowing for a simplified yet effective representation of complex data.

The calculation of AVG_ part 3 and AVG_ part 4 (was performed for each distinct dataset TCRs and TA, P/Cs, and HTs. This step was crucial in ensuring that the analysis was tailored and relevant to each group's unique perspective and role within the educational ecosystem. By averaging the scores of multiple items within each scale, a more robust and less volatile measure of each construct was achieved, facilitating more stable comparisons and inferential statistics.

Having calculated the averages for the scores, normality was tested as described under the "Descriptives" sections as per the studied datasets. Normality assumptions in statistics are essential for numerous tests, including correlations and ANOVA. Normal distribution of data supports the reliability of parametric testing and subsequent analytical outcomes. Furthermore, the scales' reliability was assured using the internal consistency determined by the coefficient of Cronbach's alpha (α), computed for dataset's original scale items to assure their reliability and accuracy in measuring intended constructs. The alpha values obtained confirmed the scales' reliability, making them suitable tools for capturing the nuances of technology's role and the barriers to its integration in educational settings.

By meticulously calculating mean scores, checking for normality, and evaluating scale reliability, the research undertook to rigorous statistical standards, and ensured that the insights derived were both credible and meaningful, tailored to the specific needs and contexts of the research's diverse participant groups.

6.2.1 Teachers and Teaching Assistants

6.2.1.1 Descriptives

The average score for the attitude regarding the role of technology in education-based learning environments (AVG_ part3) among TCRs and TAs is 3.7123, suggesting a moderately positive perception. This perception is fairly consistent, as indicated by the narrow 95% confidence interval (CI) ranging from 3.5768 to 3.8477, signifying that the true mean, with 95% confidence, lies within this range. The data's distribution is slightly left-skewed (-0.768), showing a few lower outliers, yet the general consensus leans towards a favourable view of technology-based environments, with the median score slightly higher at 3.7857. The SD is relatively low (0.46144), showing that responses are not widely spread but are clustered around the mean.

For barriers to Tech-Int (AVG_P4), the mean score is 3.5170, which similarly indicates a moderately positive attitude, albeit with more reservations compared to the role of technology. The 95% CI for this mean extends from 3.3539 to 3.6802, which is broader than that for AVG_P3, suggesting more variability in how barriers are perceived. The distribution here is less skewed (-0.197), closer to a normal distribution, which supports the idea that views on barriers are not as polarised. The median of 3.6000 is higher than the mean, hinting that a majority of the responses tend to be slightly more positive regarding the perceived barriers.

Descriptive statistics are displayed in Table 6.23.

Table 6.23: Descriptive statistics (TCRs and TAs)

AVG_P3			
Descriptives		Statistic	Std. Error
Mean		3.7723	.06731
95% CI	Lower bound	3.5768	
Mean	Upper bound	3.8477	
5% trimmed mean		3.7262	
Median		3.7857	
Variance		.213	
SD		.46144	
Minimum		2.07	
Maximum		5.00	
Range		2.93	
Interquartile range		.43	
Skewness		-.768	.347
Kurtosis		3.379	.681
AVG_P4			
Descriptives		Statistic	Std. Error
Mean		3.5170	.08106
95% CI	Lower bound	3.3539	
Mean	Upper bound	3.6802	
5% trimmed mean		3.5206	
Median		3.6000	
Variance		.309	
SD		.55573	
Minimum		2.00	
Maximum		5.00	
Range		3.00	
Interquartile range		.60	
Skewness		-.197	.347
Kurtosis		.942	.681

6.2.1.2 Reliability Analysis

Table 6.24 shows the reliability statistics for the two scales. The “Attitude” scale, consisting of 14 items, shows good internal consistency The Cronbach’s α of 0.728 shows a reliable scale, suggesting that the items are sufficiently correlated and collectively provide a consistent measure of the construct. The Alpha based on standardised items is slightly higher at 0.763, which often happens when the variability among items is uniform, reinforcing the scale’s reliability. The “Barriers and factors” scale, which includes 5 items, presents a moderate level of internal consistency. A Cronbach’s α of 0.651 is considered acceptable but indicates that the scale might benefit from some review and possible revisions to enhance its reliability. The similarity between the Alpha values for standardised and non-standardised items suggests that item variances do not differ substantially, which is positive, but the overall lower alpha value points to potential improvements in item selection or phrasing to better capture the underlying construct.

Table 6.24: Reliability statistics for “attitude” and “barriers and factors” (TCRs and TAs)

Scale	Cronbach’s α	Cronbach’s α based on standardised items	No. items
Attitude	.728	.763	14
Barriers and factors	.651	.656	5

6.2.1.3 H1: *“There is a negative correlation between the role of tech-based learning environments and the perceived barriers to Tech-Int”*

“Higher ratings on tech-based learning environments will correlate with lower perceived barriers to Tech-Int.”

Table 6.25 shows that there is a negative correlation between the role of tech-based learning environments and the perceived barriers to Tech-Int. Higher ratings on tech-based learning environments will correlate with lower perceived barriers to Tech-Int. The Pearson correlation analysis between AVG_P3 (Role of Tech-Based Learning Environment) and AVG_P4 (Barriers to Tech Integration) shows a correlation coefficient of 0.305, which is statistically significant with a p-value of 0.037 (less than the alpha level of 0.05). This result indicates a positive correlation between these two variables among TCRs and TA.

H1 stated that there is a negative correlation between the role of technology-based learning environments and perceived barriers to Tech-Int. However, the positive correlation coefficient suggests that as the perceived effectiveness or role of technology-based learning environments increases, there is also a modest increase in the perception of barriers to Tech-Int. This finding contradicts the hypothesis. This might imply that those who are more engaged or involved with technology in teaching also perceive more challenges or barriers, possibly due to higher awareness or experience with such environments. Given that the correlation is significant ($p < 0.05$) but opposite in direction to what was hypothesised, reject **H1** and conclude that there is a positive, rather than negative, relationship between these variables.

Table 6.25: Pearson correlation analysis – AVG_Q3 & AVG Q4_1 (TCRs and TAs)

		AVG_Q3	**AVG_Q4_1**
Pearson correlation	**AVG_Q3**	1	.305*
Sig (2-tailed)			.037
N		47	47
Pearson correlation	**AVG_Q4_1**	.305*	1
Sig (2-tailed)		.037	
N		47	47

*. Correlation is significant at the 0.05 level (2-tailed).

6.2.1.4 H2: "*The average role of tech-based learning environments differs among groups with positive, negative, and medium perceptions of technology's impact"*

6.2.1.4.1 ANOVA

Table 6.26 shows the ANOVA results for AVG_P3, measuring the role of technology-based learning environments across different groups (such as teaching levels and perceptions of technology's impact), providing significant insights.

Between groups: The sum of squares between the groups is 1.506 with 2 degrees of freedom, yielding a mean square of 0.753.

Within groups: The sum of squares within the groups is much higher at 8.289 with 44 degrees of freedom, resulting in a mean square of 0.188.

Total: The total sum of squares is 9.795 with a total of 46 degrees of freedom.

F-statistic and significance: The F-statistic is 3.996 with a p-value of 0.025. This indicates that there are significant differences in the role of technology-based learning environments across the groups being compared.

Table 6.26: ANOVA – AVG_P3 (TCRs and TAs)

ANOVA AVG_P3	Sum of squares	df	Mean square	F	Sig.
Between groups	1.506	2	.753	3.996	.025
Within groups	8.289	44	.188		
Total	9.795	46			

6.2.1.4.2 Effect Size Analysis

Eta-squared: 0.154, suggesting that approximately 15.4% of the variance in AVG_Q3 can be attributed to the group differences. This is a moderate effect size, indicating a reasonably strong group effect.

Epsilon-Squared: 0.115, which is similar but typically a less biased estimate compared to Eta-squared in smaller samples or unequal group sizes.

Omega-Squared for Fixed and Random Effects: These values (0.113 for fixed effects and 0.060 for random effects) provide alternative estimates of effect sizes, suggesting the proportion of variance accounted for by the model. Omega-squared for fixed effects is quite close to the Eta-squared, reinforcing the significance of the group effects.

Table 6.27: Effect sizes – AVG_P3 (TCRs and TAs)

AVG_P3	Point estimate	95% CI[b]	
		Lower	Upper
Eta-squared[a]	.154	.000	.322
Epsilon-squared[a]	.115	-.045	.291
Omega-squared fixed-effect	.113	-.044	.287
Omega-squared random-effect	.060	-.022	.167

[a.] "Eta-squared and Epsilon-squared are estimated based on the fixed-effect model."
[b.] "Negative but less biased estimates are retained, not rounded to zero."

6.2.1.4.3 Summary

H2 hypothesized that "the average role of tech-based learning environments differs among groups with positive, negative, and medium perceptions of technology's impact." The data supports this hypothesis, as showed by a significant p-value (0.025), which allows us to reject the null hypothesis of no difference between the groups. This finding confirms that the role of technology-based learning environments varies significantly across the groups.

6.2.1.5 H3: "There are differences in education levels across different teaching levels"

6.2.1.5.1 Chi-Square Test Results

Pearson chi-square: The Pearson chi-square value is 65.061 with 42 degrees of freedom, and the associated p-value is .013. This result is significant at the 0.05 level, indicating that there is a statistically significant association between the categorical variables tested.

Likelihood ratio: The Likelihood Ratio Chi-Square value is 38.323 with 42 degrees of freedom, yielding a p-value of .633. This result is not significant, suggesting that when the data is less than perfect for Chi-square analysis (e.g., small, expected counts), the Likelihood Ratio might not detect significant associations.

Linear-by-linear association: This test shows a value of 1.634 with 1 degree of freedom and a p-value of .201, indicating no significant linear trend between the variables on ordinal scales.

There are differences in education levels across different teaching levels.

Table 6.28: Chi-square tests (TCRs and TAs)

Chi-square tests	Value	df	Asymptotic significance (2-sided)
Pearson Chi-square	65.061[a]	42	.013
Likelihood ratio	38.323	42	.633
Linear-by-linear association	1.634	1	.201
N of valid cases	47		

[a.] 53 cells (94.6%) have expected count less than 5. The minimum expected count is .02.

6.2.1.5.2 Considerations on Expected Counts

A critical note in the output is that 53 cells (94.6%) have an expected count less than 5, with the minimum expected count being 0.02. This condition violates one of the key assumptions of the Chi- Square test, which requires a minimum expected count of 5 in each cell for the test to be valid. This violation can lead to a distorted Chi-Square statistic and affect the reliability of the test result, particularly the Pearson Chi-Square test. Since **H3** posited an association between categorical variables (level of education and teaching level), the Pearson chi-squared test suggests a significant association exists.

6.2.1.6 H6: "*Educators with higher education levels report fewer barriers to Tech-Int"*

6.2.1.6.1 ANOVA

Table 6.29 shows the ANOVA results for AVG_Q4_1, measuring perceptions of barriers to Tech-Int across different groups of education level, provide valuable insights into these perceptions but indicate no significant differences between groups based on the statistical test.

Between groups: The sum of squares is 2.551 with 6 degrees of freedom, giving a mean square of 0.425.

Within groups: The sum of squares is significantly higher at 11.655 with 40 degrees of freedom, resulting in a mean square of 0.291.

F-statistic and significance: The F-statistic is 1.459 with a p-value of 0.217, which is not significant at the conventional alpha level of 0.05.

Table 6.29: ANOVA – AVG_P4 (TCRs and TAs)

ANOVA AVG_P4	Sum of squares	df	Mean square	F	Sig.
Between groups	2.551	6	.425	1.459	.217
Within groups	11.655	40	.291		
Total	14.206	46			

6.2.1.6.2 Effect Size Analysis

Eta-squared: 0.180, suggesting that approximately 18% of the variance in perceptions of barriers is accounted for by group differences. Despite being a moderate effect size, the non- significant p-value suggests that these differences might not be reliable or consistent across the sample.

Epsilon-squared and omega-squared: Both of these provide more conservative estimates of effect size. Epsilon-squared is 0.057, and Omega-squared for fixed effects is 0.055, indicating much smaller actual impacts of group differences. The Omega-squared for random effects is even lower at 0.010, suggesting a very minimal true effect due to the group factor when random variability is considered.

Table 6.30: Effect sizes – AVG_P4 (TCRs and TAs)

AVG_P4	Point estimate	95% CI[b]	
		Lower	Upper
Eta-squared[a]	.180	.000	.284
Epsilon-squared[a]	.057	-.150	.177
Omega-squared fixed-effect	.055	-.146	.174
Omega-squared random-effect	.010	-.022	.034

[a.] "Eta-squared and Epsilon-squared are estimated based on the fixed-effect model."
[b.] "Negative but less biased estimates are retained, not rounded to zero."

6.2.1.6.3 Summary

Since **H6** posited significant differences in perceptions of barriers to Tech-Int across different groups (education level), the ANOVA results suggest that the hypothesis is rejected. There is no significant statistical evidence to support the claim that the perceived barriers vary significantly between the defined groups within this sample.

6.2.1.7 H7: "There is a significant difference between genders in their perceptions of the role of technology in educational environments (AVG_P3)"

The analysis of the independent samples test reveals a significant (0.132) difference in perceptions regarding the role of technology in educational environments between genders among TCRs. The t-test for equality of means shows significant results (t (41.370) = 3.043, p = .004 2-tailed), indicating that the means of the two groups are significantly different. The effect sizes, indicated by Cohen's d (.881) and Hedge's correction (.867), suggest a moderate to large effect, confirming that the mean difference (.37496) is not only statistically significant, but also of practical importance. The results suggest accepting the hypothesis that there is a significant difference between genders in their perceptions of the role of technology in educational environments (AVG_P3).

Table 6.31: Independent samples t-test – AVG_P3 (TCRs and TAs)

AVG_Q3										
Equal variances	**LTEoV**		**t-test for equality of means**							
	F	Sig.	t	df	Sig.		MD	SED	95% CIoD	
					1-s p	2-s pce			Lower	Upper
Assumed	2.348	.132	3.021	45	.002	.004	.37496	.12413	.12495	.62497
NotA			3.043	41.37	.002	.004	.37496	.12322	.12617	.62374

CIoD: Confidence interval of difference; LTEoV: Leven's test for equality of variance; NotA: Not assumed; MD: Mean difference; Sig.: Significance (1-s p: 1-sided p; 2-spce: 2-sided pce); SED: Standard error difference.

Table 6.32: Independent samples effect sizes test – AVG_P3 (TCRs and TAs)

AVG_Q3	Standardiser[a]	Point estimate	95% CI	
			Lower	Upper
Cohen's d[a]	.42540	.881	.277	1.477
Hedge's correction[b]	.43266	.867	.272	1.452
Glass's delta[c]	.49012	.765	.145	1.371

[a.] "The denominator used in estimating the effect sizes. Cohen's d uses the pooled SD."

[b.] "Hedge's correction uses the pooled SD, plus a correction factor."

[c.] "Glass's delta uses the sample SD of the control (i.e., the second) group."

6.2.1.8 H8: "*There is a significant difference between genders in their perceptions of barriers to Tech-Int in schools (AVG_P4)"*

The analysis of the TCR group through an independent samples t-test did not reveal any statistically significant differences between genders in their perceptions of barriers to Tech-Int. The p-value from the 2-sided t-test (t= .314, p = .755) indicates that the difference in means is not statistically significant, which aligns with the very small effect sizes (Cohen's d = .092, Hedge's correction = .091, and Glass's delta = .117). The CIs for these effect sizes all straddle zero, further supporting the lack of a distinct impact based on gender. Based on these results, the hypothesis that there is a significant difference between genders among TCRs can be rejected.

Table 6.33: Independent samples t-test – AVG_P4 (TCRs and TAs)

AVG_P4										
Equal variances	LTEoV		t-test for equality of means							
	F	Sig.	t	df	Sig.		MD	SED	95% CIoD	
					1-s p	2-s pce			Lower	Upper
Assumed	2.577	.115	.316	45	.377	.753	.05181	.16377	-.27804	.38166
NotA			.314	38.04	.378	.755	.05181	.16515	-.28251	.386148

CIoD: Confidence interval of difference; LTEoV: Leven's test for equality of variance; NotA: Not assumed; MD: Mean difference; Sig.: Significance (1-s p: 1-sided p; 2-spce: 2-sided pce); SED: Standard error difference.

Table 6.34: Independent samples effect sizes – AVG_P4 (TCRs and TAs)

AVG_P4	Standardiser[a]	Point estimate	95% CI	
			Lower	Upper
Cohen's d[a]	.56125	.092	-.480	.664
Hedge's correction[b]	.57082	.091	-.472	.653
Glass's delta[c]	.44126	.117	-.457	.689

[a.] "The denominator used in estimating the effect sizes. Cohen's d uses the pooled SD."

[b.] "Hedge's correction uses the pooled SD, plus a correction factor."

[c.] "Glass's delta uses the sample SD of the control (i.e., the second) group."

6.2.1.9 H9a: "*There is a significant difference in the average age of TCRs across different teaching levels"*

6.2.1.9.1 ANOVA

The hypothesis that there is a significant difference in the average age of TCRs across different teaching levels was tested using an ANOVA. The results from the ANOVA indicate a p-value of .068, which is slightly above the conventional alpha level of .05, suggesting that the differences among group means are not statistically significant at the 5% level. Therefore, it fails to reject the null hypothesis, implying that there is no significant variation in the average age of TCRs across different teaching levels.

Table 6.35: ANOVA – Q1.2 (TCRs and TAs)

	Sum of squares	df	Mean square	F	Sig.
Between groups	2083.278	7	297.611	2.090	.068
Within groups	5553.956	39	142.409		
Total	7637.234	46			

6.2.1.9.2 Effect Size Analysis

The effect sizes further illustrate the strength of the association. The Eta-squared value is .273, indicating that approximately 27.3% of the variance in age can be explained by the differences across teaching levels. However, the CIs for Epsilon-squared and Omega-squared include negative values, which can occur with small sample sizes or non-normal data, indicating some instability in these measures. The Omega-squared value of .023 suggests a very small practical significance of the teaching level differences on the age of TCRs.

Table 6.36: Effect sizes – Q1.2 (TCRs and TAs)

Q1.2 What is your age?	Point estimate	95% CI	
		Lower	Upper
Eta-squared	.273	.000	.373
Epsilon-squared	.142	-.179	.261
Omega-squared fixed-effect	.140	-.175	.257
Omega-squared random-effect	.023	-.022	.047

[a.] "Eta-squared and Epsilon-squared are estimated based on the fixed-effect model."
[b.] "Negative but less biased estimates are retained, not rounded to zero."

6.2.1.9.3 Summary

In summary, while there appear to be some differences in mean ages across teaching levels (e.g. P1 to P7), these differences are not statistically significant and have minimal practical implications based on the effect size analysis.

6.2.2 Parents and Carers

6.2.2.1 Descriptives

The average score for the role of technology-based learning environments among this second group of P/Cs is 3.7219, showing a generally positive perception. The 95% CI for this mean, ranging from 3.6262 to 3.8177, shows precision in these estimates, reflecting a consistent agreement among respondents. Notably, the data displays significant negative skewness (-1.802) and very high kurtosis (8.880), suggesting the presence of outliers and that responses are heavily tailed or peaked around the mean. The median of 3.7692 aligns closely with the mean, reinforcing the central tendency observed. The relatively low SD of 0.43844 confirms that responses are not widely dispersed.

For barriers to Tech-Int part_ 4, the mean score is 3.1876, which suggests a moderate perception of barriers among the participants. The 95% CI ranges from 3.0225 to 3.3526, indicating a slightly broader dispersion of opinions compared to AVG_ part 3. The distribution's skewness is negative (-0.809), showing some bias toward lower scores, though less pronounced than in AVG_P3. The kurtosis is closer to normal but still indicates a slightly platykurtic distribution (0.481), suggesting fewer extreme values than in AVG_P3. The interquartile range is 1.00, which is higher than in AVG_P3, and shows more variability in the middle 50% of the data.

Descriptive statistics are displayed in Table 6.37.

Table 6.37: Descriptive statistics (P/Cs)

AVG_P3			
Descriptives		Statistic	Std. Error
Mean		3.7319	.04812
95% CI	Lower bound	3.6262	
Mean	Upper bound	3.8177	
5% trimmed mean		3.7417	
Median		3.7692	
Variance		.192	
SD		.43844	
Minimum		1.38	
Maximum		4.69	
Range		3.31	
Interquartile range		.46	
Skewness		-1.802	.264
Kurtosis		8.880	.523
AVG_P4			
Descriptives		Statistic	Std. Error
Mean		3.1876	.08297
95% CI	Lower bound	3.0225	
Mean	Upper bound	3.3526	
5% trimmed mean		3.2258	
Median		3.4000	
Variance		.571	
SD		.75588	
Minimum		1.00	
Maximum		4.40	
Range		3.40	
Interquartile range		1.00	
Skewness		-.809	.264
Kurtosis		.481	.523

6.2.2.2 Reliability Analysis

Table 6.38 shows the reliability statistics for the two scales. The “technology-based learning environments” scale demonstrates good internal consistency with a Cronbach’s α of 0.734, indicating that the items are reliably measuring a single underlying construct. The alpha based on standardised items is slightly higher at 0.784, suggesting that when item variances are equalised, the internal consistency improves. This level of reliability is adequate for educational research, where a threshold of 0.7 is typically acceptable. The five-item “barriers to Tech-Int” scale consisting of 5 items, achieving a Cronbach’s α of 0.737, is notably robust, indicating a strong level of internal consistency for such a compact scale. The standardised alpha nearly mirrors the traditional alpha, reinforcing the consistency across different standardisation methods. This suggests that the items on this scale are well-calibrated, and they effectively measure the intended construct without significant deviation.

Table 6.38: Reliability statistics for “technology-based learning environments” and “barriers to Tech-Int” (P/Cs)

Scale	Cronbach’s α	Cronbach’s α based on standardised items	No. items
Technology-based learning environments (part _3)	.734	.784	13
Barriers to Tech-Int (part_4)	.737	.735	5

6.2.2.3 H1: “There is a negative correlation between the role of tech-based learning environments and the perceived barriers to Tech-Int”

“Higher ratings on tech-based learning environments will correlate with lower perceived barriers to Tech-Int.”

The results from the Pearson correlation analysis in the second dataset between AVG_P3 (Role of Tech-Based Learning Environment) and AVG_P4(Barriers to Tech Integration) show a correlation coefficient of 0.251. This correlation is statistically significant with a p-value of 0.022, showing that there is a positive association between these two variables at the 5% significance level.

Table 6.39: Pearson correlation analysis – AVG_P3 & AVG part 4 – (P/Cs)

		AVG_P3	AVG_P4
Pearson correlation	AVG_P3	1	.251*
Sig (2-tailed)			.022
N		153	83
Pearson correlation	AVG_P4	.251*	1
Sig (2-tailed)		.022	
N		83	84

*. Correlation is significant at the 0.05 level (2-tailed).

The correlation coefficient suggests a modest but significant positive relationship, meaning as perceptions of the role of technology-based learning environments improve, perceptions of barriers to Tech-Int also tend to be higher. This might imply that those who are more engaged or see more value in technology in educational settings are also more aware of or encounter more barriers, possibly due to greater interaction with or dependency on technology in their professional activities.

Given the significant positive correlation between AVG_P3 (Role of Tech-Based Learning Environment) and AVG_P4 (Barriers to Tech Integration) with a p-value of 0.022, which is below the threshold of 0.05, this indicates the rejected of **H1**.

6.2.2.4 H2: "*The average role of tech-based learning environments differs among groups with positive, negative, and medium perceptions of technology's impact"*

6.2.2.4.1 ANOVA

Between groups: The sum of squares is 5.026 with 2 degrees of freedom, leading to a mean square of 2.513. The F-statistic calculated from these values is 16.477, which is highly significant with a p-value of less than 0.001. This substantial F-statistic indicates that the group means are not all equal and that there are significant differences in how different groups perceive the role of technology-based learning environments.

Within groups: The sum of squares within groups is 22.876 with 150 degrees of freedom, resulting in a mean square of 0.153. This indicates the variance within each

Table 6.40: ANOVA – AVG_P3 (P/Cs)

ANOVA AVG_P3	Sum of squares	df	Mean square	F	Sig.
Between groups	5.026	2	2.513	16.477	<.001
Within groups	22.876	150	.153		
Total	27.901	152			

6.2.2.4.2 Effect Size Analysis

Eta-squared: The eta-squared value is 0.180, suggesting that approximately 18% of the total variance in AVG_Q3 can be attributed to differences between groups. This is considered a moderate effect size and signifies a meaningful impact of group classification on the perception of technology's role.

Epsilon-squared and omega-squared: The epsilon-squared value is 0.169 and the omega-squared for fixed effects is 0.168, both echoing the moderate effect size indicated by eta- squared. The omega-squared for random effects is lower at 0.092, which adjusts for the model's variance and still reflects a significant but smaller impact.

Table 6.41: Effect sizes –AVG_P3 (P/Cs)

AVG_P3	Point estimate	95% CI	
		Lower	Upper
Eta-squared[a]	.180	.076	.280
Epsilon-squared[a]	.169	.064	.271
Omega-squared fixed-effect	.168	.064	.270
Omega-squared random-effect	.092	.033	.156

[a.] "Eta-squared and Epsilon-squared are estimated based on the fixed-effect model."

6.2.2.4.3 Summary

Provided the significant p-value (<.001) and moderate effect sizes, we can conclude that **H2**, which posited significant differences in the perception of the role of technology-based learning environments among different groups, should be accepted. The data strongly supports the notion that different groups within the dataset have distinctly different perceptions regarding the role of technology in education.

6.2.2.5 H4: "Higher income levels are associated with fewer barriers to Tech-Int"

6.2.2.5.1 ANOVA

The ANOVA conducted on AVG_P4, which assesses perceived barriers to Tech-Int across different groups, yields significant findings in terms of statistical non-significance and effect sizes.

Between groups: The sum of squares is extremely low at 0.004 with 2 degrees of freedom, and the resulting mean square is just 0.002. The F-statistic derived from these values is 0.004, which correlates with a very high p-value of 0.996. This indicates that there is no statistical evidence of significant differences between the group means concerning perceived barriers to Tech-Int.

Within groups: The sum of squares within the groups is 46.995 with 81 degrees of freedom, leading to a mean square of 0.580, showing that the majority of variance resides within the groups rather than between them.

Table 6.42: ANOVA – AVG_P4 (P/Cs)

ANOVA AVG_P4	Sum of squares	df	Mean square	F	Sig.
Between groups	.004	2	.002	.004	.996
Within groups	46.995	81	.580		
Total	46.999	83			

6.2.2.5.2 Effect Size Analysis

Eta-squared: Virtually zero (0.000), showing that no variance in the dependent variable (perceived barriers) can be attributed to differences between the groups.

Epsilon-squared and omega-squared: Both of these values are negative (-0.025 and -0.024 respectively for fixed effects, and -0.012 for random effects), which, although typically rounded up to zero in reporting, suggest not only the absence of effect but potentially problematic calculations or model fit issues due to the very low between-group variability compared to within-group variability.

Table 6.43: Effect sizes – AVG_P4 (P/Cs)

AVG_P3	Point estimate	95% CI[b]	
		Lower	Upper
Eta-squared[a]	.000	.000	.000
Epsilon-squared[a]	-.025	-.025	-.025
Omega-squared fixed-effect	-.024	-.024	-.024
Omega-squared random-effect	-.012	-.012	-.012

a. “Eta-squared and Epsilon-squared are estimated based on the fixed-effect model.”
b. “Negative but less biased estimates are retained, not rounded to zero.”

6.2.2.5.3 Summary

Having the provided F-statistic and the associated p-value, along with the effect size estimates, **H4** is rejected. There is robust statistical evidence to conclude that there are no significant differences in the perceptions of barriers to Tech-Int across different income levels. The data strongly suggests that whatever differences might exist in perceptions are not dependent on the income categorisations.

6.2.2.6 H5: “There is a relationship between income levels and the role of tech-based learning environments in education”

6.2.2.6.1 ANOVA

The ANOVA conducted on AVG_P3, assessing the perceived role of technology-based learning environments, yields result that provide insights into the variation across different groups.

Between groups: The sum of squares between the groups is relatively low at 0.835 with 2 degrees of freedom, leading to a mean square of 0.417.

Within groups: The sum of squares within the groups is substantially higher at 27.066, with 150 degrees of freedom, resulting in a mean square of 0.180.

F-statistic and significance: The F-statistic is 2.313, with a corresponding p-value of 0.102. This p-value exceeds the typical significance level of 0.05, showing that the differences between group means are not statistically significant.

Table 6.44: ANOVA – AVG_P3 (P/Cs)

ANOVA AVG_P3	Sum of squares	df	Mean square	F	Sig.
Between groups	.835	2	.417	2.313	.102
Within groups	27.066	150	.180		
Total	27.901	152			

6.2.2.6.2 Effect Size Analysis

Eta-squared: The eta-squared value is 0.030, showing that only about 3% of the total variance in perceptions of the role of technology-based learning environments can be attributed to differences between the groups. This is considered a small effect size.

Epsilon-squared and omega-squared: Both epsilon-squared and omega-squared fixed- effect are 0.017, reaffirming a very small effect size. The omega-squared random-effect is even lower at 0.009, showing minimal variance attributed to differences among groups beyond random sampling error.

Table 6.45: Effect sizes AVG_P3 (P/Cs)

AVG_P3	Point estimate	95% CI[b]	
		Lower	Upper
Eta-squared[a]	.030	.000	.093
Epsilon-squared[a]	.017	-.013	.080
Omega-squared fixed-effect	.017	-.013	.080
Omega-squared random-effect	.009	-.007	.042

[a.] "Eta-squared and Epsilon-squared are estimated based on the fixed-effect model."
[b.] "Negative but less biased estimates are retained, not rounded to zero."

6.2.2.6.3 Summary

Based on the ANOVA results, **H5** is rejected. The statistical analysis does not support significant differences in perceptions of the role of technology-based learning environments among the defined income groups. The effect sizes, consistently small across different measures, further suggest that any differences that might exist are negligible in terms of practical significance.

6.2.2.7 H7: "There is a significant difference between genders in their perceptions of the role of technology in educational environments (AVG_P3)"

There is a significant difference between genders in their perceptions of the role of technology in educational environments (AVG_P3). In contrast, the results for parents do not indicate a significant difference between genders (t (111.564) = -1.013, p= .313 2-tailed). The effect sizes are small, with Cohen's d (-.174) and Hedge's correction (-.173) reflecting minimal practical significance. This lack of significance (.337) and small effect size leads to the conclusion that the hypothesis is rejected for this There appears to be no substantial difference between the perceptions of male and female parents regarding the role of technology in education.

Table 6.46: Independent samples t-test (AVG_P3) (P/Cs)

AVG_P3										
Equal variances	LTEoV		t-test for equality of means							
	F	Sig.	t	df	Sig.			e	95% CIoD	
					p	Sided	pce		Lower	Upper
Assumed	.928	.337	-1.059	151	.146	.291	-.07451	.07035	-.21351	.06449
NotA			-1.013	111.5	.157	.313	-.07451	.07352	-.22017	.07116

CIoD: Confidence interval of difference; LTEoV: Leven's test for equality of variance; NotA: Not assumed; MD: Mean difference; Sig.: Significance (1-s p: 1-sided p; 2-spce: 2-sided pce); SED: Standard error difference.

Table 6.47: Independent samples effect sizes (AVG_P3) (P/Cs)

AVG_P3	Standardiser[a]	Point estimate	95% CI	
			Lower	Upper
Cohen's d[a]	.42827	-.174	-.496	.149
Hedge's correction[b]	.43041	-.173	-.494	.148
Glass's delta[c]	.38003	-.196	-.519	.128

a. "The denominator used in estimating the effect sizes. Cohen's d uses the pooled SD."

b. "Hedge's correction uses the pooled SD, plus a correction factor."

c. "Glass's delta uses the sample SD of the control (i.e., the second) group."

6.2.2.8 H8: "*There is a significant difference between genders in their perceptions of barriers to Tech-Int in schools (AVG_P4)"*

For the P/Cs, the t-test results also suggest no significant gender differences, with a p-value of .071. Though marginally closer to significance compared to the TCRs, this result still does not meet the typical thresholds for statistical significance in social science research. The effect sizes, though slightly more substantial than those in the P/Cs group (Cohen's d = -.400, Hedge's correction = -.396), also indicate only a small to moderate effect, which does not provide strong evidence of a substantial gender difference in perceptions. Therefore, the hypothesis is also rejected for the P/Cs.

Table 6.48: Independent samples t-test (AVG_P4) (P/Cs)

AVG_P4										
Equal variances	**LTEoV**		**t-test for equality of means**							
	F	Sig.	t	df	Sig.		MD	SED	95% CIoD	
					1-s p	2-s pce			Lower	Upper
Assumed	.817	.369	-1.82882		.036	.071	-.61978	-.29681	.16235	.02617
NotA			-1.80473	.96	.038	.075	-.29681	.16457	-.62473	.031119

CIoD: Confidence interval of difference; LTEoV: Leven's test for equality of variance; NotA: Not assumed; MD: Mean difference; Sig.: Significance (1-s p: 1-sided p; 2-spce: 2-sided pce); SED: Standard error difference.

Table 6.49: Independent samples effect sizes (AVG_P4) (P/Cs)

AVG_P4	Standardiser[a]	Point estimate	95% CI	
			Lower	Upper
Cohen's d[a]	.74210	-.400	-.832	.034
Hedge's correction[b]	.74898	-.396	-.824	.034
Glass's delta[c]	.67358	-.441	-.877	.000

a. "The denominator used in estimating the effect sizes. Cohen's d uses the pooled SD."
b. "Hedge's correction uses the pooled SD, plus a correction factor."
c. "Glass's delta uses the sample SD of the control (i.e., the second) group."

6.2.2.9 *H9: "There is a significant relationship between the child's age group and the age of their parents"*

6.2.2.9.1 Chi Square

The analysis of the cross-tabulation and Chi-Square results explores the relationship between the age of parents and their children's age groups. The Chi-square test yields a Pearson chi-square value of 232.998 with a degree of freedom (df) of 185, and an asymptotic significance of .010, indicating a statistically significant relationship between these two variables. This is reinforced by the likelihood ratio test result of .003 and a highly significant linear-by-linear association of less than .001. These outcomes suggest that there are significant associations in the distribution of child age groups across different P/C age groups.

Table 6.50: Chi-square tests (P/Cs)

Chi-square tests	**Value**	df	**Asymptotic significance (2-sided)**
Pearson Chi-square	232.998[a]	185	.010
Likelihood ratio	241.160	185	.003
Linear-by-linear association	24.230	1	<.001
N of valid cases	156		

a. 228 cells (100.0%) have expected count less than 5. The minimum expected count is .09.

6.2.2.9.2 Symmetric Measures

The symmetric measures further corroborate these findings with a Pearson's R of .395 and a Spearman Correlation of .402, both achieving a significance level of less than

.001. These measures indicate a moderate positive correlation, suggesting that as the age of the P/C increases, the age group of the child also tends to be higher or follows a discernible trend.

Table 6.51: Symmetric measures (P/Cs)

Symmetric measures	Value	Asymptotic standard error[a]	Approximate T[b]	Approximate significance
Interval Pearson's R	.395	.085	5.342	<.001[c]
Ordinal Spearman	.402	.079	5.456	<.001[c]
Correlation				
No. valid cases	156			

[a.] "Not assuming the null hypothesis."
[b.] "Using the asymptotic standard error assuming the null hypothesis."
[c.] "Based on normal approximation."

6.2.2.9.3 Summary

Given the significant p-values in the Chi-Square tests and the correlations reported, we can accept **H9**, and that there is a significant relationship between the child's age group and the age of their parents. This suggests that parental age is an influential factor in the age group of their children, potentially reflecting generational or life stage considerations in parenting.

6.2.3 Headteachers

6.2.3.1 Descriptives

The average score for AVG_part 3 is 3.6429, with a standard error of 0.21485, indicating a moderately positive perception of the role of technology in educational environments among HTs. The 95% CI for the mean extends from 3.1171 to 4.1686, suggesting a significant difference in perceptions, which underscores the diverse experiences or expectations among HTs regarding technology use in their schools. The distribution of responses shows some asymmetry (skewness of 0.956), indicating a tendency towards higher scores, but with a significant number of responses at the lower end as well. The kurtosis value of -0.612 suggests a flatter peak than a normal distribution, which points to a spread-out range of opinions rather than clustered around the mean.

For barriers to Tech-Int AVG_ part 4, the mean score of 3.5143 reflects a moderate perception of barriers among HTs, with a notably high standard error of 0.62466 that illustrates wide variability in responses. The 95% CI ranges dramatically from 1.9858 to 5.0428, highlighting the extremely varied perceptions of barriers that could be influenced by different school contexts or personal experiences with technology. The data is highly negatively skewed (-2.051), showing that most responses cluster at the higher end of the scale, with fewer responses showing lower perceived barriers. The high kurtosis value (4.407) further emphasises the presence of outliers, indicating that while many HTs see significant barriers, a few see exceptionally few.

Descriptive statistics are displayed in Table 6.52.

Table 6.52: Descriptive statistics (HTs)

AVG_P3			
Descriptives		Statistic	Std. Error
Mean		3.6429	.21485
95% CI	Lower bound	3.1171	
Mean	Upper bound	4.1686	
5% trimmed mean		3.6230	
Median		3.5000	
Variance		.323	
SD		.56844	
Minimum		3.07	
Maximum		4.57	
Range		1.50	
Interquartile range		1.07	
Skewness		.956	.794
Kurtosis		-.612	1.587
AVG_P4			
Descriptives		Statistic	Std. Error
Mean		3.5143	.62466
95% CI	Lower bound	1.9858	
Mean	Upper bound	5.0428	
5% trimmed mean		3.6381	
Median		4.2000	
Variance		2.731	
SD		1.65270	
Minimum		.00	
Maximum		4.80	
Range		4.80	
Interquartile range		1.40	
Skewness		-2.051	.794
Kurtosis		4.407	1.587

6.2.3.2 Reliability Analysis

The part 3 scale, which consists of 14 items, has a Cronbach's α of 0.819. This indicates a high level of internal consistency among the items in this scale. A Cronbach's α above 0.8 is generally considered excellent, suggesting that the items are well-correlated and collectively provide a consistent measure of the underlying construct, presumably related to the positive aspects of technology use in educational settings. This high reliability supports the use of this scale in further analyses and decision-making processes, as it is likely to yield reliable and replicable results across similar samples.

The Part 4 scale, including 5 items, shows a Cronbach's α of 0.530. This value is considerably lower, showing moderate reliability. Typically, an alpha of 0.7 or above is desired for good internal consistency; however, scales with fewer items often struggle to achieve high alpha values. An alpha of 0.530 suggests that the scale may not be adequately capturing the construct it is intended to measure, or that the items may not be entirely cohesive. This level of reliability might be acceptable in exploratory research but is generally considered insufficient for scales that inform critical educational policies or interventions.

Table 6.53: Reliability statistics for "attitude" and "barriers and factors" (TCRs and TAs)

Scale	Cronbach's α	Cronbach's α based on standardised items	No. items
Attitude	.819	.820	14
Barriers and factors	.530	.535	5

6.2.3.3 H1: "*There is a negative correlation between the role of tech-based learning environments and the perceived barriers to Tech-Int"*

"Higher ratings on tech-based learning environments will correlate with lower perceived barriers to Tech-Int."

The correlation analysis between AVG_P3 (Role of Tech-Based Learning Environment) and AVG_P4 (Barriers to Tech Integration) from the third dataset of HTs indicates a Pearson correlation coefficient of 0.552. This suggests a moderately strong positive relationship between the perceptions of the role of technology and the perceived barriers to Tech-Int among HTs.

The significance level (p-value) for this correlation is 0.198, which is greater than the conventional alpha level of 0.05. This result indicates that the correlation observed, while moderately strong, is not statistically significant within the 95% CI typically used in social science research.

It is important to note that the sample size for this analysis is very small (n = 8). Such a small sample size can drastically limit the power of the statistical test, making it difficult to achieve statistical significance even if a real relationship exists. The small sample size also increases the risk of Type two errors (failing to reject a false null hypothesis).

Based on the statistical evidence provided by the p-value, **H1** is rejected, as there is not enough statistical evidence to support a significant correlation between the role of technology- based learning environments and perceived barriers to Tech-Int among HTs within this dataset. However, the moderate correlation coefficient indicates that a relationship could potentially exist and might be more precisely detected with a larger sample size.

Table 6.54: Pearson correlation analysis – AVG_P3 & AVG part 4 HTs

		AVG_P3	**AVG_P4**
Pearson correlation	**AVG_P3**	1	.552
Sig (2-tailed)			.198
N		8	8
Pearson correlation	**AVG_P4**	.552	1
Sig (2-tailed)		.198	
N		8	8

6.2.3.4 H2: "*The average role of tech-based learning environments differs among groups with positive, negative, and medium perceptions of technology's impact"*

6.2.3.4.1 ANOVA

The ANOVA conducted on AVG_P3, which assesses the perceived role of technology-based learning environments among HTs, offers insights into whether different groups exhibit distinct perceptions. However, the results suggest there is no statistically significant variation across the groups based on the provided data.

Between groups: The sum of squares for the between groups is notably low at 0.014 with 1 degree of freedom, yielding a mean square of 0.014. The F-statistic derived from this is 0.035, indicating an extremely low variance between the group means in comparison to the within- group variance.

Within groups: The sum of squares within the groups is significantly higher at 1.544 with 4 degrees of freedom, resulting in a mean square of 0.386. This implies that the variance within each group is notably greater than the variance between the groups.

F-statistic and significance: The F-statistic is very low, and the corresponding p-value is 0.860, far above the conventional alpha level of 0.05. This shows a lack of statistically significant differences between the groups regarding their perceptions of the role of technology in education.

Table 6.55: ANOVA – AVG_P3 (HTs)

ANOVA AVG_P3	Sum of squares	df	Mean square	**F**	**Sig.**
Between groups	.014	1	.014	.035	.860
Within groups	1.544	4	.386		
Total	1.558	5			

6.2.3.4.2 Effect Size Analysis

Eta-squared: The eta-squared value is very low at 0.009, suggesting that only 0.9% of the total variance in AVG_P3 can be attributed to the group differences, indicating an almost negligible effect.

Epsilon-squared and omega-squared: These values are negative, which in the context of effect size, typically results from calculation anomalies due to very small between-group variances. These values are theoretically supposed to be zero or positive and often reflect rounding or calculation limitations in statistical software when actual differences are exceedingly small.

Table 6.56: Effect sizes – AVG_P3 (HTs)

AVG_P3	Point estimate	95% CI[b]	
		Lower	Upper
Eta-squared[a]	.009	.000	.368
Epsilon-squared[a]	-.239	-.250	.210
Omega-squared fixed-effect	-.192	-.200	.181
Omega-squared random-effect	-.192	-.200	.181

[a.] "Eta-squared and Epsilon-squared are estimated based on the fixed-effect model."
[b.] "Negative but less biased estimates are retained, not rounded to zero."

6.2.3.4.3 Summary

Given the non-significant F-statistic and the very low (and technically improper) negative values for other effect sizes, **H2** is rejected. There is no sufficient evidence to support significant differences in the perceptions of the role of technology-based learning environments among the groups analysed within this dataset.

6.2.3.5 H3a: "There is association between level of education and experience of HTs."

6.2.3.5.1 Chi Square

The Chi-square test results are designed to assess whether there is a statistically significant association between the level of education and the experience of HTs. The following analysis is based on the resultant outputs.

Pearson chi-square: The value is 4.667 with 4 degrees of freedom, and the asymptotic significance (p-value) is 0.323. This shows that the difference between the observed and expected frequencies across categories of education and experience is not statistically significant at the conventional alpha levels (e.g., 0.05 or 0.01).

Likelihood ratio: The likelihood ratio test gives a value of 6.904 with a p-value of 0.141, also indicating no significant association between the variables at the usual levels of significance.

Linear-by-linear association: This test, which is more focused on trends in ordinal data, has a value of 1.036 with a p-value of 0.309, further suggesting that there is no significant linear trend between the levels of education and experience of HTs.

Sample size and cell counts: A critical observation here is that all 9 cells (100%) have expected counts less than 5, with the minimum expected count being 0.50. This condition can significantly affect the reliability of the chi-square test, as low expected counts lead to less precise estimations of the chi-square distribution. Chi-square tests generally require larger sample sizes or higher expected counts per cell to yield reliable results.

The results do not provide evidence to support a significant association between the level of education and experience among HTs, as indicated by the p-values across different chi-square tests. However, the reliability of these results is questionable due to the very small sample size (n = 8) and the very low expected counts in each cell. This situation likely undermines the statistical power of the test, making it difficult to detect a true association even if one exists.

Table 6.57: Association between level of education and experience of HTs

Chi-square tests	Value	df	Asymptotic significance (2-sided)
Pearson Chi-square	4.667[a]	4	.323
Likelihood ratio	6.904	4	.141
Linear-by-linear association	1.036	1	.309
N of valid cases	8		

[a.] 9 cells (100.0%) have expected count less than 5. The minimum expected count is .50.

6.2.3.6 H6: "*Educators with higher education levels report fewer barriers to Tech-Int"*

6.2.3.6.1 ANOVA

The ANOVA conducted on AVG_P4, which assesses perceptions of barriers to Tech-Int among different groups of HTs, yields intriguing results regarding the differences between these groups.

Between groups: The sum of squares is substantial at 11.362 with 2 degrees of freedom, yielding a mean square of 5.681. This suggests notable variance between the groups regarding their perceptions of barriers.

Within groups: The sum of squares within the groups is 5.027 with 4 degrees of freedom, resulting in a mean square of 1.257, indicating that there is also significant variability within the groups themselves.

F-statistic and significance: The F-statistic is 4.521, which approaches significance with a p-value of 0.094. While this value is above the conventional threshold of 0.05 for statistical significance, it is close enough to suggest a potential trend that may warrant further investigation.

Table 6.58: ANOVA – AVG_P4 (HTs)

ANOVA AVG_P4	Sum of squares	df	Mean square	**F**	**Sig.**
Between groups	11.362	2	5.681	4.521	.094
Within groups	5.027	4	1.257		
Total	16.389	6			

6.2.3.6.2 Effect Size Analysis

Eta-squared: The eta-squared value is 0.693, suggesting a very large effect size, as this value indicates that 69.3% of the variance in perceptions of barriers can be attributed to differences between groups. This is a substantial effect, showing that the group factor plays a significant role in how barriers are perceived.

Epsilon-squared and omega-squared: These values are quite high (0.540 for epsilon-squared and 0.501 for omega-squared fixed-effect), further supporting the significance of group differences in influencing perceptions of barriers. However, the wide CIs and some negative values in the lower bounds suggest instability in these estimates, likely due to the small sample size and unequal group sizes.

Table 6.59: Effect sizes – AVG_P4 (HTs)

AVG_P4	Point estimate	95% CI[b]	
		Lower	Upper
Eta-squared	.693	.000	.819
Epsilon-squared	.540	-.500	.729
Omega-squared fixed-effect	.501	-.400	.697
Omega-squared random-effect	.335	-.167	.697

[a.] "Eta-squared and Epsilon-squared are estimated based on the fixed-effect model."
[b.] "Negative but less biased estimates are retained, not rounded to zero."

6.2.3.6.3 Summary

Given the nearly significant p-value and the large effect sizes, the results suggest that while **H6**, which likely posited significant differences in perceptions of barriers to Tech-Int among groups, cannot be definitively accepted based on conventional criteria ($p < 0.05$), it also should not be outright rejected. The evidence suggests a strong trend that different groups of HTs may indeed perceive barriers differently.

6.2.3.7 H7: "There is a significant difference between genders in their perceptions of the role of technology in educational environments (AVG_P3)"

The results for HTs, similar to P/Cs, do not show a significant difference in perceptions based on gender ($t\ (4.930) = .583$, $p = .586$ 2-tailed). The effect sizes, such as Cohen's d (.413) and Glass's delta (.359), also indicate a minor practical impact. These findings suggest that among HTs, there is no significant gender-based difference in perceptions regarding technology's role in educational settings, leading to a rejection of **H7**.

In summary, while TCRs showed a clear gender-based difference in perceptions of technology in education, parents and HTs did not show such differences. These results highlight the varied impacts and perceptions of technology across different groups, emphasising the role of context and demographic factors in educational technology research.

Table 6.60: Independent samples t-test – AVG_P3 (HTs)

AVG_P3										
Equal variances	**LTEoV**		**t-test for equality of means**							
	F	Sig.	t	df	Sig.		MD	SED	95% CIoD	
					1-s p	2-s pce			Lower	Upper
Assumed	.686	.445	.541	5	.306	.612	.25000	.46227	-.93829	1.43829
NotA			.583	4.930	.293	.586	.25000	.42907	-.85765	1.35765

CIoD: Confidence interval of difference; LTEoV: Leven's test for equality of variance; NotA: Not assumed; MD: Mean difference; Sig.: Significance (1-s p: 1-sided p; 2-spce: 2-sided pce); SED: Standard error difference.

Table 6.61: Independent samples effect sizes – AVG_P3 (HTs)

AVG_P3	Standardiser[a]	Point estimate	95% CI	
			Lower	Upper
Cohen's d[a]	.60525	.413	-1.124	1.911
Hedge's correction[b]	.71989	.347	-.945	1.607
Glass's delta[c]	.69620	.359	-1.190	1.854

[a.] "The denominator used in estimating the effect sizes. Cohen's d uses the pooled SD."

[b.] "Hedge's correction uses the pooled SD, plus a correction factor."

[c.] "Glass's delta uses the sample SD of the control (i.e., the second) group."

6.2.3.8 H8: *"There is a significant difference between genders in their perceptions of barriers to Tech-Int in schools (AVG_P4)"*

The HT group presented a unique scenario with larger effect sizes (Cohen's d = .639, Hedge's correction = .537) but still non-significant t-test results (t=.983, p = .395 for 2-sided). The CIs for the effect sizes are wide, pointing to considerable uncertainty in the estimates due to the small sample size of this subgroup. This uncertainty and the non-significant statistical test lead to the rejection of the hypothesis for the HTs as well, indicating no substantial evidence of gender differences in their perceptions regarding barriers to Tech-Int.

Across all group's TCRs, P/Cs, and HTs there is consistent evidence suggesting the absence of significant gender differences regarding perceptions of barriers to Tech-Int in schools. Each group's analysis underscores the similarity in perceptions between genders, leading to the rejection of the hypothesis across the board. These findings suggest that other factors beyond gender may influence perceptions of technology barriers in educational settings.

Table 6.62: Independent samples t-test – AVGQ_ part 4 (HTs)

AVGQ_ part 4										
Equal variance	**LTEoV**		**t-test for equality of means**							
	F	Sig.	t	df	Sig. 1-s P	Sig. 2-s pce	Mean diff.	Std. error diff.	95% CIoD Lower	95% CIoD Upper
Assumed	3.272	.130	.836	5	.221	.441	1.08333	1.29510	-2.24582	4.41249
NotA			.983	3.157	197	.395	1.08333	1.10164	-2.32617	4.49284

CIoD: Confidence interval of difference; LTEoV: Leven's test for equality of variance; NotA: Not assumed; MD: Mean difference; Sig.: Significance (1-s p: 1-sided p; 2-spce: 2-sided pce); SED: Standard error difference.

Table 6.63: Independent samples effect sizes – AVGQ_part4 (HTs)

AVG_P4	Standardiser[a]	Point estimate	95% CI Lower	95% CI Upper
Cohen's d[a]	1.69568	.639	-.936	2.156
Hedge's correction[b]	2.01687	.537	-.787	1.812
Glass's delta[c]	2.17486	.498	-1.083	2.006

[a.] "The denominator used in estimating the effect sizes. Cohen's d uses the pooled SD."

[b.] "Hedge's correction uses the pooled SD, plus a correction factor."

[c.] "Glass's delta uses the sample SD of the control (i.e., the second) group."

6.3 Main Statistical Analysis Findings

This section summarises key statistical findings, focusing on reliability, perceptions of Tech-Int's role, barriers, challenges to integration, and correlations between perceived roles and barriers across stakeholder groups. Significant trends and differences are reported, with more details provided in Appendix F.

6.3.1 TCRs and TAs

Reliability of utilised measurement scales: by Cronbach's α of 0.728 and 0.651 for the attitudes and barriers scales, respectively.

Perceptions of Tech-Int role: moderately positive perceptions were held, with a mean of 3.71, although with significant variance across subgroups (**H2**) ($F = 3.996$, $p = 0.025$). These outcomes indicate the requirement for targeted strategies addressing particular educators' needs and views.

Barriers to Tech-Int: moderate perceptions were showed by TCRs and TAs, with a mean of 3.517, commonly citing barriers of costs and misalignment with curriculum goals. Statistical analysis about **H6** uncovered no significant variance across education levels for perceived barriers ($F = 1.459$, $p = 0.217$).

Gender differences: attitudes were significantly affected by gender, as per **H7** ($t = 3.043$, $p = 0.004$), but perceived barriers did not (**H8**) ($p = 0.753$), thus gender-tailored interventions concerning barriers do not appear to be necessary.

Role-barrier correlation: A positive correlation exists between perceptions of Tech-Int role and barriers to integration H1 ($r = 0.305$, $p = 0.037$). This suggests that educators who are more engaged with technology also perceive greater challenges, possibly due to increased awareness of Tech-Int complexities

6.3.2 Parents and Carers

Reliability of utilised measurement scales: by Cronbach's α of 0.734 and 0.737 for the "attitude" and for "barriers" scales (respectively).

Perceptions of Tech-Int role: P/Cs generally hold positive attitudes toward technology in education (Mean = 3.72). However, perceptions vary significantly across groups H2 ($F = 16.477$, $p < 0.001$).

Barriers to Tech-Int: moderate perceptions of barriers were experienced across the group (mean = 3.18), with no notable differences related to gender or income.

Role-barrier correlation: A positive correlation exists between perceptions of Tech-Int role and barriers H1 ($r = 0.251$, $p = 0.022$), suggesting greater engagement leads to higher awareness of challenges.

Age: the age of P/Cs was significantly related with the children's age (**H9**) (chi-square = 232.998, Pearson's R = 0.395, $p = 0.010$).

6.3.3 Headteachers

Reliability of utilised measurement scales: by Cronbach's α of 0.819 (which signifies notably high internal consistency) for the "attitude" scale, and moderate reliability ($\alpha = 0.530$) for the "barriers" scale, which suggesting some limitations in capturing the construct effectively.

Perceptions of Tech-Int role: HTs' perceptions were moderately positive on Tech-Int (mean = 3.64), with no statistically significant differences among subgroups (**H2**) ($F = 0.035$, $p = 0.860$), indicating homogenous views in the studied sample.

Barriers to Tech-Int: Barriers were perceived moderately (Mean = 3.51), with significant variability across school contexts (SD = 1.65). Prominent barriers included high costs (WM = 88.6) and lack of curriculum-aligned resources (WM = 85.8). Although H6 approached significance ($F = 4.521$, $p = 0.094$), the small sample size limits interpretation.

Gender differences: gender was not significantly associated with attitudes (**H7**) ($p = 0.586$) or barriers **H8** ($p = 0.395$). The effect sizes indicated to small practical implications (i.e., Cohen's d of 0.413 and 0.639 for attitudes and barriers, respectively).

Role-barrier correlation: the results revealed a moderate positive correlation ($r = 0.552$) between perceptions of Tech-Int role and perceived barriers (**H1**), but this did not achieve statistical significance ($p = 0.198$), which was related to the limited size of the sample. Nevertheless, the indications are that HTs with positive attitudes toward technology are likely to be more warning to barriers to its adoption and use.

6.4 Summary

Chapter 6 provided an in-depth analysis of stakeholder efficiency, perceptions, attitudes, and barriers toward Tech-Int in Scottish primary schools (see Appendix F). The findings discovered that, across all groups, Tech-Int was generally perceived positively for potential to enhance teaching and learning, though significant variability was observed in specific perceptions and challenges. Common barriers, such as high costs of devices and lack of curriculum-aligned resources, appeared as universal issues, highlighting systemic challenges that require strategic interventions. TCRs and TAs showed significant differences in perceptions of Tech-Int role, reflecting diverse needs and experiences within educational roles. P/Cs shared optimism about technology's potential but faced similar barriers regardless of income or gender. HTs, despite a small sample size, emphasised the dual challenges of financial constraints and misaligned resources. Gender was found to influence attitudes toward Tech-Int among educators, though perceptions of barriers were consistent across genders, emphasising shared challenges. Positive correlations between perceptions of technology's role and awareness of barriers suggest that increased engagement with technology may enhance awareness of its complexities. These findings underscore the importance of addressing systemic barriers while implementing tailored approaches to meet the unique needs of different stakeholder groups. By reduce financial barriers, improving curriculum alignment, and offering differentiated training, the Tech-Int in primary education can be both inclusive and effective, enhancing better learning outcomes.

Phase 3

Chapter 7
Interview Analysis

In exploring Tech-Int in primary education, the interview was developed based on the conceptual framework introduced in Chapter 3, which identified key constructs: “efficiency,” “attitude,” and “challenges and barriers.” These constructs provided the foundation for both the quantitative analysis and subsequent qualitative exploration. These findings served as a foundation for the semi-structured interviews, allowing for a deeper exploration of the themes found in the survey data. By following up with qualitative interviews, this research aims to provide an understanding of the survey results Chapter 6 and shows how the qualitative data provides depth and context to the quantitative findings, giving more detailed insights into the experiences and perspectives of the stakeholders involved. The perceptions collected are outlined within the context of the Fundamental Conceptual Framework Development, focusing on three levels of effect: the micro-system (P/Cs), the meso-system (TCRs and TAs), and the macro-system (HTs). This theoretical framework allows for a complete understanding of how various environmental factors and interactions influence the integration and utilisation of technology in educational settings. This chapter presents the findings using semi-structured interviews with 14 participants the characteristics of these participants are shown in Table 7.1.

Table 7.1: Interviewee' socio-demographic characteristics

Parents/ carers					
Participants	Location	Age (yrs)	Level of education	Income (GBP)	Child's age (yrs)
P. PC 1	Aberdeenshire	40-49	Bachelor	>40,001	10
P. PC 2	Highland	30-39	Some college credit, no degree	20,001-30,000	8-9,10-11
P. PC 3	Edinburgh	40-49	Bachelor	20,001-30,000	10
P. PC 4	North Ayrshire	30-39	Bachelor	30,001-40,000	4-5.
P. PC 5	Edinburgh	40-49	Some college credit, no degree	20,001-30,000	7
Teachers and teaching assistants					
Participants	Location	Age (yrs)	Level of education	Experience (yrs)	Level teaching
P. TTA 1	Glasgow	40-49	Associate degree	6-10	P1
P. TTA 2	Perth & Kinross	20-29	Bachelor	1-5	P4
P. TTA 3	Dundee	30-39.	Master	6-10	P6
P. TTA 4	Inverclyde	40-49	Professional degree	16-20	P7
P. TTA 5	Highland	30-39	Master	6-10	P7
P. TTA 6	Renfrewshire	30-39	Master	11-15	P6
Headteachers					
Participants	Location	Age (yrs)	Level of education	Experience (yrs)	
P. HT 1	Scottish Borders	55	Master	>20	
P. HT 2	Inverclyde	40-49	Professional degree	16-20	
P. HT 3	North Lanarkshire	40-49	Bachelor	11-15	

P. PC: Participants P/Cs.
P. TTA: Participants TCR and TAs.
P. HT: Participants HTs

7.1 Data Saturation

In qualitative research, data saturation is a significant concept that ensures an understanding and analysis of the studied situation. It shows the point at which no new information or themes are observed in the data, referring that the data collection process can be concluded (Naeem *et al*., 2024). During the interviews with participants for this research, data saturation was achieved in 14 interviews. This included 5 P/Cs, 6 TCRs and TAs, and 3 HTs, with no new themes appearing regarding Tech-Int in primary education. This point was reached after exploring various aspects such as efficiency, attitudes towards technology, and the barriers and challenges encountered. Each key theme and sub-theme had been sufficiently covered, ensuring that the collected data was complete and reflective of the participants' experiences and perspectives.

7.2 Coding and Analysis

The coding and analysis for this research adhered to the strategy outlined by Maguire and Delahunt (2017), focusing on the multifaceted aspects of Tech-Int in primary education. Key themes are presented in Table 7.2. The data were analysed through thematic analysis and sub-theme analysis for each group (see Appendix G).

Table 7.2: Coding process

P/Cs	
Themes	Sub-Themes
1. Efficiency	Engagement and Motivation Skill Development Accessibility Content and Curriculum Integration Critical Thinking and Information Literacy
2. Attitude	Perceived Role of Technology Concerns About Online Safety Positive and Negative Impacts of Technology Use
3. Challenges and Barriers	Parental Involvement Effective Communication Between Schools and Parents Balancing Traditional and Technology-Enhanced Learning
TCRs and TAs	
Themes	Sub-Themes
1. Efficiency	Engagement and Motivation Skill and Professional Development Interactive Learning
2. Attitude	Assessment of Technology Effectiveness Future Perspectives on Tech-Int Balancing Technology-Based Learning and Traditional Methods
3. Challenges and Barriers	Student Misuse and Distractions Access and Availability Need for Professional Development and Collaboration
HTs	
Themes	Sub-Themes
1. Efficiency	Methods of Assessment Strategic Priorities Adaptation to Emerging Technologies
2. Attitude	Vision for Tech-Int Involving Parents and the Wider School Community
3. Challenges and Barriers	Support and Empowerment for TCRs Strategies for Fair Access to Technology Overcoming Integration Challenges

Efficiency

The theme of efficiency focuses on how effectively technology is integrated into the learning environment and its impact on students' education. Participants' responses were coded to identify specific instances where technology-facilitated learning, increased engagement, or improved understanding of subjects.

Attitude

The attitude theme describes the perceptions and beliefs of parents, TCRs, and HTs towards technology in education. Coding focuses on identifying positive and negative attitudes, perceived benefits, and concerns related to technology use. The "attitude" theme is divided based on the TPB into "behavioural," "normative," and "control" beliefs.

Barriers and challenges

This theme explores the barriers and challenges faced by participants in Tech-Int in primary education. Coding identified specific challenges and proposed solutions to address these barriers.

7.3 P/C Interview Findings

7.3.1 Efficiency

This section presents insights from P/C interviews about the efficiency of technology use in their children's learning in Scotland. The responses from parents/cares highlight several key sub-themes under efficiency, including engagement and motivation, skill development, curriculum integration, and critical thinking. The identified thematic categories offer understanding of impacts and improvement targets about Tech-Int in primary education.

7.3.1.1 Engagement and Motivation

"Motivation and engagement" in education are heavily influenced by technology aspects, as the P/Cs reflected. (P. PC 1) noted that "iPad enhances engagement through interactive activities," highlighting how "interactive tools" can enhance student involvement by making lessons more dynamic and involved. (P. PC 2) emphasised that "technology motivates a dyslexic child by using text-to-speech and interactive apps," illustrating how adapted technological solutions can enhance "motivation," particularly for students with specific learning needs. (P. PC 5) added that "educational games like Sumdog make learning fun and interactive, which keeps the child interested in math and other subjects," showing the effectiveness of "fun learning methods" in supporting student interest and promoting engagement across various subjects. Together, these insights present how interactive tools, motivational strategies, and enjoyable learning methods contribute to improved student engagement and motivation.

7.3.1.2 Skill Development

The feedback from P/Cs shows that technology significantly enhances skill development. (P. PC 1) emphasised the "importance of learning basic IT skills on laptops," highlighting the foundational role of technology in developing "basic IT skills." (P. PC 3) noted that the "use of smartphones and computers develops IT knowledge," emphasising how various technological tools contribute to expanding IT ability. As (P. PC 5) pointed, "technology-based homework supports various types of learners and teaches problem-solving skills independently," which indicates how technology seats diverse learning styles and promotes critical problem-solving abilities. Collectively, these insights show how technology aids in developing basic IT skills, expanding IT knowledge, and enhancing problem-solving skills, all of which are crucial for students' skill development.

7.3.1.3 Accessibility

P/Cs' insights highlight how technology significantly enhances accessibility in education. (P. PC 2) noted that "technology tools like text-to-speech software improve accessibility for a dyslexic child, making learning less intimidating and more adaptive." This indicates the way in which "adaptive learning" can specifically target educational resources for the needs of individual learners, thus helping those requiring specific support to overcome their personal challenges. (P. PC 4) observed that "Apps that provide information about different places in the world offer accessible content that broadens a child's learning experiences," showing how interactive experiences helped by technology can make diverse and educational content readily available, enhancing overall learning accessibility. These perspectives illustrate how adaptive learning tools and interactive technology contribute to a more inclusive and accessible educational environment.

7.3.1.4 Critical Thinking and Information Literacy

"Critical thinking and information literacy" are necessary skills fostered through technology, as highlighted by (P. PC 3), who emphasised the importance of "teaching children to critically evaluate online information." This focus on evaluating information shows the need to develop students' abilities to assess the reliability and relevance of the substantial array of content available online. By emphasising critical evaluation, parents can help their children navigate and understand digital information more effectively, enhancing their overall informational literacy and critical thinking skills.

7.3.1.5 Content and Curriculum Integration

The feedback from P/Cs demonstrates a significant advancement in content and curriculum integration through technology. (P. PC 2) highlighted the value of "a platform aligned with the local curriculum to track progress," emphasising how technology can enhance the relevance and effectiveness of learning by ensuring that educational tools are in sync with local curricula. (P. PC 4) added that "real-world simulations and interactive learning opportunities" offer practical learning experiences that bridge classroom knowledge with real-life scenarios, further enriching the educational experience. (P. PC 5) noted that "Tech-Int in homework to enhance learning" supports students by extending learning opportunities further than the classroom and supporting and applying knowledge through technology-based tasks.

Together, these insights illustrate how curriculum alignment, practical learning opportunities, and technology-based homework contribute to a more integrated and effective educational approach.

7.3.2 Attitude

This section presents a thematic analysis of P/C interviews focusing on their attitudes toward Tech-Int in primary education. The analysis identifies key sub-themes under Attitude, including the perceived role of technology in education and the specific benefits and concerns related to its use.

7.3.2.1 Perceived Role of Technology

"The perceived role of technology" in education highlights its multifaceted impact on the learning experience. Technology enhances learning by making it "more interactive and engaging." As (P. PC 1) noted, "it makes learning more fun and interactive," while (P. PC 4) supported this by noting that "interactive educational apps have made complex concepts easier" for their child to understand. Additionally, technology plays a crucial role in "preparing students for future academic and career challenges." (P. PC 1) also highlighted the importance of preparing students for future academic and career challenges by embracing technology now. (P. PC 5) added that "technology helps my child learn better... and encourages them to be creative and think carefully," emphasising how technology not only supports learning but also fosters creativity and critical thinking. (P. PC 2) points out that "stuff like educational games and online resources can really help combined with regular teaching," suggesting that technology serves as a valuable "supplement to traditional teaching methods."

Such views indicate to the major role of technology in learning enhancement, empowering students with tools for future and complementing traditional educational approaches.

7.3.2.2 Concerns About Online Safety

"Concerns about online safety" are an important theme among participants, reflecting a shared focus on protecting students in a digital environment. (P. PC 1) expressed the need for "making sure online safety is taught properly," highlighting the importance of comprehensive online safety education for students. (P. PC 2) repeated this concern by emphasising the need to "make sure the school's got all the right security stuff sorted out," underscoring the necessity for strong security measures within the school environment. Additionally, (P. PC 4) raised a concern about the potential negative effects of excessive screen time, noting that “Too much screen time can be a problem... We need to set rules for screen time and balance it with other activities.”

These findings suggest the need for stronger and effective screen time management, to ensure that technology use is balanced with other important activities. These concerns show the critical areas of online safety education and screen time management as key concerns for parents and educators navigating the digital environment.

7.3.2.3 Positive and Negative Impacts of Technology Use

“The positive and negative impacts of technology use” in education are apparent from the parents’/carers feedback. On the positive side, (P. PC 1) noted that “it makes learning more fun and interactive,” while (P. PC 2) added that “educational games and online resources can really help make things more fun and interesting.” These comments reflect how technology “enhances engagement” by making learning enjoyable and stimulating. (P. PC 3) further highlighted that “educational apps have significantly improved their understanding and engagement with the subject,” clarifying the positive impact on “learning outcomes” through better comprehension and involvement. Additionally, (P. PC 5) emphasised that “technology gives them lots of ways to learn and encourages them to be creative,” showing how diverse technological tools can foster creativity and varied learning methods.

However, the discussion also raised concerns about the negative impacts of technology use. (P. PC 3) pointed out that “one concern is that children are writing less and less as a lot of work is done electronically,” indicating a “reduction in traditional skills” such as handwriting. (P. PC 4) repeated concerns about the “potential for addiction,” noting that “24-hour access can be addictive. We need to set rules for screen time.”

These findings highlight the need for screen time management to prevent overuse and maintain a healthy balance between technology and other activities. These beliefs confirm the dual nature of technology’s impact on education, providing both significant benefits and important challenges.

7.3.3 Challenges and Barriers in Tech-Int

This section presents P/C interviews about the barriers and challenges to Tech-Int in their children's learning. The analysis examines key issues such as the necessity of parental involvement, the importance of efficient communication between schools and parents, and how to balance traditional and technologically assisted learning.

7.3.3.1 Parental Involvement

"Parental involvement" plays an important role in supporting children's technology use, as highlighted by various participants. (P. PC 1) pointed out that parents can effectively help their children in their tech learning by exploring similar resources online. That way, "they can see what their kids are up to and step in to lend a hand if they need it," emphasizing the importance of "access to online materials" and active engagement with their children's digital activities. (P. PC 2) added: "parents can really help their kids with tech stuff by being open and honest about it," and advised that parents have "to talk to them about all the cool ways they can use tech for learning and keep it real about the not so great stuff too," underlining the need for "open and honest communication" regarding both the benefits and potential drawbacks of technology.

Similarly, (P. PC 3) mentioned that "We set limits on technology use and use parental controls to manage what our child can access," highlighting the importance of "setting limits" and "monitoring" to ensure safe and balanced technology use. In support of this, (P. PC 5) said "To support my child's technology use, I set clear rules, monitor their online activity, and encourage open communication," proving a comprehensive approach to managing technology use.

Finally, (P. PC 4) noted that "Parents can help their children with technology by using it together for learning and fun, doing hands-on activities like exploring educational apps," which reflects the value of "encouraging both educational and recreational use" of technology through joint activities.

These perceptions illustrate how parental involvement can effectively support and enhance children's technology use through active engagement, communication, monitoring, and collaborative learning.

7.3.3.2 Effective Communication Between Schools and Parents

"Effective communication between schools and parents" is essential for successful Tech-Int in education. (P. PC 1) proposed that "primary schools can keep parents in the loop by sending emails or using an online app to provide updates on what kind of tech the kids are using," emphasising the role of "digital communication tools" in ensuring parents are informed. (P. PC 5) repeated this by recommending that "primary schools can talk about using technology by sending emails, using group chats, sending letters, or having meetings with parents," emphasising a multi-channel approach to communication.

(P. PC 2) proposed that "it would be awesome if schools hosted some chill [relaxed] meetings to talk about all this tech stuff with parents," pointing to the value of "organising meetings and workshops" for more interactive discussions. "Schools can send newsletters or reports outlining the most recent technological updates and projects," (P. PC 4) added, suggesting that "regular updates and reports" are crucial for keeping parents informed about ongoing tech initiatives.

Lastly, (P. PC 3) stressed the importance of providing "adequate information on how technology is being used in school, what the plan for the term/year is, and how this can be supplemented at home," importance the need for complete information to help parents support their children's learning.

These perceptions clarify that effective communication involves using digital tools, organising informative meetings, and providing regular updates to encourage collaboration between schools and parents.

7.3.3.3 Balancing Traditional and Technology-Enhanced Learning

P/Cs employ a key strategy of "balancing traditional and technology-enhanced learning" to create a balanced educational experience at home. (P. PC 1) shared that

“We keep things balanced at home by limiting screen time and encouraging other activities, like reading books and doing hands-on projects,” showing an approach that “sets clear limits on screen time” while promoting traditional activities. (P. PC 4) also emphasised the importance of “setting limits,” noting that “we have rules for using technology, like only one hour of screen time each day.” This underscores the role of “setting time limits” in keeping a healthy balance.

(P. PC 2) described a “mix between traditional and technology-based learning,” by “following a schedule that gives specific times for screens and other activities,” highlighting the value of a structured approach to integrating different learning methods. (P. PC 5) added, “We balance how my child learns by using both traditional methods like books and newer things like educational apps,” showing a combined learning approach. Lastly, (P. PC 3) suggested “setting a daily schedule that includes time for both traditional activities like reading and outdoor play, as well as technology-based learning,” supporting the idea of a balanced schedule that sets various learning methods.

These views reflect how setting time limits, employing a scheduled approach, and combining different learning methods contribute to a balanced and effective educational environment.

7.4 TCR and TA Interview Findings

7.4.1 Efficiency

This section presents understandings from TCR and TA (TTA) interviews about the efficiency of technology use in their teaching practices. The responses from TCRs emphasise several key sub-themes, including engagement and motivation, skill development, professional development, and interactive learning. These themes provide an inclusive understanding of the impact and areas for improvement in Tech-Int in primary education.

7.4.1.1 Engagement and Motivation

TCRs and TAs have demonstrated that various technological integrations significantly enhance engagement and motivation in education. (P. TTA 1) noted that "using Google for research on interesting topics" keeps students engaged and excited about learning, showing the power of interactive technology to stimulate curiosity. (P. TTA 2) highlighted the effectiveness of "interactive lessons using a Promethean board," where students engage directly with the content, thus enhancing their involvement. (P. TTA 4) noted that "using iPads for game-based learning" keeps children's interest through interactive and enjoyable educational games.

Additionally, (P. TTA 1) pointed out that "educational apps like 'Teach Your Monster to Read' make learning enjoyable and engaging," further emphasising the role of fun, interactive tools. (P. TTA 3) added that "using technology to explore musical examples from different cultures" creates a more immersive and enjoyable learning experience. Finally, (P. TTA 5) noted that "smart boards help visualise concepts in a way that is engaging for students," proving how technological resources can offer increased accessibility and engagement with otherwise impervious and abstract concepts.

Taken together, such outcomes indicate the way in which technological resources can offer more interactivity and enjoyment for learners, thus improving their motivation and engagement.

7.4.1.2 Skill and Professional Development

Various technological tools and methods significantly enhance skill development, as the feedback from TCRs and TAs shows. (P. TTA 1) emphasised that "students learn to research and analyse information online, improving their research skills," demonstrating how technology aids in the development of crucial research and analytical abilities. (P. TTA 4) added that "researching price differences using websites helps students develop analytical skills related to real-world applications," further emphasising the role of online tools in honing students' analytical capabilities. (P. TTA 2) pointed out that the "use of various tools on the Promethean board improves mathematical understanding and skills," showcasing how interactive technology can enhance students' ability in specific subjects. Additionally, (P. TTA 5) noted that "smart boards help in explaining complex concepts like prisms, aiding in skill development in visual and spatial reasoning," proving how technology can make abstract ideas more accessible and stimulating.

Collectively, these insights confirm how interactive technology and enjoyable learning methods contribute to enhanced student engagement and motivation.

7.4.1.3 Interactive Learning

TCR and TA feedback highlights the significant enhancement of interactive learning through various technological tools and applications. (P. TTA 2) observed that the "Promethean board allows for interactive participation and use of built-in tools for geometry," illustrating how interactive tools enhance hands-on learning and engagement with mathematical concepts. (P. TTA 4) emphasised the extensive use of interactive whiteboards and iPads for hands-on learning, proving the efficacy of these technologies in offering practical, interactive experiences. (P. TTA 3) emphasised that "technology is used to present musical examples and diverse cultural content, creating an interactive learning experience," showing how technology can enrich lessons by making them more engaging and immersive. (P. TTA 6) highlighted that "using smart boards, Google Classrooms, and Seesaw" supports interactive and blended learning experiences, reflecting the broad application of various digital tools to enhance educational interactions.

Collectively, these insights reveal how interactive tools and technology-enhanced lessons contribute to a more engaging and effective learning environment.

7.4.2 Attitude

This section presents an analysis of TCR interviews, focusing on their attitudes toward the efficiency of Tech-Int in education. The responses highlight many key sub-themes, including "assessment of technology effectiveness", "future perspectives on Tech-Int", and "balancing technology-based learning with traditional methods". These themes provide a complete understanding of TCRs' attitudes and the implications of Tech-Int in primary education.

7.4.2.1 Assessment of Technology Effectiveness

"Assessment of Technology Effectiveness" involves various methods and indicators to ensure that technological tools are enhancing educational outcomes. (P. TTA 1) described a hands-on approach, noting, "I keep an eye on how into [i.e., engaged in] the lessons the kids are when we use tech compared to the old-school way. I quiz and assign them to see if they're learning, and I ask kids what they think about using tech in class." This highlights the use of direct observation and student feedback as methods of evaluation.

(P. TTA 2) emphasised the use of "student performance data, feedback, engagement levels" and their alignment with learning objectives to evaluate the positive impact of technology on understanding and skill development, thereby reflecting a more data-driven approach to evaluation. (P. TTA 5) indicated that effectiveness is measured by whether "students can show me that they understand the lesson aims" and whether technology contributed to that understanding, underscoring the importance of demonstrating learning outcomes linked to tech use.

(P. TTA 4) emphasised the assessment of "student engagement by comparing progress to historical data collected without the use of technology," a process that involves comparing current data to past performance. (P. TTA 3) focused on whether students "remember what they've learnt" and whether technology aids in quicker understanding by using quizzes and assignments as tools for assessment. Finally, (P. TTA 6) observed that "a noticeable increase in engagement and drastic differences in work completion" serve as indicators of technology's success in the classroom.

Collectively, these insights reveal diverse methods and indicators for evaluating the effectiveness of technology in education, emphasising both qualitative and quantitative measures of success.

7.4.2.2 Future Perspectives on Tech-Int

"Future perspectives on Tech-Int" reveal a dynamic and evolving role for technology in education, with various expected changes and roles outlined by TCRs and TAs. (P. TTA 1) envisioned a future where "every kid having their own tablet or laptop to use both at school and home" would make lessons more interactive and personalised, potentially leading to "more mixed or fully online classes," especially for subjects that receive help from visual and interactive tools. (P. TTA 2) expected advancements such as "personalised learning, increased use of AI technologies, immersive tools like AR/VR, and enhanced digital literacy" would collectively contribute to "more engaging learning environments."

(P. TTA 6) shared this optimistic, forward-looking perspective, noting that "the use of AI and changes in our teaching of many curricular subjects" will be significant. However, (P. TTA 3) tempered this by emphasising that technology will play a *supportive* role, saying "Tech's going to keep playing a big role in our classrooms, but not necessarily taking over completely." This view considered that technology will serve as a supportive tool, enhancing existing teaching methods rather than replacing them entirely. Finally, (P. TTA 5) suggested that "technology could be used more in all aspects, including learning at home," with a focus on interactive learning games, technology for assessments, and teaching students to use search tools to expand their knowledge.

These perspectives collectively highlight anticipated changes and the evolving role of technology in enhancing educational practices.

7.4.2.3 Balancing Technology-Based Learning and Traditional Methods

"Balancing technology-based learning and traditional methods" is crucial for creating an effective educational environment, as highlighted by the TCR's and TA's perspectives. (P. TTA 1) emphasised the need for a balance, stating, "I think it's crucial to find a balance between old-school ways and all this tech stuff. Pen and paper are still super important for honing skills, but technology can make learning more fun and interactive. So, I try to mix it up in my lessons."

Similarly, (P. TTA 2) stressed the importance of combining technology-based learning with traditional methods to ensure “diverse skill development, maintain student engagement, and address differing attention spans,” thereby leveraging the strengths of both approaches. (P. TTA 4) agreed, noting that while technology engages children, “pencil and paper often offer more scope for accuracy and focus on learning.”

(P. TTA 3) highlighted that “traditional methods are great for building foundational skills, like writing and problem-solving,” while technology can “add some spice to the mix” and enhance the learning experience. (P. TTA 5) underscored the necessity of blending both approaches, asserting, “I believe in a good mix of technology and pen and paper. Very few jobs will require absolutely no technology in the future. Our job is to prepare kids for that future by using technology effectively.”

These insights collectively underscore the importance of balancing technology with traditional methods to optimise educational outcomes and prepare students for a technology-integrated future.

7.4.3 Challenges and Barriers in Tech-Int

This section analyses interviews concerning the barriers encountered when actually applying Tech-Int in classroom contexts. Participants noted key sub-themes such as “student misuse and distractions,” “access and availability” (including issues of technological failure), and the “need for professional development and collaboration.” These involve educators’ identified barriers and help identity required assistance that can be developed to facilitate Tech-Int.

7.4.3.1 Student Misuse and Distractions

“Misuse and distractions” are major barriers to classroom-level Tech-Int. (P. TTA 1) identified that “one of the biggest challenges I face is kids using the tech for stuff they shouldn’t be doing, like playing games or checking out stuff that’s does not age appropriate,” describing the difficulties in managing inappropriate tech use. To address this, (P. TTA 1) employs “restrictions and guidelines for how they can use the tech” to mitigate misuse.

(P. TTA 5) similarly noted that despite “school internet blocks on certain websites,” students sometimes circumvent these restrictions to access non-educational content, leading them to implement a “trust and reward-based system,” where breaking trust results in restricted technology use under supervision. (P. TTA 3) highlighted issues with “keeping the kids focused,” as the appealing content on tablets can easily distract them from their tasks, necessitating a careful balance to ensure that technology use remains educational rather than for fun.

Collectively, these insights underscore the challenges of managing technology misuse and distractions in the classroom and the strategies used to keep focus and appropriate use.

7.4.3.2 Access and Availability

“Access and availability” are critical factors and barriers impacting the effective use of technology in education, as highlighted by TCR and TA feedback. (P. TTA 1) expressed a need for “more gadgets for the kids,” envisioning a classroom where “each of them had their own device” to enable a range of activities from research to interactive lessons. (P. TTA 4) emphasised the need for “higher-quality and more reliable laptops,” noting that the current devices are “at the end of their lifespan and are very unreliable and slow.” (P. TTA 6) highlighted additional challenges related to “availability, Wi-Fi, and the condition of technology,” pointing out issues with “children not having enough literacy skills to log in,” as well as problems with “losing passwords and login information.”

These insights underscore the difficulties in ensuring adequate access to and availability of technology, highlighting the need for more devices, improved equipment quality, and better support for connectivity and digital literacy.

7.4.3.3 Need for Professional Development and Collaboration

“Professional development and collaboration” are essential components for effectively integrating technology into teaching, as highlighted by the TCRs and TAs. (P. TTA 2) emphasised the importance of ongoing professional development, access to updated devices and software, reliable internet, technical support, and opportunities for collaboration with other educators to share ideas. (P. TTA 5) repeated this opinion, noting that "more CPD [continuous professional development] would be great," such as "workshops or training sessions where I can learn about the latest tech tools and how to use them in my teaching." (P. TTA 1) mentioned informal collaboration, saying, "We just chat about stuff during breaks or team meetings," sharing "cool ideas or new apps" via email.

(P. TTA 2) also highlighted structured collaboration, using "staff meetings weekly, social media (group chats), and general chat pre-during a post-workday" to engage with colleagues. (P. TTA 3) described sharing "tutorials on how to use different tech tools and apps," while Participant 4 mentioned working closely with a "stage partner" to design engaging lessons. Additionally, (P. TTA 6) called for a supportive role, providing "tech support for some teachers who have low confidence with technology" by sharing advice and helping build their confidence.

These perceptions emphasise the importance of both formal professional development and collaborative efforts to enhance Tech-Int in education.

7.5 HT Interview Findings

7.5.1 Efficiency

This analysis examines HT interviews with a focus on the theme of efficiency in Tech-Int. The responses provide insights into how schools assess the impact of technology, set strategic priorities, and plan for future trends in primary education.

7.5.1.1 Methods of Assessment

HTs considered that "methods of assessment" for Tech-Int in education involve various techniques to evaluate its effectiveness and impact. (P. HT 1) highlighted that "evaluating the effects of Tech-Int using different techniques" includes "observations by teachers," which provide "instant insights into how well technology is being used in the classroom." "Professional discussions and learning rounds" complement this approach, involving both staff and students to assess and refine practices. The focus of

P. HT 2 was on monitoring "engagement and attendance levels" as key indicators of students' responses to technology-enhanced learning environments. They also emphasised the importance of "collecting and analysing data to measure progress and outcomes" ensuring that technology positively impacts student achievement. (P. HT 3) described a systematic approach, using "benchmarking each pupil according to our agreed set of outcomes, such as "logging in, saving files, entering text, creating a bitmap image, coding," and employing a "RED, AMBER, GREEN system" to measure engagement levels. They also conduct evaluations at the end of the school year to track progress. These insights underscore the importance of diverse assessment methods, including observations, data analysis, and benchmarking, to effectively evaluate Tech-Int in education.

7.5.1.2 Strategic Priorities

"Strategic priorities" in Tech-Int highlight several key areas of focus. (P. HT 2) found upgrading "technology infrastructure, including both the hardware and the network," as a main priority to reduce "downtime and obstruction caused by outdated or slow systems." They also emphasised the importance of "professional development," committing to "continuous training" for staff to keep them updated with the latest technological advances and pedagogical strategies. (P. HT 1) added that creating "student files that can be shared with parents" is another strategic priority, aiming to enhance "communication and engagement with parents" by showing students' work and progress. (P. HT 3) highlighted the need to "upskill staff in using coding languages (Scratch, microbits)" and to provide "students with opportunities for independent learning" in areas such as computational thinking and basic digital skills.

Together, these details demonstrate a comprehensive approach to strategic priorities, which encompasses improvements in technology infrastructure, staff development, enhanced student portfolios, and support for independent learning.

7.5.1.3 Adaptation to Emerging Technologies

"Adaptation to emerging technologies" involves several strategic actions aimed at staying current with technological advancements. (P. HT 1) emphasised the importance of “continuous staff training” to keep pace with emerging technologies and trends, highlighting the value of “sharing knowledge and skills within our school community.” They also encouraged staff to “observe Tech-Int in other educational settings, both locally and internationally,” to gain broader insights. (P. HT 2) said a commitment to incorporating “artificial intelligence (AI) instruction in our curricula,” underscoring the need for students to “acquire the skills necessary to accept and responsibly utilise this rapidly evolving technology.” According to. (P. HT 3), the “School Improvement Plan” has already incorporated AI into the classroom, offering applications like “image creation, report writing, website text generation, and cleaning up images for our social media posts.”

These perspectives reflect a proactive approach to integrating new technologies, emphasising the need for continuous learning, AI inclusion, and leveraging future trends to enhance educational practices.

7.5.2 Attitude

This thematic analysis presents HT interviews, focusing on their attitudes toward TIPS. The responses highlight views on technology use and methods of involving parents and the community.

7.5.2.1 Vision for Tech-Int

“Vision for Tech-Int” emphasises the strategic role of technology in education. (P. HT 1) suggested a vision where technology “enhances and shares learning” rather than replacing traditional methods, aiming to make learning “more engaging and accessible for all students.” They emphasised that thoughtful Tech-Int can provide a “richer educational experience” and better prepare students for the future. (P. HT 2) presented a scenario in which every student has access to “personal, high-quality equipment” for easy curriculum access, emphasising that “engagement and attendance” are central priorities, with technology playing a crucial role in achieving these goals. (P. HT 3) focused on ensuring that “all staff are trained and confident” in using technology, with the goal of helping “all students reach their true digital potential,” ensuring that their success in this area supports their overall school journey.

This vision highlights a balanced approach to Tech-Int, emphasising enhancement, access, engagement, and comprehensive staff training to maximise students’ digital capabilities.

7.5.2.2 Involving Parents and the Wider School Community

“Involving parents and the wider school community” focuses on engaging external stakeholders in Tech-Int process. (P. HT 1) emphasised the importance of “information sharing and communication,” explaining that the school provides “parent information sheets” and keeps up-to-date information available on the school website and social media platforms. These efforts aim to keep parents informed and involved in decisions about technology use. (P. HT 2) highlighted “engagement through meetings and feedback,” noting that regular emails, updates on the school website, and community workshops are utilised to gather insights and opinions on technology initiatives. These workshops facilitate community involvement and feedback. (P. HT 3) mentioned that “parental input” is actively sought during “Parent Voice” monthly meetings, especially for decisions on new technology purchases and updates to the “School Improvement Plan.”

This inclusive approach ensures that technology decisions benefit from the active participation and perspectives of both parents and the wider school community, enhancing the overall implementation and acceptance of technological advancements.

7.5.3 Challenges and Barriers

This thematic analysis examines HT interviews, focusing on challenges and barriers faced in Tech-Int in primary school education. The responses highlight support strategies for TCRs, fair access to technology, and overcoming integration challenges.

7.5.3.1 Support and Empowerment for TCRs

Support and empowerment for TCRs focuses on enhancing educators’ ability to effectively integrate technology into their teaching. The school “supports our TCRs by sharing knowledge, skills, and strategies during regular staff training sessions,” as stated by. (P. HT 1). This approach aims to build TCRs’ confidence and ability in using technology. (P. HT 2) added that “numerous chances for regular training and professional development” are provided, emphasising that these sessions are designed to help TCRs stay current with the latest educational technologies and teaching methods. This ongoing professional development equips TCRs to better enhance their instructional practices and improve student learning outcomes. According to (P. HT 3), “the school provides in-house training from other staff members and actively promotes participation in local authority ICT training events.” This multi-faceted support strategy ensures that TCRs have suitable growth opportunities and are well-prepared to integrate technology effectively into their classrooms.

7.5.3.2 Strategies for Fair Access to Technology

“Strategies for fair access to technology” focuses on ensuring that all students have fair access to digital tools and resources. (P. HT 1) emphasised the approach of providing “all students with the same type of device” to foster a fair learning environment where every student has the necessary tools for success. (P. HT 2) highlighted the role of “timetabling technology” and “substantial investment” to ensure equitable access, noting that national and local funding frequently enhances the school’s digital infrastructure. (P. HT 3) discussed additional support measures, such as offering laptops to “our poorest pupils,” providing “mobile data cards,” and engaging with parents from low socioeconomic backgrounds, as per the Scottish Index of Multiple Deprivation (SIMD), to ensure that children can use the laptops at home.

Together, these strategies aim to bridge the digital divide and support all students in accessing and benefiting from technology.

7.5.3.3 Overcoming Integration Challenges

Overcoming integration challenges involves addressing various technical and systemic issues that can impede the effective use of technology in education. (P. HT 1) alluded to “system failures when many users try to access technology simultaneously” as a significant challenge, along with “upgrades and system changes” such as password updates, which can be both time-consuming and frustrating. They address these issues through “proactive planning and support” to minimise disruptions. (P. HT 2) highlighted "hardware and network failures" as major problems, which are reduced by investing substantial funds into the latest technology and employing a dedicated IT staff member to resolve issues at once. (P. HT 3) emphasised the importance of regular communication with a "local authority ICT lead" and a "specialist ICT network representative" who provides fortnightly visits to address problems, noting that engaging older TCRs with new digital techniques can be particularly challenging.

Together, these strategies aim to manage and overcome the challenges associated with Tech-Int in educational settings.

7.6 Summary of Chapter

The chapter synthesises insights from interviews with P/Cs, TCRs and TA, and HTs regarding technology in primary education. Parents view technology positively for its role in enhancing engagement, developing IT skills, and supporting diverse learning needs. However, P/Cs emphasise the importance of managing screen time and ensuring online safety. TCRs and TAs appreciate how interactive tools enhance motivation and skill development, but they face challenges like student distractions and access issues that call for ongoing professional development. HTs support for strategic and balanced Tech-Int, focusing on efficiency, infrastructure upgrades, and professional growth while addressing challenges such as fair access and technical support. These findings align with the research question by providing insights into stakeholder attitudes and behavioural influences (Objective 2) and identifying barriers and challenges of Tech-Int (Objective 3). They underscore that while technology offers opportunities to enrich education, realising its potential requires addressing barriers, promoting collaboration among stakeholders, and ensuring fair access and effective implementation.

PART III: DISCUSSION, AND CONCLUSION

Chapter 8
Discussion

8.1 Introduction

This chapter discusses the research findings from the quantitative and qualitative phases on the role of technology integration on teaching and learning outcomes in primary schools in Scotland, as presented in Chapters 6 and 7, and context them in relation to existing literature.

This research was guided by the primary research question: “What is the role of technology integration on teaching and learning outcomes in Scotland's primary schools?” To address this question, a mixed-methods approach was employed, beginning with a quantitative analysis through online surveys (Chapter 6) and a sequence of semi-structured interviews (Chapter 7). These methods were designed to explore the effectiveness of technology use in primary school education, with participants including P/Cs, TCRs and TAs, and HTs from various primary schools across Scotland. The research used a theoretical framework grounded in educational technology integration models (as explained in Chapter 3), focusing on how technology influences teaching practices and learning outcomes.

This mixed-methods design addressed the following research objectives. These objectives were to:

- ❖ Critically review and evaluate the role of technology integration on teaching and learning in primary schools.
- ❖ Analyse stakeholder attitudes and behavioural influences on Tech-Int.
- ❖ Identify barriers and challenges to technology integration in education.

This chapter discusses the findings from both research phases, interpreting them in relation to the systematic literature review presented earlier in Chapter 5 and the theoretical framework introduced in Chapter 3. The discussion is structured around the study's objectives and demonstrates how the research question has been addressed through the combined findings.

8.2 Critically review and evaluate the role of technology integration on teaching and learning in primary schools

The research results offered a clear overview of the key findings about the role of technology use in education across various stakeholder groups, including P/Cs, TCRs, TAs, and HTs. Interview data provides qualitative insights, supporting quantitative findings on the importance of technological infrastructure and the need for thorough evaluation of devices, resource types, and efficiency in educational institutions (Building the 21st Century Classroom, 2018).

8.2.1 Technology Use Frequency: School vs. Home Settings

The examination of technology use frequency found a significant difference between homes and school settings, with 40.4% of TCRs and TAs showing daily technology use, in contrast to 36.3% of P/Cs. The interviews with educators and TA indicate that they integrate technology more frequently into classroom activities than in home settings. Participants such as (P. TTA 2) support the effectiveness of interactive lessons using resources such as the Promethean board, asserting that these types of lessons "keep students engaged and excited about learning." A study by Ozerbas and Erdogan (2016) also reported this notion, indicating that the integration of digital classrooms and technological equipment improves student success, especially when educators have a strong sense of self-efficacy in employing these technologies.

However, P/Cs reported challenges in achieving the same level of technology use at home, often due to factors such as "limited access to resources, "competing priorities, or safety concerns online." The interviews with P/Cs confirmed this finding; for instance, (P. PC 3) described a balanced approach to technology management, saying, "We set limits on technology use and use parental controls to manage what our child can access." This approach shows that, while parents acknowledge the educational benefits of technology, they also aim to ensure it complements rather than take over other aspects of their children’s learning. Also, (P. PC 5) shared, “To support my child’s technology use, I set clear rules, monitor their online activity, and encourage open communication.”

These observations support the concept of digital parenting, as explained in recent studies (Livingstone and Blum-Ross, 2020; Boyer *et al*., 2023). Digital parenting refers to the strategies and practices parents use to understand, support, and manage their children’s activities in digital environments (Clark, 2013). EST (Bronfenbrenner, 1979) shows the influence of different environments on learning and development; in this context, educational and home environments influence children’s digital experiences, with structured schools facilitating consistent usage, while home environments balance educational requirements with parental control and safety concerns.

8.2.2 Technological Devices Preferences in Education

This section explores the preferences for different technological devices in primary education, presenting findings on how TCRs, parents, and children prefer common devices used for educational purposes.

8.2.2.1 Tablet Preference

The results show that tablets are the major devices used for T&L, with 37% of TCRs and TAs and 48.8% of P/Cs reporting a preference for them. Participants’ feedback confirms this significant preference for tablets. For instance, (P. PC 1) stated, “The iPad enhances engagement through interactive activities,” whereas (P. TTA 4) observed that “using iPads for game-based learning keeps children’s interest through interactive and enjoyable educational games.” These findings show the effectiveness of tablets in engaging children in both home and school settings.

8.2.2.2 Computers and Laptops

Computers and laptops also play an important role in education. Among TCRs, 30.1% preferred computers, and 24.7% chose laptops. Among parents, 16% preferred computers, and 22% chose laptops. (P. PC 1) highlighted the “importance of learning basic IT skills on laptops," showing that these devices help children develop essential digital skills. Comparably, (P. TTA 3) observed that "students acquire the ability to research and analyse information online," indicating that computers and laptops are essential in improving students' IT skills.

8.2.2.3 Smartphone Usage

Although smartphones are used less frequently, they continue to provide instructional objectives. Only 5.5% of TCRs and 12.4% of parents identified smartphones as their preferred devices; nonetheless, (P. PC 3) noted that "use of smartphones and computers develops IT knowledge." This indicates that even low smartphone usage can enhance technological competencies, consistent with other studies (Kumar Basak, Wotto and Belanger, 2018; Lai, Saab and Admiraal, 2022).

8.2.2.4 Devices Commonly Used by Children

When asked about devices children commonly use, tablets were again the most popular choice, with 47.6% of TCRs and 45.6% of parents reporting them as the top device. Although less frequently used, laptops and smartphones followed behind. Only 13% of TCRs and a similar percentage of parents reported that children commonly used desktop computers. These finding align with previous research (Furió *et al*., 2015; Hennessy, Haßler and Hofmann, 2015; Johnson *et al*., 2016; Kim and Frick, 2017). Tablets being preferred at home as well as in the classroom reflects their effectiveness and accessibility.

8.2.3 Technological Resource Preferences in Education

This section of the investigation shows how different stakeholders prefer technology resources and how these are relevant to context, and educational requirements. These results align with previous studies that have linked specific types of resources to improved engagement and learning outcomes (Connolly *et al*., 2012; Young *et al*., 2012; Li and Tsai, 2013).

8.2.3.1 Game-Based Learning

The high preference for game-based learning across all stakeholder groups (educators 34.7%, parents 42.4%) suggests a convergence of views about its educational value. This alignment challenges earlier research by Chang *et al*. (2017) that suggested potential conflicts between educator and student preferences. (P. TTA 4) noted that "Using iPads for game-based learning keeps children's interest through interactive and enjoyable educational games." Similarly, (P. PC 5) commented: "Educational games like Sumdog make learning fun and interactive, which keeps the child interested in math and other subjects." This observation extends on the work of Spires (2015) concerning educational gaming by showing how engagement translates into practical learning outcomes. However, the similar rates of preference across groups raise important questions about how different stakeholders interpret and implement game-based learning approaches.

8.2.3.2 Learning Platforms

This research found a conflict between structure and flexibility in resource preferences. 28.6% of TCRs and TAs prefer online learning platforms, including LMS, but 26.3% of P/Cs report a slight preference for online learning platforms at home. (P. PC 4) affirmed that "Apps providing global information offer easily accessible content that expands a child's educational journey." Such minor differences in participants' perspectives indicate the different objectives between schools and home learning environments. As observed by (P. TTA 1), "Educational apps like 'Teach Your Monster to Read' make learning enjoyable and engaging while maintaining the necessary structure." This finding extends Rusli *et al*.'s (2017) research on LMS effectiveness by highlighting the importance of balancing engagement with organisational needs.

8.2.3.3 Children's Preferences for Technological Resources

Children's preferences for technological resources show a significant inclination toward game-based learning, with 42.4% favouring this approach due to its interactive and enjoyable nature. This finding is consistent with the findings of previous studies by Chang *et al*. (2017) and Vasalou *et al*. (2017), who observed that these resources enhance student engagement and also decrease disinterest and boredom, consequently enhancing the motivation and effectiveness of learning. Digital stories, such as interactive storybooks, are also popular, with 23.2% of children appreciating the engaging narratives and visual elements they provide. This strategy can enhance student engagement and academic performance (Ayten and Polater, 2021).

8.2.4 Children's Subject Preferences for Technology Assisted Learning

This research's findings on subject preferences reveal the importance of how technology supports different subjects of learning while raising significant questions about effective implementation across the curriculum. The analysis both supports and extends current theoretical understandings of educational technology's role in subject-specific learning.

8.2.4.1 STEM Education and Technology

STEM subjects (particularly "science" and "mathematics") were the most popular subjects for tech deployment according to the majority of participants (70.2% of TCRs and TAs and 82.2% of P/Cs), indicating the natural alignment of technological solutions with such subjects. This confirms previous research on STEM (Kiili and Ketamo, 2018; Hillmayr *et al*., 2020; Huang, Kuo and Chen, 2020).

8.2.4.2 Literacy and Language Development

Reading also has a significant interest, with 40.4% of TCRs and TAs, and 53.5% of P/Cs favouring it as a subject for technology-based learning. This reflects a broad appreciation for the role of technology in supporting literacy development. (P. PC 2) confirmed that "technology motivates a dyslexic child by using text-to-speech and interactive apps," presenting how Tech-Int can especially enhance 'motivation' for students with specific learning needs. This finding aligns with previous research that has shown that incorporating technology into reading instruction can improve vocabulary, student motivation, and comprehension skills (Korat, 2010; Kucirkova, Littleton and Cremin, 2017).

8.2.4.3 Cross-Curricular Applications

Subjects such as geography and history show notable interest among children, particularly from the perspective of P/Cs, with 38.2% and 37.6%, respectively, suggesting these subjects receive help from the interactive and engaging nature of technology. Furthermore, the preference for using technology in language learning is notable, with 57.3% of P/Cs and 44.7% of TCRs and TAs reporting it as a preferred subject. This finding aligns with a previous study (Hwang *et al*., 2017), which underscores the value placed on technology's role in facilitating language acquisition. It allows students to practice vocabulary, grammar, and language skills through interactive activities that can greatly benefit from digital resources.

8.2.5 Impact of Technology on Learning Outcomes

The discussion of the findings shows a generally positive belief in technology's impact on learning outcomes, as shown by quantitative data. The quantitative data shows that HTs show the highest optimism, with 75% viewing technology as having a positive impact. Most TCRs and TAs and almost half of P/Cs shared this view (with 59.6% and 47.8%, respectively). Themes from interviews supporting the role of tech in learner engagement included interactivity, motivation, and skills acquisition. HTs also cited the efficiency of Tech-Int, especially evaluation methods to develop strategy and respond to needs.

8.2.5.1 Engagement and Motivation

Both parents and TCRs confirmed the role of technology in enhancing student engagement and motivation. For instance, (P. PC 1) noted that "iPad enhances engagement through interactive activities," highlighting how interactive tools can make lessons more dynamic and involved. This finding aligns with research by Kim and Frick (2017), Furió *et al*. (2015), and Hennessy, Haßler and Hofmann (2015). Similarly, TCRs reported that technology encourages motivation among students, particularly those with specific learning needs. For example, (P. TTA 2) stated that "using interactive platforms allows students to participate actively in lessons, which keeps them focused and interested." This aligns with the earlier study by Platinum

Copier Solutions Team (2017), which stressed that active engagement in learning significantly improves student achievement.

8.2.5.2 Skill Development

Skill development is another theme where technology has a positive impact, as highlighted by both parents and TCRs. (P. PC 1) highlighted the "importance of learning basic IT skills on laptops," while (P. TTA 3) observed that "technology-based homework supports various types of learners and teaches problem-solving skills independently." These insights illustrate how technology supports in developing essential skills, including "digital literacy" and "critical thinking," which are crucial for students' future success. This observation is supported by Kim, Raza and Seidman (2019), who argue that Tech-Int in education prepares students for future challenges by promoting critical skills necessary for success in a fast-changing world.

8.2.5.3 Accessibility

Accessibility in education is notably enhanced using technology, as highlighted by parents. such as (P. PC 2) noted, "Technology tools like text-to-speech software improve accessibility for a dyslexic child," explain how adaptive learning tools can modify educational experiences to meet individual needs. This opinion is repeated by TCRs who recognise the importance of technology in creating inclusive learning environments. For instance, Participant TTA 4 stated, "We use various digital tools to ensure all students can access the curriculum effectively." These findings on accessibility align with the findings of Davies and West (2014) and Drossel, Eickelmann and Gerick (2017), who confirmed that fair access to technology is essential for maximising its educational benefits.

8.2.5.4 Content and Curriculum Integration

The integration of content and curriculum is significantly enhanced using technology, as evidenced by feedback from both parents and TCRs. (P. PC 2) emphasised the importance of "a platform aligning with the local curriculum to track progress," highlighting how technology can improve the relevance and effectiveness of learning experiences. This alignment ensures that educational tools are not only engaging but also directly support curricular goals, helping a more coherent learning journey for students. TCRs also underscored the necessity of incorporating technology into their instructional strategies. (P. TTA 1) noted that “Educational apps like ‘Teach Your Monster to Read’ make learning enjoyable and engaging,” illustrating how technology can effectively support curriculum objectives while simultaneously enhancing student engagement.

This perspective aligns with research indicating that technology can provide interactive and personalised learning experiences that cater to diverse learning styles (Paterson, 2018; OECD, 2021). Furthermore, (P. PC 4) noted that Tech-Int in the curriculum enables the inclusion of “real-world simulations and interactive learning opportunities.” By incorporating real-world applications and simulations, technology makes learning more relevant and applicable to students’ lives (Wu, 2018).

8.2.5.5 Critical Thinking and Information Literacy

Critical thinking and information literacy are necessary skills enhanced through technology, as highlighted by parents and TCRs. Similarly, (P. PC 3) confirmed the importance of “teaching children to critically evaluate online information,” which is crucial in today’s information-rich environment. This focus on critical evaluation is repeated by TCRs who recognise the need to prepare students with the skills to navigate digital information effectively. (P. TTA 5) said “We teach students how to assess the reliability of online sources, which is essential for their academic success.” Hussein *et al*. (2019) also noted the essentiality of critical thinking in relation to technology potentially improving students’ skills of analysis.

8.2.5.6 Assessment of Technology Effectiveness

TCRs and TAs also highlighted the importance of assessing the effectiveness of technology in the classroom. (P. TTA 2) noted, “We regularly evaluate the impact of our technology initiatives to ensure they align with our educational goals.” This proactive approach to Tech-Int is crucial for maximising its benefits and ensuring that resources are distributed effectively. This sentiment is confirmed in the findings of

Ređep (2021), who stresses that the effectiveness of digital technologies in education is dependent on their rational and strategic application.

8.2.5.7 Methods of Assessment and Strategic Priorities

Research supports the importance of systematic assessment in Tech-Int, indicating that effective evaluation methods can significantly enhance educational outcomes. For instance, Ređep (2021) highlights the complexities associated with technology-enhanced learning and stresses the need for comprehensive assessment frameworks to understand the nuanced effects of Tech-Int in various educational contexts. This aligns with the HTs' emphasis on demonstrating criteria for evaluating technology's impact, ensuring that decisions regarding technology investments are data-driven and aligned with educational goals. The HTs emphasised the need for clear assessment methods and strategic priorities in Tech-Int, such as "observations and feedback," "data and engagement metrics," and "benchmarking and evaluation."

As (P. HT 2) confirmed, "We have established criteria for evaluating technology's impact on student learning, which helps us set strategic priorities for future investments." This methodical approach guarantees the alignment of technology initiatives with the school's educational goals and the efficient employment of resources. Additionally, HTs highlighted the importance of adapting to emerging technologies to continue relevant in a rapidly changing educational environment.

8.2.6 Training and Professional Development

This research found that professional development is crucial for the successful Tech-Int in education, with both quantitative and qualitative data supporting this argument. A significant majority of TCRs (87.1%) reported receiving training in using technology for educational purposes, indicating a strongly recognised focus on enhancing their digital skills. This high percentage suggests that there is a clear commitment to supplying TCRs with the necessary tools to incorporate technology into their classrooms effectively.

However, the research also found a gap in training among TAs, with only 62.5% receiving similar support. This gap in professional development points to a potential weakness in the broader strategy for Tech-Int, as TAs play a critical role in supporting student learning, especially in technology-enhanced environments (Conrads *et al.*, 2017). These findings show the need to address this issue to ensure that all educational staff are effectively prepared to contribute to successful Tech-Int. Qualitative data from interviews further emphasised the importance of ongoing professional development. (P. TTA 5) strongly wanted continuous learning opportunities to keep up with technological advancements, saying, “More CPD [continuous professional development] would be great.” Similarly, (P. TTA 2) highlighted the need for collaboration, noting the importance of “ongoing professional development and collaboration opportunities with other educators to share ideas.” These insights support Bingimlas’s (2009) findings, which emphasise the need for comprehensive training, technical support, and collaboration to overcome barriers to Tech-Int.

Additionally, this research suggests that the insufficient training of educational leaders may be a broader issue than the lack of sufficient training for TAs. Ipsos’s (2019) previous research suggests that a lack of strong leadership supporting the training needs of all staff, including TAs, could compromise the overall effectiveness of Tech-Int.

8.3 Analysing Stakeholder Attitudes and Behavioural Influences on Tech-Int

The TPB, which focuses on attitudes, subjective norms, and perceived behavioural control as key influencers of intentions and actions, can understand the attitudes of stakeholders toward Tech-Int in primary education. Additionally, EST highlights the role of different environmental systems: HTs as part of the macro-system, TCRs and TAs within the meso-system, and parents in the micro-system. These systems collectively shape stakeholder attitudes toward Tech-Int. Supporting these systems is essential for effective Tech-Int, while misalignment can create challenges. By combining TPB and EST, a comprehensive view is gained of how various perspectives affect the successful Tech-Int in education.

8.3.1 Attitudes Toward Behaviour

In both the TPB and the TAM, “attitudes toward behaviour” refer to the degree of favourable or unfavourable evaluation of a person’s intended behaviour (Moon and Kim, 2001). According to Ajzen (1991), attitudes involve considering the potential outcomes of performing the behaviours. This research argues that attitudes toward TIPS should consider the specific performance expectations and concerns of different stakeholders within the EST (P/Cs, TCRs and TAs, and HTs).

P/Cs have a favourable attitude toward Tech-Int in primary education. The mean agreement scores of 74.44% reflects this positive outlook, indicating that they largely perceive technology as beneficial for enhancing learning and development. A significant majority (86%) agreed that technology helps children learn more effectively, and 85.8% appreciated the blend of fun and utility that educational technology brings to the home environment (see Table 6.17). For a more in-depth understanding of attitudes toward behaviour, themes from interviews with P/Cs offer further understanding. Participants, such as (P. PC 1), commended the interactive and engaging nature of technology in learning, while (P. PC 4) saw “how educational apps simplify complex concepts for their children, echoing these attitudes in the interviews.” Moreover, (P. PC 5) emphasised that “technology enhance creativity and critical thinking, preparing students for future academic and career challenges.”

TCRs and TAs also show positive attitudes towards Tech-Int in education, acknowledging its benefits in enhancing student interaction, engagement, and understanding of complex topics. Quantitative data indicates that 98% of teaching respondents strongly agreed that technology TAs in skill acquisition among children, and 82.6% agreed that it simplifies complex concepts. This positive evaluation is consistent with the TPB’s concept of “attitude toward behaviour,” which involves individuals evaluating the positive and negative aspects of a behaviour, such as the use of technology in education. However, moderate concerns about prospective drawbacks attitude this enthusiasm.

Specifically, 62.22% of respondents expressed moderate agreement on issues such as the potential for “digital content to limit physical activity and reduce face-to-face interaction.” This might be seen from interviewees’ responses, such as (P. TTA 1) and (P. TTA 4), which reveal that these educators actively assess the impact of digital technology on student learning using methods like “direct observation,” “student feedback,” and “comparisons with historical data.” This balanced view reflects a confident yet cautious attitude as educators look to enhance learning outcomes through technology while remaining careful of its limitations.

HTs also showed positive attitudes towards Tech-Int in education, as demonstrated by their recognition of its benefits in enhancing student engagement, interaction, and understanding of complex topics. For instance, (P. HT 1) emphasised that technology enhances learning by making it more engaging and accessible, aligning with the overall positive outlook, as evidenced by a mean agreement score of 72.8%. However, practical considerations like the “costs involved and teachers’ readiness to adopt new technologies temper this enthusiasm.” Some examples of their responses clarify such as (P. HT 2) highlighted the importance of “balancing the benefits with the challenges of implementation,” indicating cautious optimism. This balanced perspective suggests that while HTs view technology as a valuable tool, they are mindful of its limitations and the need to integrate it thoughtfully alongside traditional teaching methods. TPB’s concept of attitude toward behaviour, which influences the evaluation of a behaviour’s perceived advantages and potential disadvantages, aligns with this approach.

8.3.2 Subjective Norms

The expectations of significant others, such as family, peers, and professional communities, often shape subjective norms, which are defined as “the perceived social pressure to perform or not to perform a behaviour” (Ajzen, 1991, p. 188; Finlay, Trafimow and Moroi, 1999). Subjective norms relevant to primary education Tech-Int shape how P/Cs, TCRs, and HTs regard and employ classroom tech with consideration of professional and social backgrounds.

P/Cs' acceptance of Tech-Int is shaped by social pressures and the perceived expectations from others. While there is consensus on the benefits of technology, concerns are also prevalent regarding its potential negative effects. For instance, 57.8% of P/Cs expressed concern that digital content could contribute to emotional and behavioural issues, reflecting a social norm that values the protection of children's well-being. Some examples from their responses exemplify and support this. Interview participants highlight how concerns about "online safety," "the reduction of traditional skills like handwriting," and "the potential for addiction" are shared among P/Cs. These shared concerns and the importance placed on protecting children's well-being reflect the social norms that guide their attitudes and behaviours toward technology use in education.

TCRs and TAs are also aware of the need to balance technology use *alongside* traditional methods. 62.2% of respondents expressed concerns about the potential for technology tools to limit physical activity. Moreover, interviewees like (P. TTA 1) and (P. TTA 5) highlighted challenges in managing inappropriate tech use, such as "access to non-educational content" and "distractions in the classroom." These concerns underscore the need for a careful balance to ensure that technology is used primarily for educational purposes rather than as a source of entertainment.

HTs: Subjective norms, particularly the expectations of their leadership roles and broader educational policies, significantly influence Tech-Int among HTs. The vast majority (95%) of HTs reported a positive reception of technology among students and parents, underscoring the social pressures to support its use in education, which in this case pertains to actual educational service users (i.e., consumers), underscores the influence of community expectations on decision-making. Interviews reveal that HTs feel a strong responsibility to involve parents and the wider community in decision-making processes regarding technology use.

For instance, (P. HT 3) noted that “Engaging parents and the community is crucial for successful Tech-Int,” which illustrates the influence of societal and institutional expectations on their approach to Tech-Int. However, HTs also ensure that their decisions align with practical truths, such as “budget constraints and TCR preparation.” This focus on “community engagement” and support, as well as the “empowerment of TCRs” in practical matters. The influence of these social pressures highlights the importance of aligning technology initiatives with the values and expectations of the school community, consistent with the TPB framework.

8.3.3 Perceived Behavioural Control

Self-efficacy theory deeply roots the concept of perceived behavioural control in the TPB (Chou *et al.*, 2024). Self-efficacy, a cornerstone of various behaviour changes theories, including SCT, refers to an individual’s belief in their ability to manage and influence their actions and navigate daily challenges (Bandura, 1977). It is a person’s confidence in their ability to succeed in specific situations. Perceived behavioural control (Ajzen, 1985), on the other hand, specifically addresses individuals’ perceptions of their ability to perform a particular behaviour, considering any obstacles or constraints they might face. In the context of technological integration in education, perceived behavioural control plays a crucial role across different stakeholder groups as explained in the following:

P/Cs perceive both the benefits and challenges of controlling technology use in their children’s education. They recognise the educational advantages, but are aware of potential difficulties, such as managing screen time and preventing issues like addiction. (P. PC 4) and (P. PC 3) “emphasised the need to balance technology with traditional skills, such as handwriting, to ensure well-rounded development.” The strategies they employ to mitigate potential drawbacks further reflect this sense of control. where (P. PC 4) confirmed the importance of “setting limits,” such as restricting screen time to one hour per day, to support a healthy balance. (P. PC 2) described using a structured schedule that integrates both traditional and technology-based learning, ensuring that each has its designated time. Additionally, (P. PC 5) “discussed balancing their child’s education by combining traditional methods, like books, with newer approaches, such as educational apps." These strategies underscore the importance of a thoughtful, controlled approach to Tech-Int in children's education.

TCRs and TAs demonstrate a strong sense of perceived behavioural control in their approach to Tech-Int in education. This is evident in their meticulous assessment of the effectiveness of technology and their capacity to adjust their teaching methods, accordingly, thereby embodying the concept of "perceived behavioural control," which pertains to the perceived ease or difficulty of executing a behaviour. For instance, (P. TTA 1) implements specific guidelines and restrictions to prevent technology misuse and ensure its right use in the classroom. Similarly, (P. TTA 5) "mentioned that breaking trust regarding technology use results in restricted access under supervision," illustrating how educators enforce control measures to continue a productive learning environment. (P. TTA 3) stressed the difficulties in supporting students' focus while using technology, underscoring the significance of controlling the use of digital tools. These strategies reflect the educator's confidence in their ability to control and optimise technology use in a way that enhances learning while addressing potential issues.

HTs show a strong sense of perceived behaviour control in their strategic approach to Tech-Int. They actively address potential challenges, such as financial costs and the need for TCR training, to ensure that technology enhances educational outcomes without undermining traditional methods. For example, (P. HT 1) described taking "proactive measures" by providing high-quality equipment, while (P. HT 2) emphasised "involving the community to gain support and resources," reflecting their confidence in effectively managing Tech-Int. This sense of control is essential for navigating the complexities of technological use in schools and empowering HTs to implement solutions that maximise the benefits of digital tools while mitigating potential obstacles. This approach aligns with TPB's concept of perceived behavioural control, which emphasises the ability to manage and perform behaviour despite expected barriers.

After analysing the attitudes of stakeholders, the next section explores how this view affects barriers to technological integration.

8.4 Identifying Barriers and Challenges to Tech-Int Across Stakeholder Groups

The analysis of barriers to Tech-Int in primary education revealed distinct challenges across four stakeholder groups: TCRs, TAs, HTs, and P/Cs. These barriers were examined through the theoretical frameworks of TPACK, the TPB, and the TAM.

8.4.1 Unavailability of Designs According to the Curriculum Content

Analysis revealed that all stakeholder groups showed the lack of curriculum-aligned technology resources as a significant barrier to integration. TCRs and HTs expressed particularly strong concerns, with mean scores of 3.55 and 4.40, respectively, while P/Cs acknowledged this challenge with a mean score of 3.32. These findings highlight a real gap in technological contextual knowledge within the TPACK framework, specifically regarding the availability of curriculum-specific digital resources (Dinc, 2019).

The lack of technological designs that align with educational objectives substantially constrains educators' capacity to effectively utilise digital technology. Wang *et al*. (2023) confirms this finding, noting that misalignment between technology resources and curriculum standards often hinders meaningful implementation, ultimately limiting potential learning outcomes. Furthermore, Şenyiğit and Serin (2022) emphasised that successful Tech-Int need careful consideration of how digital tools support specific learning objectives, suggesting that incompatibility between technology and curriculum can result in suboptimal teaching practices.

In addition, the findings of Bai and Lo (2018) support the contention that technology resource development and curricular requirements must be closely aligned to ensure effective implementation. Without such alignment, the potential benefits of Tech-Int continue largely unrealised, leaving educators inadequately equipped to incorporate these tools into their teaching practice. This suggests that educational institutions and policymakers should prioritise the development of curriculum-aligned technology resources. Moreover, enhanced collaboration between curriculum developers and technology designers could facilitate the creation of resources that both meet educational standards and enrich the overall learning experience.

8.4.2 Lack of Experience Using Technology for Teaching

The lack of experience in using technology for teaching has emerged as a significant barrier across all stakeholder groups, with mean scores of 2.64 for TCRs, 2.58 for P/Cs, and 3.40 for HTs. The findings underscore a crucial issue concerning PEOU in the TAM and TPK in the TPACK framework. The data show that both educators and parents encounter difficulties in the practical application of technology in educational settings, ultimately limiting the effectiveness of Tech-Int. This observation is consistent with previous studies, such as those conducted by Hayak and Avidov-Ungar (2020), Wang *et al*. (2021), and Mahdi and Al-Dera (2013), which emphasise the importance of experience in facilitating technology use in teaching. indicating that educators who lack experience with technology often feel less confident in their ability to integrate these tools into their teaching practices. This lack of confidence can lead to reluctance to adopt new technologies, further perpetuating the cycle of limited adoption.

8.4.3 Negative Beliefs About Impacts of Technology on Children

All stakeholder groups found negative beliefs about the impact of technology on children as a moderate barrier, with mean scores of 3.43 for TCRs, 3.06 for parents, and 3.60 for HTs. These concerns align with the TPB, which suggests that such negative attitudes can significantly influence the adoption and use of digital tools in educational settings. It was found that all stakeholder groups have noticeable concerns about potential harms to children associated with increasing technology use in education, including reduced face-to-face interaction, limited physical activity, and the risk of technology addiction. These concerns are consistent with existing literature on technology’s role in children’s development, such as studies by the AAP (2011), Teichert and Anderson (2014), and Aldhafeeri, Palaiologou and Folorunsho (2016). From the perspective of technology adoption, such negative attitudes can act as significant barriers, discouraging the effective Tech-Int in education. Research by Morgan (2010) and Alotaibi *et al*. (2020) further supports this, noting that doubts about digital resources can hinder their adoption, limiting the potential benefits as well as dangers of technology in the classroom.

8.4.4 High Cost of Designs and Devices

The high cost of technology has emerged as one of the most significant barriers to effective Tech-Int, as indicated by all stakeholder groups within primary educational contexts. TCRs, HTs, and parents reported mean scores of 4.13, 4.40, and 3.58, respectively, indicating a substantial level of concern regarding the financial constraints that hinder access to technological resources. These scores reflect a consensus across stakeholder groups about the critical nature of this barrier. Two theoretical frameworks intricately link with this financial challenge: the “facilitating conditions” component of the TAM, and the TK aspect of the TPACK model.

The TAM posits that facilitating conditions, including the availability of resources, significantly influence users’ acceptance and utilisation of technology (Wang *et al*., 2023). In this context, the high costs associated with devices and software can deter educators and institutions from adopting new technologies, thereby limiting their potential benefits. Similarly, within the TPACK framework, TK encompasses the understanding of how to effectively integrate technology into teaching practices. Financial limitations can restrict access to essential devices and resources, obstructing educators’ abilities to develop the necessary technological competencies and pedagogical strategies required for successful Tech-Int (Şenyiğit and Serin, 2022).

This lack of access not only affects the school environment, but also extends to home settings, where parents may struggle to provide their children with the necessary technological tools for learning. The implications of these financial barriers are profound, as they underscore the urgent need for targeted interventions to alleviate cost-related challenges. Addressing these issues is critical for enhance an environment conducive to the broader and more effective use of technology in education. Potential solutions may include government subsidies, grants for educational institutions, and partnerships with technology companies to provide affordable devices and resources.

8.4.5 Lack of Courses in Technology-Related Subjects

The lack of courses in technology-related subjects appeared as a significant barrier to effective Tech-Int in educational settings. This issue is particularly pronounced among HTs, who reported a mean score of 4.43, while TCRs and parents recognised its impact with mean scores of 3.85 and 3.31, respectively. These findings indicate a widespread acknowledgement of the critical gap in TK as outlined in the TPACK model. The lack of comprehensive technology-related training significantly impedes stakeholders' capacity to develop essential digital competencies. This aligns with Tosuntaş, Çubukçu and Inci's (2019) research, which identified educators' perceived lack of knowledge and skills as a primary barrier to Tech-Int. This limitation not only constrains the implementation of innovative pedagogical approaches but also impacts the quality of technology-enhanced learning experiences available to students.

Li *et al.*'s (2015) research also supports these findings, emphasising that collaborative professional development and continuous learning opportunities are crucial for advancing Tech-Int in primary education. The lack of structured training programs may weaken educators' ability to implement effective technology-enhanced pedagogical strategies, so developing classroom challenges. These findings underscore the pressing need for educational institutions to prioritise technology-focused professional development initiatives. Strategic investment in comprehensive training programs could enhance stakeholders' digital competencies, ultimately enriching the educational experience and better-preparing students for an increasingly digital society.

8.5 Moderators Factors of Tech-Int in Education

The research results from the systematic review, along with the quantitative and qualitative research phases, facilitated the creation of a four-part framework to analyse the dynamics between "demographics," "efficiency," "attitude," and "barriers." This framework, which is the primary research output, serves as a tool for assessing and planning the alignment of Tech-Int with learning outcomes. Stakeholders interested in exploring TIPS, or those already implementing digital technology, can use this framework to plan and evaluate their current pedagogical design and delivery.

8.5.1 Parents' Income Level and Tech-Int

Socioeconomic factors often heavily influence Tech-Int in education, with research from UNICEF (2017) and UNESCO (2021) suggesting that higher income levels lead to better access to digital tools and resources. Livingstone *et al*. (2015) highlight that wealthier families can afford better technology and internet services; their children are likely to have better educational opportunities, while children from less wealthy families may fall further behind, expanding the variation in educational outcomes. This raises important questions about fair access, particularly for lower-income students who may face greater barriers to receiving help from technological advancements.

This research challenges the assumption that income level is a primary determinant of perceived barriers to Tech-Int. Contrary to expectations, the ANOVA analysis for **H4** revealed no significant differences in perceived barriers across different income levels ($F = 0.004$, $p = 0.996$). Similarly, reject **H5**, finding no meaningful relationship between income levels and the role of tech-based learning environments in education. These findings suggest that income does not significantly affect parents' perceptions of barriers or their engagement with educational technology in the studied sample.

The interview results revealed that the strategies discussed by the HTs in interviews (P. HT 1, P. HT 2, P. HT 3) offer insights into how schools can reduce this variance. By implementing uniform device policies, strategically planning technology use, and providing targeted support to disadvantaged students, these school leaders are working to create a fairer learning environment. Instead, qualitative interviews with parents revealed that challenges and barriers, such as "parental involvement," "effective communication between schools and parents," and "a balanced approach to traditional and technology-enhanced learning," are more critical for successful Tech-Int. While higher income may provide greater access to technology, it does not necessarily reduce perceived barriers or address negative attitudes toward its use.

These results underscore the importance of non-financial factors in effectively implementing educational technology.

8.5.2 Differences in Education Levels and Teaching Levels

This research results underscore the complex relationship commonly documented in the educational literature between teaching quality and educational achievement. According to Burić, Butković and Kim (2023), teaching quality is a critical component of overall TCR effectiveness, which also includes important elements such as instructional techniques, student engagement and achievement outcomes, and TCR qualifications. Improved TCR qualifications consistently correlate with higher education levels, positively influencing instructional strategies and student outcomes. However, the inclusion of digital technology in the classroom complicates this relationship. The literature (Archer *et al*., 2014; Davies and West, 2014; Drossel, Eickelmann and Gerick, 2017) emphasises the significance of TCR confidence and ongoing professional development for successful technology use in classrooms.

However, the empirical data from this research provides an alternative viewpoint on **H6** ("Educators with higher education levels report fewer barriers to Tech-Int." The ANOVA test showed that there were no significant differences in the perceived barriers (AVG- part 4) to Tech-Int across different education levels ($F = 1.459$, $p = 0.217$). This means that contrary to the original hypothesis, higher education levels may not significantly lower perceived barriers to Tech-Int. This finding aligns with previous research (Archer *et al*., 2014; Davies and West, 2014; Drossel, Eickelmann and Gerick, 2017). Furthermore, **H3**, which suggested a relationship between education levels and teaching methods across teaching levels, was confirmed by the Pearson chi-squared test ($\chi^2 = 65.061$, $p = 0.013$). This indicates a significant association between educators' education levels and the teaching methods they apply across different teaching levels, which aligns with Burić, Butković and Kim (2023).

The findings confirmed that while education levels are linked to improved teaching strategies, they do not necessarily reduce perceived barriers to Tech-Int.

8.5.3 Gender Differences in Perceptions and Barriers to Tech-Int in Education

The discussion about gender differences in perceptions (AVG_3) and barriers (AVG_4) to Tech-Int in education reveals a complex interplay between various stakeholders, including parents, TCRs, and TA. The basis for this analysis is reflected in **H7** ("There is a significant difference between genders in their perceptions of the role of technology in educational environments") and **H8** ("There is a significant difference between genders in their perceptions of barriers to Tech-Int"), which explore how gender influences perceptions of technology's role in education and the barriers to its integration. The findings indicate that gender does not significantly affect the perceptions of P/Cs regarding technology's role in education.

The results of the independent samples test (t (111.564) = -1.013, p = 0.313) indicate that both male and female parents hold similar views about the benefits of technology in enhancing their children's learning experiences, thus rejecting **H7**. Previous research by Fidan and Olur (2023) revealed additional factors other than gender that are highly instrumental in shaping parents' perceptions, including the significance of self-efficiency in influencing attitudes towards technology in educational settings. Furthermore, the analysis of barriers to Tech-Int also shows no significant gender differences among parents, with a p-value of 0.071 and small to moderate effect sizes (Cohen's d = -0.400, Hedge's correction = -0.396). Interviews confirm these findings, showing that both genders face similar barriers and challenges, such as "concerns about screen time" and "online safety." Previous studies also reported that individual beliefs and experiences shape parental, carer attitudes towards technology more than gender, indicating that gender is not a determining factor in perceiving barriers to Tech-Int (Gjelaj *et al*., 2020; Fidan and Olur, 2023).

Conversely, data from TCRs and TAs supported **H7**, with females being more confident in their ability to adopt and use Tech-Int in practice, confirming studies which reported gender impacts on educators' technology propensity (Bai and Lo, 2018). However, when examining hypothesis **H8** regarding perceived barriers to Tech-Int, the analysis results indicate no significant gender differences. The interview found that both male and female TCRs reported facing similar barriers and challenges, such as "limited resources," "insufficient training," and "unreliable technology infrastructure."

Overall, the findings of this research are consistent with previous research findings, which identified common barriers faced by educators regardless of gender (Dinc, 2019).

8.5.4 Age and Generational Differences in Children's Technology Use

The theoretical perspectives provided by Hollingworth *et al*. (2011) offer valuable insights into the relationship between parental age and children's experiences with technology. One of their most significant findings is the concept of "generational gaps." This generational divide suggests that parents from different age groups often hold varying perspectives and attitudes toward technology, directly influencing how they manage their children's exposure to digital tools.

Statistical analysis supports the hypothesis (**H9**) that "there is a significant relationship between a child's age group and their parents' age," building on these theoretical insights. The Chi-square test results confirm a significant relationship between the child's age group and the age of their parents ($\chi^2 = 232.998$, $p = 0.010$). By recognising the differing attitudes and behaviours toward technology across various family settings, it becomes possible to bridge the digital and generational gaps identified by Hollingworth *et al*. (2011), leading to more tailored and effective strategies for Tech-Int in children's education.

Furthermore, the research investigated the **H9.a** hypothesis, which suggested "a significant difference in the average age of TCRs and TAs across different teaching levels." The ANOVA results revealed a p-value of 0.068, slightly above the conventional significance threshold of 0.05, suggesting that the differences in average age among teaching levels are not statistically significant. Therefore, we cannot reject the null hypothesis, suggesting that there is no significant variation in the average age of TCRs and TAs across different teaching levels.

Previous research has shown that TCR age influences their use of technology in education. Interviews with HTs at Scottish schools confirmed this finding. For example, one HT (P. HT 3) noted that “engaging older TCRs with new digital techniques can be particularly challenging.” This shows that older TCRs have a less distinct tendency to use technology. This finding aligns with previous research by Drossel, Eickelmann and Gerick (2017).

8.5.5 The Impact of Perceived Efficiency on Attitudes Toward Technology Integration

Perceptions, attitudes, and demographic factors shape the complex process of Tech-Int in educational environments, whether from the perspective of TCRs, TA, parents, or carers. **H2** explores “how tech-based learning environments function differently among groups with positive, moderate, or negative perceptions of technology.” The TPB is a useful model for understanding this process, as it highlights how subjective beliefs about the usefulness and ease of using technology influence attitudes and behaviours toward adopting it (Ajzen, 1991; Davis, Bagozzi and Warshaw, 1989). Perceptions have a significant impact on how educators and parents integrate technology into educational settings. TCRs’ beliefs about the consequences of technology use, combined with factors such as confidence and openness to change, play a critical role in their willingness to integrate new technologies (Ertmer *et al*., 2012).

Similarly, parents’ attitudes toward technology influence their support for its use. Positive perceptions generally lead to more effective integration, as noted in studies by Vanderlinde and Van Braak (2011) and Li *et al*. (2015). The ANOVA results for **H2** show significant differences in the role of tech-based learning environments among perception groups, further supporting these findings. For TCRs, a p-value of 0.025 highlights the importance of their attitudes in determining effective technology use in classrooms. For parents, a p-value of less than 0.001 underscores their crucial role in shaping their children’s tech-based learning experiences.

These results suggest that, whether in the classroom or at home, self-efficiency in influencing attitudes towards perceptions of technology plays a key role in determining its successful integration into education (Fidan and Olur, 2023).

8.5.6 The Impact of Perceived Technology-Based Learning Environments on Barriers to Tech-Int

The Tech-Int in education presents both challenges and barriers, as evidenced by the findings for both parents and educators in **H1**, which initially posited that "the effectiveness of tech-based learning environments would reduce perceived barriers for P/Cs." Previous research (Ertmer *et al*., 2012; Osorio-Saez, Eryilmaz and Sandoval-Hernandez, 2021) supports this, indicating that effective Tech-Int enhances learning, particularly for students with learning difficulties, by increasing engagement and motivation.

This aligns with the interview findings of P/Cs' perspectives on the impact of tech-based learning environments. However, the Pearson correlation analysis revealed a positive correlation (r = 0.251, p = 0.022) between tech-based learning environments (AVG_ part 3) and perceived barriers (AVG_ part 4), which contrasts with the expectations of **H1**. Interviews further explored this finding, identifying key factors such as "parental involvement," "effective communication between schools and parents," and concerns around "online safety" as crucial in addressing these barriers.

For educators, the barriers to Tech-Int are more nuanced. Literature highlights concern that technology might degrade instructional quality and student interaction (Morgan, 2010; Alotaibi *et al*., 2020), alongside challenges such as inadequate resources and poor planning (Plowman, McPake and Stephen, 2010; Aubrey and Dahl, 2014). Interviews with TCRs and TAs confirmed that (P. TTA 1) and (P. TTA 5) had difficulties with student distractions and misuse of technology, while (P. TTA 4) and (P. TTA 6) cited limited access and poor connectivity as barriers. The finding analysis revealed a positive correlation (r = 0.037, p = 0.037) between tech-based learning environments (AVG_3) and perceived barriers (AVG_4). This positive correlation does not align with **H1**, which predicted a negative correlation (i.e., fewer barriers with more effective tech use).

The findings from P/Cs, TCRs, and TAs provide a more complex picture than expected. While technology holds the potential to improve learning outcomes, perceived and real barriers continue to present significant challenges to its successful integration. Contrary to **H1**, increased engagement with tech-based learning environments can also lead to increased challenges and barriers to Tech-Int.

8.6 Emergent Conceptual Framework Based on Empirical Findings

This section presents a refined conceptual model that emerged from the integration of findings across both quantitative and qualitative phases of the research. Building upon the theoretical foundations introduced in Chapter 3, particularly the frameworks of the Theory of Planned Behaviour (TPB), Ecological Systems Theory (EST), and the Technology Acceptance Model (TAM), this model incorporates empirical evidence derived from stakeholder responses. The refined model illustrates the dynamic interaction between key constructs such as stakeholder attitudes, behavioural control, environmental conditions (including access, training, and policy), and the outcomes of technology integration in teaching and learning. Its further accounts for moderating factors such as generational differences and institutional support.

By mapping influences across individual, school, and systemic levels, including teacher experience, headteacher leadership, parental involvement, socioeconomic background, and technological access, the model provides a nuanced representation of the contextual realities within Scottish primary education.

What this research adds, beyond reinforcing existing literature, is an empirically grounded framework that integrates multiple stakeholder perspectives within a single, practical model tailored to the complexities of primary school settings. The framework thus contributes both theoretically, by refining how we conceptualise context and influence in Tech-Int, and practically, by supporting targeted strategies for policy and school-level decision-making. The final version of the conceptual framework, constructed from the empirical findings of this research, is illustrated in Figure 8.1.

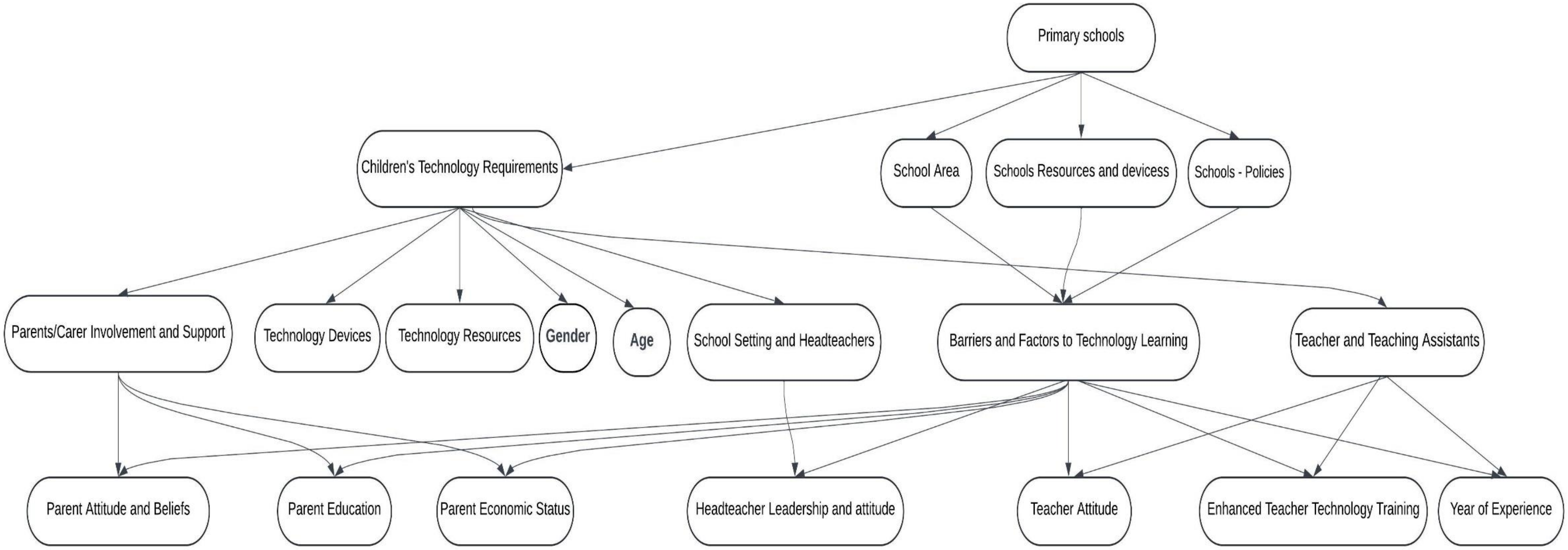

Figure 8.1: Emergent Conceptual Framework (TIPS) Based on Empirical Findings

8.7 Chapter Summary

This chapter discusses the findings from both qualitative and quantitative methodologies. The research's findings addressed how Tech-Int affects T&L in primary schools in Scotland, especially on key concerns such as usage frequency, device preferences, and specific topics where technology proves most advantageous. The findings showed the relevance of theoretical frameworks like TAM, TPB, and TPACK in understanding stakeholders' attitudes and behaviours toward technology use. Moreover, the research found several barriers to effective Tech-Int, including limited resources, lack of training, and concerns about online safety. These findings contributed to developing an emergent conceptual framework and provided an answer to the research question: What is the role of technological integration in teaching and learning in primary schools in Scotland? Specifically, the research showed that the role of technology integration is multi-dimensional, supporting enhanced engagement, differentiated learning, and digital skill development while also being shaped by contextual factors such as stakeholder perceptions and school infrastructure.

In addition, limitations and recommendations were presented. Limitations included the need for broader representation and geographic diversity among participants, and recommendations were made to address these areas and support more inclusive technology policies.

The next chapter concludes the thesis by summarising its main findings and suggesting recommendations for future studies for improving Tech-Int in primary education.

Chapter 9
Conclusion

9.1 Chapter Overview

This chapter concludes exploring the impacts of technology integration on teaching and learning in primary schools in Scotland. This research aimed to answer the research question: What is the role of technology integration in teaching and learning in primary schools in Scotland?

The research focused on three primary objectives: (1) to critically evaluate the role of technology integration on teaching and learning; (2) to analyse stakeholder attitudes and behavioural influences on technology integration; and (3) to identify barriers and challenges to technology integration in education. A sequential explanatory mixed methods design was employed to address the research question and objectives as summarised below.

9.2 Achievement of the Research Aim and Objectives

This research aimed to examine the role of digital technology integration on teaching and learning outcomes in primary schools in Scotland. The aim was achieved through the following three objectives:

Objective 1: *To critically review and evaluate the role of technology integration on teaching and learning in primary schools.*

This objective was achieved through a systematic literature review, presented in Chapter 5. The review provided a foundation for understanding the benefits, challenges, and role of Tech-Int in educational settings. Additionally, the review highlighted the limitations of Tech-Int, such as issues with fairness access, and professional training, which informed the research design for next phases. Key conclusions include:

- **Impact on Engagement and Learning**: Technology promotes active learning and engagement, particularly in interactive and collaborative tasks.
- **Skill Development**: Digital technology contributes to students' IT literacy and problem-solving skills.
- **Challenges:** Barriers such as unequal access to resources, insufficient teacher training, and concerns about online safety were consistently identified.

The findings from the systematic literature review informed the development of survey instruments and guided the formulation of the research hypotheses.

Objective 2: *To analyse stakeholder attitudes and behavioural influences on technology integration.*

This objective was addressed through the questionnaire analysis presented in Chapter 6 and semi-structure interviews Chapter 7. The survey captured data from P/Cs, TCRs and TAs, HTs in primary schools across Scotland, providing insights into stakeholder attitudes toward technology use in learning. The analysis was guided by theoretical frameworks outlined in Chapter 3. Key behavioural influences were analysed using theoretical frameworks such as TAM, TPB, and TPACK, which shown:

- **Perceived Benefits:** Stakeholders recognised the value of digital technology in improving teaching efficiency, enhance collaboration, and supporting different learners.
- **Behavioural Influences:** Factors such as perceived ease of use, usefulness, and attitudes toward change significantly influenced stakeholders' willingness to Tech-Int.
- **Theoretical Alignment:** TAM and TPB frameworks proved how behavioural intentions and perceived control influence Tech-Int.

The qualitative interviews provided context-rich insights, highlighting how personal experiences, professional roles, and school policies shape attitudes and behaviours toward Tech-Int.

Objective 3: *To identify barriers and challenges to technology integration in education.*

This objective was achieved by synthesising findings from all three research phases. The systematic literature review Chapter 5, questionnaire analysis Chapter 6, and interview analysis Chapter 7 collectively revealed several key barriers. The TPACK framework, introduced in Chapter 3, was instrumental in analysing these barriers. Key barriers included:

- **Resource Limitations:** Schools often face insufficient digital infrastructure and unequal access to devices, which fall under the Technological Knowledge (TK).
- **Professional Development:** Teachers require ongoing training to effectively integrate technology into their teaching practices, which aligns with the Pedagogical Knowledge (PK)
- **Online Safety Concerns:** Parents and educators emphasised the need for strong measures to ensure student safety when using digital tools.

These findings, supported by the theoretical from Chapter 3, highlight the importance of strategic planning, stakeholder collaboration, and policy repairs to overcome these barriers and enhance the effectiveness of technology integration.

9.3 Summary of Key Findings

This research provides insights into Tech-Int in primary schools in Scotland and its impacts on T&L are summarised below.

9.3.1 Positive Impacts on Learning Outcomes

Tech-Int was found to enhance engagement, motivation, and cognitive development among primary school students. Devices such as tablets, as well as resources like digital games and storytelling, positively influenced skills such as problem-solving, literacy, and numeracy.

9.3.2 Stakeholder Attitudes

TCRs, parents, and HTs generally held positive attitudes toward technology in education, acknowledging its potential to support various learning needs and improve digital literacy. However, stakeholder attitudes varied slightly in relation to demographic factors, with some gender and generational differences observed.

9.3.3 Challenges and Barriers

Despite the benefits, this research showed several barriers to effective Tech-Int, such as limited resources, insufficient training for educators, and concerns about online safety. These challenges indicate a need for improved support systems and training programs to ensure technology is used effectively in educational settings.

9.3.4 Influence of Educational Theories

The research's findings align with key educational theories, including the TAM, the TPB, and TPACK. which were used to understand how the behaviours and attitudes of stakeholders affect primary education Tech-Int. Specifically, PEOU and attitudinal outcomes can be understood in relation to TAM and TPB, and TPACK underscores the pedagogical importance of technology, teaching skills, and content knowledge.

9.3.5 Role of Demographic Factors

Technological access was not affected by sociodemographic fundamentals (i.e., gender, income, and educational level), but stakeholder attitudes were significantly related to perceptions of Tech-Int and use barriers. Interestingly, positive attitudes toward technology were associated with an increase in perceived barriers, suggesting that stakeholders who recognise the value of technology may also be more aware of the challenges in implementing it effectively. Additionally, teaching levels were found to impact TCRs’ confidence and efficacy in Tech-Int.

These findings, as summarised in Table 9.1, deepen our understanding of the effective Tech-Int in primary education and the factors influencing its success. Recommendations were provided to address these challenges and support inclusive technology policies in Scottish primary schools.

Table 9.1: Summary of key findings

Positive Impact on Learning Outcomes
Enhanced engagement, motivation, and cognitive development
Tablets, digital games, storytelling positively affect problem-solving, literacy, and numeracy skills
Stakeholder Attitudes
Teachers, parents, and headteachers held generally positive attitudes
Supporting diverse learning needs
Improving digital literacy
Some gender and generational differences
Challenges and Barriers
Limited resources, insufficient training for educators, online safety concerns
Need improved support systems and training
Influence of Educational Theories
TAM, TPB (perceived ease of use and attitudes on technology adoption)
TPACK (aligning technological, pedagogical, and content knowledge)
Role of Demographic Factors
No significant impact of income level
Significant relationship between stakeholder attitudes and perceived barriers to technology use
Positive attitudes toward technology associated with increased perceived barriers
Teaching levels affected teachers' confidence and efficacy in Tech-Int

9.4 Impact of the Research

The current research has several strengths. Firstly, its mixed-methods approach enabled the researcher to overcome the limitations of using either quantitative or qualitative methods alone. By integrating both methods, the research reflects both quantitative trends and qualitative visions about technology use in primary education. This approach provided inclusive information about stakeholder attitudes and behaviours, barriers, as well as the specific educational impacts of technology use. The methodological triangulation added depth and validity to the findings, offering a well-rounded view of how Tech-Int influences T&L within primary schools.

Secondly, this research is grounded in established educational theories, specifically the TAM, the TPB, and the TPACK framework. By aligning findings with these frameworks, the research's identifies practical trends and additionally situates them within recognised theoretical constructs, which helps in understanding the fundamental attitudes and behaviours regarding Tech-Int. This theoretical grounding enhances the reliability of the findings and contributes to ongoing discussions on Tech-Int in educational research.

Thirdly, this research included a diverse group of key stakeholders (TCRs, TAs, HTs, P/Cs). This inclusive approach offered a complete view of the educational ecosystem, capturing the unique perspectives of each group and revealing how different attitudes and experiences influence TIPS. Unlike earlier studies that tended to focus on specific participant groups in isolation, this research's broad inclusion enables a balanced understanding of both the challenges and successes in technology use, making it relevant to educators and policymakers.

Another notable strength is the research's focus on real-world educational settings. By examining technology use in primary schools across Scotland, the research's findings are grounded in actual classroom and home contexts, adding practical relevance to the results. This focus ensures that the research's recommendations are both applicable and implementation, bridging the gap between theory and practice and offering valuable visions that can inform classroom practices and school policymaking.

Lastly, this research finds key barriers to Tech-Int, such as limited resources, a lack of training, and online safety concerns. By exploring these barriers from multiple perspectives, the research offers implementation insights that educational leaders can use to improve training programs, resource allocation, and support systems for both educators and parents. This practical focus on overcoming barriers enhances the research's relevance, offering concrete steps that can be taken to improve Tech-Int and ultimately support positive learning outcomes.

9.5 Practical Recommendations

This section provides recommendations for Tech-Int in primary schooling, aimed at educational institutions, policymakers, and administrators. The objective is to enhance effective practices and improve technological use in educational settings. The research's findings propose the following recommendations:

9.5.1 Enhancing Training and Support for Technology Use

To fully develop technology in the classroom, TCRs and TAs should receive specialised CPD and classroom training in educational tech use and additional support.

9.5.2 Increase Resource and Device Availability for Technological Infrastructure

Technological hardware and software limitations can be addressed by investing in cost-effective resources and ensuring quality connections to the internet Tech-Int.

9.5.3 Enhancing Stakeholder Engagement in Technology Decision Making

HTs and policymakers should encourage increased participation from stakeholders, particularly families, in the development of technology policies and practices. Improved communication with families may promote a supportive home environment for technology use and ensure consistency in technology-related educational activities.

9.5.4 Encourage Future Research on Technology Policies Across School Types and Locations

The current thesis is not concerned with the comparison of urban and countryside schools or public and private Tech-Int differences, which ought to be investigated by future research, especially with a view to more fair and inclusive policy development, regardless of their school's location or type.

9.6 Limitations and Future Research Directions

The main limitations of this research are outlined below, which can guide future research.

9.6.1 Self-Reported Data

As this research adopted on self-reported data through questionnaires and semi-structured interviews, the findings may be influenced by biases such as social desirability, selective recall, or misunderstanding of questions. Participants may have provided responses they believed were expected or acceptable rather than a fully accurate reflection of their views or practices. These limitations should be considered when interpreting the results. Future research could incorporate complementary methods such as classroom observations, digital usage records, or document analysis to validate and triangulate self-reported data.

9.6.2 Limited Representation of Headteachers

The total sample of 213 participants was generally acceptable, but only eight HTs took part in the questionnaire, followed by three interviewees. This limited representation may restrict the ability to generalise the findings specifically related to HTs' perspectives. Future studies could aim to increase the representation of HTs to offer a more comprehensive view of their experiences and attitudes toward Tech-Int.

9.6.3 Geographical Concentration in Data Collection

Although the research was conducted across Scotland, the majority of survey responses were collected in the Glasgow City Council region. This geographical concentration may affect the quantitative findings and limit the ability to compare Tech-Int across different Scottish regions fully. Future studies could try for broader geographic representation by engaging participants from multiple council areas to enhance generalisability.

9.6.4 Limited Comparison Between School Types and Locations

The lack of detailed analysis of urban-rural or public-private contexts in this research restricts its ability to assess how school location or type may influence Tech-Int. Future studies could expand the framework to include these comparisons, offering a more nuanced understanding of how different school characteristics affect technology use and perceptions.

9.7 Thesis Conclusion

The research started with a detailed review of relevant theories and models in Chapter 3, showing the theoretical framework that guided the research. Key theoretical models such as the TAM, the TPACK, and the TPB were examined to understand how they inform attitudes, behaviours, and competencies related to Tech-Int in Scottish primary education. This theoretical foundation highlighted gaps in the literature regarding stakeholder attitudes, demographic influences, and barriers in primary school contexts. These insights informed the formulation of the research problem, objectives, and guiding question. To address these objectives, a sequential exploratory mixed methods approach was employed across three phases.

Phase 1 involved a systematic literature review to confirm a foundation understanding of Tech-Int's effects, benefits, and challenges in primary education. This review provided foundational insights that helped shape the development of hypotheses, survey questions and further defined the research's scope and framework.

Phase 2 concerned an online quantitative survey distributed to Scottish primary education stakeholders to explore attitudes and experiences concerning Tech-Int and its challenges and advantages, as well as considering sociodemographic factors. The data were analysed using descriptive and statistics analysis by IBM SPSS (v. 28), which helped identify the factors influencing technology use in educational contexts.

Phase 3 involved qualitative semi-structured interviews with headteachers, teachers, teaching assistants, and parents and carers. This phase aimed to delve deeper into the survey findings, providing valuable insights into the real-world challenges, stakeholder efficiency, attitudes, and barriers to Tech-Int. Thematic analysis was used to interpret the qualitative data, adding enriching to the quantitative findings and revealing the underlying factors affecting successful integration. Chapters 5, 6, and 7 presented the results from each phase, while Chapter 8 discussed the integrated findings.

This research found that stakeholder attitudes, demographic factors, and perceived barriers significantly influence the success of Tech-Int in primary education. Positive attitudes were linked with an increased awareness of barriers, suggesting that stakeholders who value technology may also recognise its limitations and challenges.

While income did not show a significant effect on access, educational levels were found to impact teachers’ confidence and efficacy in using technology effectively.

The findings contribute to a deeper understanding of Tech-Int in primary education, offering valuable insights for educators, policymakers, and researchers. The findings emphasise how important to focus on empirical research outcomes in relation to underlying theoretical paradigms, and in the case of this research, this approach has highlighted that stakeholders need specialised support and training for educators and educational policies to know tech-int challenges that include parental consultation to increase equitable access to learning technologies across (the home as well as in the school). These outcomes look to encourage a more theoretically sound, fair, and effective integration of modern learning technologies in Scottish primary schools and primary education in general.

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Appendix A: Survey Questions

Survey 1: Parents/Carers

Part 1: Demographic characteristics

Q1.1 In which council area is your primary school located?

Q1.2 What is your age?

Q1.3 How would you describe your gender?

Male ☐

Female ☐

Transgender ☐

Prefer not to say ☐

Q1.4 What is you're the highest degree or level of education you have completed?

Q1.5 What is your child's age? (years)

4-5	☐	6-7	☐
8-9	☐	10-11	☐
12-13	☐	Prefer not to say	☐

Q1.6 What is your total household income? (GBP per year)

▼ Below £10,000 (4) ... Prefer not to say (9)

<10,000	☐	10,001-20, 000	☐
20,001-30,000	☐	30,001-40,000	☐
>40,001	☐	Prefer not to say	☐

Part 2: Efficiency using technology resources and devices

Please tick the responses that apply.

Q2.1 Do you use technology devices (computer, laptop, tablet etc.) and resources (game-based learning, digital story, E-book etc.) for children educational purposes?

- All lessons
- At least once a day
- At least once a week
- Frequently
- Never

Q2.2 Which technology devices do you prefer to use for teaching children? Please tick all that apply.

- Computer
- Tablet
- Laptop
- Smartphone
- Others ____

Q2.3 Based on your observations, which technological devices do children commonly used for learning? Please tick all that apply.

- Desktop
- Tablet
- Laptop
- Smart phone
- Others ____

Q2.4 For which subjects would children like to use technology for learning?

- Math
- Science
- Reading
- Geography
- History
- Learning Languages
- Others ____

Q2.9 What type of technological resources do children prefer to use for learning?

- Games based learning: Educational video games, gamified learning apps.
- Digital story: Interactive storybooks, digital storytelling.
- E-book: Electronic versions of textbooks or reading materials, interactive e-books.
- Online learning platform: Educational websites, learning management systems (LMS).
- Others ____

Q2.10 How do you perceive the impact of technology on teaching outcomes?

- Negative
- Medium
- Positive

Q2.11 If you have responded to question 2.10, please explain your answer in a few words:

Part 3: Parent/carer beliefs about using technology, sources, and digital devices

Q3. As a parent/carer, technology resources-based education and digital devices provide an environment in which:

	1	2	3	4	5	0
1 = strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, 5 = strongly agree; 0 = no opinion						
1- Children can develop and learn.						
2- Children can explore first-hand experiences while also assisting them in developing and learning via play.						
3- Children are actively involved, and self-motivated.						
4- There is increased understanding and ability to solve problems and understanding.						
5- Children's interactions are increased, enabling them to acquire new skills.						
6- Children can re-enact real-life events for educational objectives.						
7- Complex topics can be more easily understood for children.						
8- Teachers should encourage the use of technology source-based education and digital devices in educational process.						
9- Using educational technology at home, in my opinion, is a combination of fun and utility.						
10- I believe that digital contents limit children's interaction and physical activity, leading to emotional problems and behaviours.						
11- I believe that digital contents are an ineffective way of teaching.						
12- Its design is not in line with the educational content, which causes children to not pay attention to the educational content.						
13- I believe that is good way for entertainment.						

Part 4: Barriers and factors to technology learning

Q4.1 To what extent do you agree with the following statements with regard to barriers when you use technology in your school?

	1	2	3	4	5	0
1 = strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, 5 = strongly agree; 0 = no opinion						
1- Unavailability of designs according to the curriculum content.						
2- I don't have enough experience to using to teach						
3- Negative beliefs about the impact of technology on children have discouraged developing effective digital instructions.						
4- The high cost of designs and device affected their use in the classroom and home.						
5- Lack of courses in technology-related subjects.						

Survey 2: Teachers and Teaching Assistants

Part 1: Demographic characteristics

Q1.1 In which council area is your primary school located?

Q1.2 What is your age?

Q1.3 How would you describe your gender?

Male ☐

Female ☐

Transgender ☐

Prefer not to say ☐

Q1.4 How many years of experience do you have in your current role?

Q1.5 What level are you teaching currently?

- P1
- P2
- P3
- P4
- P5
- P6
- P7
- Prefer not to say

Q1.6 What is you're the highest degree or level of education you have completed?

Part 2: Samples efficiency using technology resource and device.

Q2.1 Have you received any training on how to use technology devices (computer, laptop, tablet etc.) and resources (game-based learning, digital story, E-book etc.) in education teaching?

Yes

No

Q2.2 How did you learn about the use of the following technologies?

	Technology devices (computer, laptop, tablet etc.)	Resources (game-based learning, digital story, E-book etc.)
Self-learning		
Seminars/ conferences/ workshops		
Professional training courses		
School training		
Prefer not to say		

Q2.3 How often do you use technology in a lesson?

- All lessons
- At least once a day
- At least once a week
- Frequently
- Never

Q2.4 Do you use technology devices (computer, laptop, tablet etc.) and resources (game-based learning, digital story, E-book etc.) for children educational purposes?

- All lessons
- At least once a day
- At least once a week
- Frequently

- Never

Q2.5 Which technology devices do you prefer using for teaching children? Please tick all that apply.

- Computer
- Tablet
- Laptop
- Smartphone
- Others ____

Q2.3 How often do you use technology in a lesson?

- All lessons
- At least once a day
- At least once a week
- Frequently
- Never

Q2.4 Do you use technology devices (computer, laptop, tablet etc.) and resources (game-based learning, digital story, E-book etc.) for children educational purposes?

- All lessons
- At least once a day
- At least once a week
- Frequently
- Never

Q2.5 Which technology devices do you prefer using for teaching children? Please tick all that apply.

- Computer
- Tablet
- Laptop
- Smartphone

- Others ____

Q2.6 Based on your observations, which technology devices do children commonly used for learning? Please tick all that apply.

- Desktop
- Tablet
- Laptop
- Smart phone
- Others ____

Q2.7 For which subjects would children like to use technology for learning?

- Math
- Science
- Reading
- Geography
- History
- Learning languages
- Others ____

Q2.8 Which technology resources do you use for teaching in the class?

- Games based learning: Educational video games, gamified learning apps.
- Digital story: Interactive storybooks, digital storytelling.
- E-book: Electronic versions of textbooks or reading materials, interactive e-books.
- Online learning platform: Educational websites, learning management systems (LMS).
- Others ____

Q2.9 What type of technological resources do children prefer to use for learning?

- Games based learning: Educational video games, gamified learning apps.
- Digital story: Interactive storybooks, digital storytelling.
- E-book: Electronic versions of textbooks or reading materials, interactive e-books.
- Online learning platform: Educational websites, learning management systems (LMS).
- Others ____

Q2.10 How do you perceive the impact of technology on teaching outcomes?

- Negative
- Medium
- Positive

Q2.11 If you have responded to question 2.10, please explain your answer in a few words:

Part 3: What teachers and teaching assistants believe using technology source and digital device.

Q3.1 Technology resources-based education and digital devices provide an environment in which:

	1	2	3	4	5	0
1 = strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, 5 = strongly agree; 0 = no opinion						
1- Children can explore first-hand experiences while also assisting them in developing and learning via play.						
2- Children are actively involved, and self-motivated.						
3- Classroom engagement is increased, providing unique learning experiences						
4- Physical, cognitive, emotional, and social skills are activated through technology resource-based education and digital device.						
5- Understanding and ability to solve problems is increased						
6- Children’s interactions are facilitated, enabling them to acquire new skills.						
7- The classroom atmosphere is more enjoyable than traditional methods						
8- Technology resource-based education and digital devices establish an atmosphere in which children can re-enact real-life events for educational objectives.						
9- Complex topics can be made easier to understand for children.						
10-I believe that policy makers should consider introducing technology resource-based education and digital devices in educational process						
11- Digital contents limit children’s interaction and physical activity, leading to emotional and behavioural problems						
12- Digital resources harm instructional content.						
13- Digital contents are an ineffective way of teaching						
14-Design is not in line with the educational content, which causes students to not pay attention to the educational content						

Part 4: Barriers and factors to technology learning

Q4.1 To what extent do you agree with the following statements with regard to barriers when you use technology in your school?

	1	2	3	4	5	0
1 = strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, 5 = strongly agree; 0 = no opinion						
1- Unavailability of designs according to the curriculum content.						
2- I don't have enough experience to using to teach						
3- Negative beliefs about the impact of technology on children have discouraged developing effective digital instructions.						
4- The high cost of designs and device affected their use in the classroom and home.						
5- Lack of courses in technology-related subjects.						

Survey 3: Headteachers

Part 1: Demographic Characteristics

Q1.1 In which council area is your primary school located?

Q1.2 What is your age?

Q1.3 How would you describe your gender?

Male ☐

Female ☐

Transgender ☐

Prefer not to say ☐

Q1.4 How many years of experience do you have in your current role?

Q1.5 What is you're the highest degree or level of education you have completed?

Part 2: Efficiency using technology resource and device

Q2.1 How do you perceive the impact of technology on teaching outcomes?

- Negative
- Medium
- Positive

Q2.2 If you have responded to question 2.1, please explain your answer in a few words:

…………………………………………………………………………………………….

Part 3: What is Headteacher believes using technology source and digital device.

Q.3 To what extent do you agree or disagree to the following points about the educational philosophy of your primary school?

	1	2	3	4	5	0
1 = strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, 5 = strongly agree; 0 = no opinion						
1- Teachers and children prefer to use technology resources to teach and learn.						
2- Technology resources and device are only appropriate for use in your primary school if it reflects the curriculum requirements.						
3- Teachers must attend technology training to become more effective when teaching using technology.						
4- The majority of the teaching staff can use technology resources comfortably.						
5- The high cost is the primary barrier to using technology in your primary school.						
6-The use of technology resources and devices comes with remarkable benefits and is highly encouraged across the primary education continuum.						
7- Keeping pace with the fast-changing technology is cumbersome and unnecessary for teachers in your primary school.						
8- Children in your school generally receive technology resources positively.						
9- Children are more likely to use technology at home than in school.						
10-The adoption of technology in this school is supported by the children’s parents.						
11- The use of technology resources in this school makes teachers uncomfortable.						
12- Most of the teachers in your school feel more positive about using technologies in teaching.						
13-New teachers majorly prefer using technology in teaching.						
14-Education, in the future, will be primarily based on technologies.						

Part 4: Barriers and factors to technology learning

Q4.1 To what extent do you agree with the following statements with regard to barriers when you use technology in your school?

	1	2	3	4	5	0
1 = strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, 5 = strongly agree; 0 = no opinion						
1- Unavailability of designs according to the curriculum content.						
2- I don't have enough experience to using to teach						
3- Negative beliefs about the impact of technology on children have discouraged developing effective digital instructions.						
4- The high cost of designs and device affected their use in the classroom and home.						
5- Lack of courses in technology-related subjects.						

Appendix B: Participant Information Sheet for Interview Participants

Name of department: Computer and Information Sciences

Title of the study: Exploring the Impact of Technology Integration on Teaching and Learning Outcomes in Primary Schools

Introduction

My name is Altaib Alzawam and I'm a doctoral student in the Department of Computer and Information Sciences at the University of Strathclyde.

What is the purpose of this research?

This survey and the subsequent interviews together form an initial investigation into the use of technology on children's ability learning outcomes specifically how this technology is currently used and what attitude participants.

Do you have to take part?

No, participation is voluntary. All participants have the right to withdraw from this research at any point with no repercussions.

What will you do in the project?

This project broken down into two phases. The first step of the process is a survey about the impact of technology on children's education. Completing the survey should take between 15 and 20 minutes.

The second stage is a 25-40-minute interview about your specific experiences, efficiency and what is barriers of technology in primary schools. This interview will take place over the phone or by video on a digital web platform. It could also take place in person. Recordings could be produced in either audio or video format. A separate consent form will be emailed to you in advance, and you will need to sign it and send it back to me before you can take part in the interview. At the beginning of the interview, before I start recording it, I will also orally inquire about the participant's permission to record the conversation. As a token of our appreciation for their participation in the interview process, each interviewee will receive a voucher for a retail store in the amount of 10 pounds.

You are not required to reply to any aspects of the investigation with which you are not comfortable, and doing so would not be required of you.

Who can take part in the project?

All headteachers, teachers, and parents can take part.

What are the potential risks to you in taking part?

The investigation is not expected to pose any health or safety hazards or risks. The research will be conducted online.

What information is being collected in the project?

The survey data will be collected online for anonymously. All of the interviews will have audio recordings taken. Both survey and interview data will be anonymised to reduce identifiability. Only the researcher and his supervisor, listed below, will have access to the data.

Where will the information be stored and how long will it be kept for?

The data obtained during the study of this research will initially be kept on private and protected secure internal university systems. At the end of the research, the anonymized data will be transferred to Pure, which is the research information portal at the University of Strathclyde. On the other hand, the data repository in question will only make a summary of the final data available to the public. Every physical note will be stored safely, and then it will be digitised later. I will be adhering to the guidelines provided by the EPSRC, which state that the data must be kept for a minimum of 10 years.

The University of Strathclyde is registered with the Information Commissioner's Office, which is responsible for enforcing the Data Protection Act of 1998, and all data will be processed accordingly.

Reading our Privacy Notice for Research Participants is also recommended:
(https://www.strath.ac.uk/media/ps/strategyandpolicy/Privacy_Notices_Applicants_and_Potential_Applicants.pdf)

What happens next?

After reading this form, if you are willing to take part in this research project, please click the "Agree" option so that we can get started with the survey.

You are confirming that you are aware that your participation in the study is voluntary and that you are aware that you may choose to cancel your involvement at any time and for any reason.

Researcher contact details:

If you have any further questions about this study, feel free to contact any of the people below:

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Dr Martin Halvey
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Appendix C: Interview Consent Form

Consent Form for Interview Participants

Name of department: Computer and Information Sciences

Title of the study: Exploring the Impact of Technology Integration on Teaching and Learning Outcomes in Primary Schools

I confirm that I have read and understood the Participant Information Sheet for the above project and the researcher has answered any queries to my satisfaction.

- I confirm that I have read and understood the Privacy Notice for Participants in Research Projects and understand how my personal information will be used and what will happen to it (i.e., how it will be stored, and for how long).
- I understand that my participation is voluntary and that I am free to withdraw from the project at any time, up to the point of completion, without having to give a reason and without any consequences.
- I understand that I can request the withdrawal from the study of some personal information and that whenever possible researchers will comply with my request. This includes the following forms of personal data:
  - Video recordings of interviews that identify me;
  - Audio recordings of interviews that identify me;
  - My personal information from survey transcripts.
- I understand that anonymised data (i.e. data that do not identify me personally) cannot be withdrawn once they have been included in the study.
- I understand that any information recorded in the research will remain confidential and no information that identifies me will be made publicly available.
- I consent to being a participant in the project. Yes / No
- I consent to being audio recorded as part of the project. Yes / No
- I consent to being video recorded as part of the project. Yes / No

Date:

Appendix D: Interview Questions

Parents/ Carers

Part 1: General information

Location		Age	
Gender		Level of education	
Level of income		Child's age	

Part 2: Efficiency

1. How do perceive the efficiency of technology in providing diverse learning formats suited to individual children's needs?
2. Can you discuss how view the impact of technology on teaching outcomes, particularly in terms of personalised learning experiences and access to resources?

Part 3: Attitude

1. What are some positive attitudes that are expressed towards the use of technology in enhancing children's engagement with learning?
2. How do parents balance their concerns about the potential drawbacks of technology with their recognition of its benefits in education?

Part 4: Challenges and barriers

1. What challenges do parents identify when it comes to ensuring a balanced use of technology for learning, especially regarding potential distractions and overreliance?
2. How do parents perceive the role of technology in addressing diverse learning needs while also considering challenges like the digital divide and privacy concerns?

Teachers and Teaching Assistants

Part 1: General information

Location		Age	
Gender		Years of experience	
		Current teaching level	

Part 2: Efficiency

1. How do you perceive the role of technology in facilitating different learning formats tailored to children's individual needs?
2. In what ways do you believe technology can enhance children's engagement with learning, particularly through gamification and interactive elements?

Part 3: Attitude

1. Could you share your insights on the potential advantages and disadvantages of introducing technology as a learning tool at a young age?
2. What are your thoughts on the balance between technology-based learning and traditional methods, such as pen-and-paper activities, especially concerning children's attention spans and focus?

Part 4: Challenges and barriers

1. How do you navigate the challenges of ensuring responsible and productive use of technology among children, considering its potential for both positive and negative impacts on their learning experiences?
2. In your experience, what challenges do you encounter when using technology in the classroom, such as distractions or potential for misuse, and how do you address these challenges effectively?

Headteachers

Part 1: General information

Location		Age	
Gender		Years of experience	

Part 2: Efficiency

1. How do you assess the impact of technology integration on teaching effectiveness and student outcomes in your school?

2. What strategic priorities do you envision for further advancing technology integration and digital learning in your school?

3. Looking ahead, how do you plan to change to emerging technologies and trends in primary education?

Part 3: Attitude

1. What is your vision for technology integration in your primary school?

2. How do you involve parents and the wider school community in discussions and decisions related to technology integration?

Part 4: Challenges and barriers

1. How do you support and empower teachers to effectively integrate technology into their teaching practices?

2. What strategies or ideas have you implemented to ensure fair access to technology resources among students?

3. What challenges have you met in leading technology integration efforts, and how have you addressed them?

Appendix E: Systematic Review Data Extraction Table

(Overleaf)

Author & year	Title	Subject	Type device	Type resources	Sample size	Country	Issues addressed by the researchers	Method
Tsai *et al*. (2012)	Exploring the factors influencing learning effectiveness in digital game-based learning	Mathematics & science	Computer lab	Game based learning	8 sixth-grade students	Taiwan	Why differences in the effectiveness of knowledge acquisition existed among the study participants.	Experimental Without (no randomization group)
Conclusions/ implications: Many variables have been found to interactively affect the performance of DGBL learning by students. The encouragement of students' learning, desire to learn and play skills may be main factors affecting the efficacy of the DGBL acquisition. In addition, the desire to play, previous knowledge and online gaming experiences respectively influenced students' cognitive development and learning skills. The findings of this study will allow teachers to evaluate how to use an education game to increase the efficacy of the DGBL learning of students.								
Vanbecelaere *et al*. (2020)	The effects of two digital educational games on cognitive and non-cognitive math and reading outcomes	Mathematics and reading	Tablet	Digital educational games	336 first graders	Belgium	Multiple questions about the effectiveness of educational games with respect to cognitive and non-cognitive effects remain unclear	Quasi-experiment with 336 first graders with randomised control trial
Conclusions/ implications: The findings showed that children who were involved in playing games had better reading and number line estimation skills. On the other hand, for digital comparison, letter awareness and math ability, no major differences were noticed								
Kiili and Ketamo (2018)	Evaluating cognitive and affective outcomes of a digital game-based math test	Mathematics	Tablet	Web-based application	51 sixth graders	Finnish	This paper aims to explore if a game-based math test can provide added value to math education with respect to cognitive and affective outcomes	Experimental study Without (no randomization group)
Conclusions/ implications: The findings show that test scores related to game-based performances were substantially associated with papers-based test scores, which suggested that the game-based evaluation was successfully carried out and comparable data was generated with the paper-based test method. More significantly, the findings indicate that game-based evaluation lowered academic stress and increased dedication that is likely to minimise test anxiety bias. Furthermore, the results indicate that previous experience in gaming and gender differences did not affect the game test results, which suggest that the game evaluation methodology was fair.								
Huang, Kuo and Chen (2020)	Applying digital escape rooms infused with science teaching in elementary school: learning performance, learning motivation, and problem-solving ability	Science teaching	Tablets		40 students from fourth-graders	Taiwan	Investigate the effect of digital escape room on students' learning performance, a teaching approach involving a digital escape room (DER) was introduced into science teaching	Quasi-experimental approach with control group (no randomization)
Conclusions/ implications: The research indicated that participants in the experimental group had greater inclination for developing problem solving skills than those in the comparative group. Both classes, however, had the same scientific standard of learning success. Overall, the students viewed the DER experience favourably and found the DER teaching technique to be convincing and successful. Finally, recommendations based on the findings of this research are given for improving teaching experience and guiding future research.								

Author & year	Title	Subject	Type device	Type resources	Sample size	Country	Issues addressed by the researchers	Method
Outhwaite, Gulliford and Pitchford (2017)	Closing the gap: efficacy of a tablet intervention to support the development of early mathematical skills in UK primary school children	Mathematical	Tablet	App	133 pupils aged 4–7 years	UK	Efficacy of a tablet intervention to support the development of early mathematical skills	Experimental study without randomize trail
Conclusions/ implications: The findings indicated significant, apparent, and continuous learning benefits after the intervention, especially for children who have been identified as poor performers. The first language or socio-economic status of the child was not important, but students with weak memory abilities showed stronger acquisitions. Overall, these conclusions suggest that if software is age-appropriated and well-designed, tablet technology may offer a form of customised effective support for early mathematical growth. Repeated interactive apps can help lower cognitive task demands that can be of particular benefit to low-income individuals and can help to bridge the gap from the very beginning of primary school for early mathematical learning potential.								
Bakker, van den Heuvel-Panhuizen and Robitzsch (2015)	Effects of playing mathematics computer games on primary school students' multiplicative reasoning ability	Mathematics	Computer	Game	719	Netherlands	Investigate the effects of a mini-games intervention when implemented as part of the regular educational practice.	Experimental study. With randomised control trial
Conclusions/ implications: Path analyses revealed that the mini-games in the Ehome school were most successful, where both the abilities and insight of the students were affected positively unlike control group (considerable ds ranged from 0.22 to 0.29). The effect was only observed in Grade 2 (d = 0.35) in the Eschool condition, although no substantial effects were observed in the Ehome students was correlated to their learning performance.								
Partovi and Razavi (2019)	The effect of game-based learning on academic achievement motivation of elementary school students	Academic achievement motivation	Computer	Game based learning	60 students	Iran	The effect of game-based learning on academic achievement motivation of elementary school students	Semi-experimental design (with randomised control trial)
Conclusions/ implications: The findings demonstrate the need for primary school students to use computer-based games. Consequently, a more fitting position must be sought in the regular curriculum for teachers. The findings of this study will benefit educators, game developers, instructional designers and researchers from design, implementation and research angles.								
Ninaus *et al*. (2017)	Assessing fraction knowledge by a digital game	Numerical learning	Tablet	Digital game	54, fifth grade classes	Finnish	Investigated whether game-based approaches may not only be useful to foster numerical learning but may also be valid as an assessment tool.	Experimental without randomised control trial)
Conclusions/ implications: Findings suggested that the characteristic effects of fractional magnitude processing usually found in basic science like the numerical distance effect were effectively reproduced using game-based evaluation. In addition, the success of fraction comparison and the accuracy of fraction estimates have greatly correlated with the maths of students. The findings of the present study, therefore, indicate that game-based classroom activities may also facilitate a fair assessment of the students' fractional awareness (even through the use of Tilt Control).								

Author & year	Title	Subject	Type device	Type resources	Sample size	Country	Issues addressed by the researchers	Method
Ke (2016)	Computer-game-based tutoring of mathematics	Mathematics	Computer	Games based learning	Sixty-four grade 6–8 students were recruited from the two schools	US	The potential of implementing computer mathematics games as an anchor for tutoring of mathematics	Mixed-method, descriptive case study approach (Yin, 2008)
Conclusions/ implications: Findings have shown that tutoring is diverse in initiation, timing, material, and teaching style. The State Test Performance was increased in the pueblo school following the game-based tutoring programme, but statistically the change in urban school was not important. The study can be a catalyst for understanding and further analysis by using online games as an instructional tool to improve other teaching approaches.								
Nizam and Law (2020)	Derivation of young children's interaction strategies with digital educational games from gaze sequences analysis	Interaction	Mobile device	Educational Games	94 five-year-olds	UK	To what extent does the learning effect of a DEG on numeracy differ from its physical (cardboard) Version?	Experimental without control
Conclusions/ implications: The findings indicated a slight difference in learning potential between the cardboard and online games. Similarly, it was found that the interactive methods for children varied considerably against their level of achievement. Moreover, the gender of children was not an important factor in assessing the influence of DEG learning. Implications are developed for child friendlier eye monitoring technologies and degas for young children.								
Vasalou *et al*. (2017)	Digital games-based learning for children with dyslexia: a social constructivist perspective on engagement and learning during group game-play	Words Matter	Tablet	Game Words Matter	Eight children (4 male, 4 female) in Year 6 (aged 11e12 years old) participated	UK	The present research is an instrumental case study with the goal to inform the theoretical relationship between social interaction, game design, engagement and learning	Case study
Conclusions/ implications: The study showed that students spontaneously talk about the performance, behaviour's, content, and experiences of the game. Although this talk of the game offers a clear sense of social commitment and playfulness, it also provides a number of new learning experiences through sparking tutors and student-initiated interventions. Along with the social theoretical approach to interactive gaming-based learning, the paper also explores the game-based social experiences, and the decisions made in the context of the game design.								
Schenke *et al*. (2020)	Does "measure up!" Measure up? Evaluation of an iPad app to teach pre-schoolers measurement concepts	Mathematics		Digital app	Ninety-nine 4- and 5-year-old children	US	Understanding digital supports for early learning is paramount for school readiness and later mathematics learning.	Experimental study with randomised control trial
Conclusions/ implications: Analyses demonstrated a highly significant impact on post test scores (about two more questions correct), pre-test testing, and demographic feature controls (gender, SES) in the treatment community (Measure up! Or Measure up! Ms Super Vision). In particular, the perception of pan balance by children has been gained. Between the two treatment classes, no substantial difference was found. The findings suggest that applications can be built to help children develop essential mathematical skills. Implications of game-based learning instruments assessment and design have been discussed.								

Author & year	Title	Subject	Type device	Type resources	Sample size	Country	Issues addressed by the researchers	Method
Yamaç and Ulusoy (2016)	The effect of digital storytelling in improving the third graders' writing skills	Writing skills	Computers	Digital storytelling	The number of the participants was 26 (16 female and 10 male students).	Turkey	Investigate the effects of digital storytelling in improving the writing skills of third grade students enrolled in rural primary schools.	Interviews
Conclusions/ implications: The findings revealed steady improvement in digital elements, as well as in technical literacy and student competency. In addition, digital telling improved the narrative writing process and became a valuable method to break the digital gap by enhancing understanding of literacy skills and abilities. The digital narrative also built learning communities by improving connections among classroom students and enhancing their writing motivation.								
Richter and Courage (2017)	Comparing electronic and paper storybooks for pre-schoolers: attention, engagement, and recall☆	Readings	Tablet	E-books and storybooks	79 participants 3- to 5-year-olds	Canada	How Does preschool children's engagement in a traditional paper storybook compared to their engagement in a story read from an e-book? How does reschool children's recall of story information read from a traditional paper book compared to their recall of information presented in an e-book?	Experimental Without randomized
Conclusions/ implications: Results revealed that (1) almost double time duration took e-book for completion, (2) attention level of students was higher with e-book, (3) during e-book, students communicated more about the device, whereas for paper boo, they communicated more about the story, (4) by format, no difference in recall was found, (5) as compared to age, executive functioning strongly predicted storey recall and attention. Moreover, there has been a discussion on the cognitive theory of multimedia.								
Korat (2010)	Reading electronic books as a support for vocabulary, story comprehension and word reading in kindergarten and first grade	Language	Computer	Electronic storybook (e-book	90 children from ten classes	Israeli	Reading electronic books as a support for vocabulary, story comprehension and word reading in kindergarten and first grade.	Experimental With randomize control
Conclusions/ implications: In terms of word sense and word reading, as compared to the control group, children reading the e-book made substantial improvement. Children from kindergarten improved dramatically in word reading in separate care groups rather than first graders. Ceiling effect of the 1st graders can explain it better in contrast to the kindergarten children who did not provide much space for improvement in this area. There has been no correlation between age and treatment classes. Children in the kindergarten had a strong understanding of the past, just like first graders, but their performance of the story was lower. Implications for education and future research have been explored.								

Author & year	Title	Subject	Type device	Type resources	Sample size	Country	Issues addressed by the researchers	Method
Domingo and Garganté (2016	Exploring the use of educational technology in primary education: teachers' perception of mobile technology learning impacts and applications' use in the classroom	Educational technology	Mobile Application	Application	102 teachers of 12 different primary schools	Spain	Less is known about teachers' perceptions of how mobile technology impacts in learning and its relation to Applications (Apps) use in the classroom	Survey data
Conclusions/ implications: Findings also indicate that teachers' views of the influence of mobile technology on students' learning potential contribute to the selection of the applications. Findings could assist teachers in making the best use of the combination of mobile devices and software to enhance some learning practice aspects.								
Gjelaj *et al*.2020),	Digital technologies in early childhood: attitudes and practices of parents and teachers in Kosovo	Preschool teachers' and parents' attitudes	___	____	8 preschool teachers	Kosovo	Investigate preschool teachers' and parents' attitudes and practises towards the use of digital technologies in early childhood education	Mix research approach: Interviews and an online questionnaire
Conclusions/ implications: Parents and teachers have contradictory views on the use of digital technologies in young children's learning and development, requiring continuous cooperation to maximize benefits and mitigate risks.								
Hsu *et al*. (2017)	Surveying in-service teachers' beliefs about game-based learning and perceptions of technological pedagogical and content knowledge of games		----------	Games based learning	316 teachers	Taiwan	This study investigated 316 Taiwanese in-service teachers' teaching beliefs about game-based learning and their perceptions of game-based pedagogical content knowledge (GPCK).	Questionnaires
Conclusions/ implications: The findings show that GPK plays a key role in the prediction of GPCK among the GTBS and TPACK-G factors. Moreover, teachers of the elementary school level had a greater confidence, belief and inspiration to use GPK and GPCK as compared to the middle school level teachers. Only in GK there was a gender gap. Younger teachers' GK and GCK were more than the older teachers. In contrast to experienced teachers, inexperienced teachers have always assumed that digital games can help learning and training in their TPACK-G and have seen greater self-efficacy.								

Author & year	Title	Subject	Type device	Type resources	Sample size	Country	Issues addressed by the researchers	Method
Hwang, Wu and Ke (2011)	An online game approach for improving students' learning performance in web-based problem-solving activities	Natural science course	Computer	Online game	Fifty students	Taiwan	Can the proposed online game approach promote students' learning attitudes toward science learning?	Experimental With out randomly control
Conclusions/ implications: The research results indicated that the suggested method not only substantially promoted students' learning interest, learning attitudes, flow experience, and acceptance of technology, but also allowed them to better learn in the internet-based problem-solving exercise.								
Hussein *et al*. (2019)	"A digital game-based learning method to improve students' critical thinking skills in elementary science," 2	Science	Computer	Game based learning	127 fifth-grade	Malaysia.	Experiment conducted to investigate instructional benefits on learners' critical thinking, motivation, and self-efficacy.	A quasi-experiment with control group (no randomization)
Conclusions/ implications: Ecoship Endeavour improved critical thinking skills, but DGBL activity had no effect on learning motivation and self-efficacy. More research is needed to evaluate its effectiveness.								
Smeets and Bus (2015)	The interactive animated e-book as a word learning device for kindergartners	Language	Computer	E-book	A sample group of 136 4- and 5-year-old kindergarten children	Netherlands	This study was designed to examine whether these additional elements aid word learning and story comprehension and whether effects cumulate making the animated e-book that also includes hotspots the most promising device.	Experimental with randomized control trial
Conclusions/ implications: The objective language originating in the narrative has found significant therapeutic effects. After students read interactive animated e-books, followed by non = interactive animated e-books and then static e-books, their vocabulary improvement was really significant. However, for storey comprehension, e-books did not turn out to be much useful. Results indicate that e-storybooks are valuable add-ons for the interactive animated e-book-based classroom curriculum.								
Tetourová *et al*. (2020)	To solve or to observe? The case of problem-solving interactivity within child learning games.	Biological topic		Game-based learning	Children aged 8–10 years	Czech	Explored whether problem-solving interactivity within an instructional game foster learning for children	Experimental with Randomized control trial
Conclusions/ implications: The findings indicate that interactive and non-interactive interventions are effective but can vary based on the learning environment (e.g., school vs. Home).								

Author & year	Title	Subject	Type device	Type resources	Sample size	Country	Issues addressed by the researchers	Method
Imlig-Iten and Petko (2018)	Comparing serious games and educational simulations: effects on enjoyment, deep thinking, interest and cognitive learning gains	Engagement and cognitive learning	---------	Serious games And educational simulations:	Twelve primary school classes with 153 students from 9 to 12 years of age	Switzerland	Explore learner engagement as well as on cognitive learning with regard to digital serious games.	Experimental With Randomized control trial
Conclusions/ implications: Results did not reveal any variations in the category of tested gains or self-reported benefit or a rise in the interest in learning. Even though no differences in reading enjoyment level for found, deeper learning was higher for serious games. It was also found that while knowledge after testing is only based on previous knowledge, independent interest gains and cognitive learning gains are both positively associated with enjoyment and deep learning. These findings indicate that serious games-based learning is not supposed to always lead to the anticipated increases in interaction and learning outcomes in all aspects. Research must therefore deal more thoroughly with the interplay of game elements and their effect on interaction and learning.								
Zapata-Cáceres and Martín-Barroso (2021)	Applying game learning analytics to a voluntary video game: intrinsic motivation, persistence, and rewards in learning to program at an early age	Learning to program at an early age	Tablet8	Game-based environment that is both a Learning	3 to 12 years-old players 4124 sample	-----------------	Learning to program at an early age helps develop Computational Thinking but lacks voluntary assessment of intrinsic motivation such as interests, skills, persistence in solving a problem and behaviour in response to rewards.	Experimental without randomized control trial
Conclusions/ implications: Age and gender differences in interests, skills, achievement, and progression through attempts were observed, with concepts achievable between 3 and 6 years and full mastery by 4 years, regardless of gender.								

Author & year	Title	Subject	Type device	Type resources	Sample size	Country	Issues addressed by the researchers	Method
Hsu *et al*. (2020)	Probing in-service elementary school teachers' perceptions of tpack for games, attitudes towards games, and actual teaching usage: a study of their structural models and teaching experiences	Attitudes towards games, and actual teaching usage: a study of their structural models and teacher experiments	------	Games	376 in-service teachers in Taiwan	Taiwan	Investigate differences in junior and senior (categorised by their years of teaching experience) elementary School teachers' perceptions of the Technological Pedagogical Content Knowledge – Games (TPACK-G), attitudes towards game, and actual teaching usage.	Questionnaire
Conclusions/ implications: Results also indicated that junior teachers were usually higher than the seniors for GK, GCK and GPCK. If we talk about GK alone, it might not be enough to reflect the actual use of teachers. The junior teachers could rely on their GPCK to evaluate the actual use of teachers, while the seniors could depend on GPK.								
Martín del Pozo *et al*. (2017)	A quantitative approach to pre-service primary school teachers' attitudes towards collaborative learning with video games: previous experience with video games can make the difference	Attitudes towards collaborative learning with video games			193	Spain	Increasing interest has been shown in using video games. However, Their use in schools is still far from mainstream practice,	Questionnaire
Conclusions/ implications: Generally, teachers at pre-service are optimistic regarding collaboration of learning experiences with the use of video games that may influence the usage of these tools in education. In order to achieve the goal of the education system, that is, the complete development of children, children and teachers must be receptive to the new experience as a key change in the education process.								
Remillard *et al*. (2021)	Elementary teachers' reflections on their use of digital instructional resources in four educational contexts: Belgium, Finland, Sweden, and US.	Mathematics			39 elementary school teachers	Belgium, Finland, Sweden, And U.S.	Examine teachers' reflections on incorporating digital instructional resources (dirs) into their mathematics teaching	Analyse qualitative interviews
Conclusions/ implications: Teachers use dirs to support student practice, but few transform learning spaces. dirs can be used to stimulate change by understanding current practices and identifying potential levers to support change.								

Author & year	Title	Subject	Type device	Type resources	Sample size	Country	Issues addressed by the researchers	Method
Li *et al*. (2015)	How and why digital generation teachers use technology in the classroom: an explanatory sequential mixed methods study	Attitudes toward technology and challenges of integrating technology to teaching.	----	-------	Seventy-one student teachers	US	Aimed to examine the current technology usage of digital generation student teachers and the impact of possible internal and external barriers (such as self-efficacy, risk taking, and technology access and support) On their use of technology	L mixed methods Research
Conclusions/ implications: Digital generation student teachers' use of technology in the classroom was correlated with self-efficacy, computer skills, and technology access and support, but not risk taking.								
Kucirkova and Flewitt (2022)	Understanding parents' conflicting beliefs about children's digital book reading	Reading	--------	Digital book	Seven families	UK	Understand parents' views on children's digital book reading	Focusing on the interview
Conclusions/ implications: Parents' views about digital book features are entangled with their social perceptions of the value of digital reading, with conflicting themes of trust/mistrust, agency/dependency and nostalgia/realism.								
Ayten and Polater (2021)	Values education using the digital storytelling method in fourth grade primary school students	Values education	---------	Digital Storytelling	31 students Fourth grade	Turkey	The present study aims to investigate the use of digital storytelling method in values education in primary school fourth grade	Case study design
Conclusions/ implications: Students developed technology and story writing skills, but experienced difficulties due to lack of equipment.								
Al-Abdullatif (2022)	Towards digitalization in early childhood education: pre-service teachers' acceptance of using digital storytelling, comics, and infographics in Saudi Arabia.	Pre-Service Teachers' Acceptance of Using Digital Storytelling,	-------	Digital Storytelling,	102 pre-service teachers	Saudi Arabia	Investigate early childhood Pre-service teachers' intentions to use digital technology as teaching tools.	A quantitative approach using a descriptive correlational design
Conclusions/ implications: Investigate early childhood Pre-service teachers' intentions to use digital technology as teaching tools. Pre-service teachers' attitudes and perceived usefulness are key predictors of their intentions to use digital storytelling, comics, and infographics in their future classrooms.								

Author & year	Title	Subject	Type device	Type resources	Sample size	Country	Issues addressed by the researchers	Method
Aldhafeeri, Palaiologou and Folorunsho (2016)	Integration of digital technologies into play-based pedagogy in Kuwaiti early childhood education: teachers' views, attitudes and aptitudes	Teachers' views, attitudes and aptitudes	------	Digital technology	195 teachers	Kuwait	Investigation in an attempt to understand how teachers are Positioning themselves in terms of a play-based pedagogy and Digital technologies.	Questionnaire
Conclusions/ implications: The key findings demonstrated that although the Kuwaiti teachers are competent users of digital technologies in their personal lives and the Kuwaiti classrooms have been digitalised to a large extent, the teachers are still hesitant in embedding these in their curriculum practices.								
Cakir (2012)	Technology integration and technology leadership in schools as learning organizations	Technology Integration and Technology Leadership in Schools	-----	-------	38 school administrators 35 computer teachers	Turkey	Investigate technology integration in primary schools from the perspective of leadership in learning organizations.	Questionnaire
Conclusions/ implications: The questionnaire results indicated that while administrators generally had a positive attitude toward technology, they provided negative responses to certain items. Similarly, although teachers are familiar with Web 2.0 technologies, only a few consider using them in the classroom.								
Ertmer *et al*. (2012	Teacher beliefs and technology integration practices: a critical relationship	Teacher beliefs and technology integration practices	-----	---------	12 teachers	US	"How do the pedagogical beliefs and classroom technology practices of teachers, recognized for their technology uses, align?"	Multiple case-study +interviews
Conclusions/ implications: The study found that student-cantered beliefs are the foundation of practices like authenticity, student choice, and collaboration. Teachers who hold these beliefs tend to apply student-cantered curricula, even when faced with obstacles such as technological, administrative, or assessment challenges. Additionally, internal factors and external support play a role in shaping their practices. Barriers to using technology include prevailing attitudes and levels of knowledge.								

Appendix F: Summary of Main Findings from Chapter 6

Part 1: Demographic Data

Category	Key Finding
Response Rate	Total valid responses: 212 (57% completion rate)
	Largest representation: Glasgow City Council (21.7%)
Role Distribution	Parents/Carers (P/C): 74.1% dominate the sample.
	Teachers (TCR): 14.6%, Teaching Assistants (TA): 7.5%, HT: 3.8%.
Age Distribution	Median age: 41 years (range: 22–76).
	Largest age group: 40–49 years (33.96%).
Gender	Male: 42.9%, Female: 57.1%.
Educational Levels	Advanced degrees (Master's/Doctorate): 52.35% overall
	High representation of professional degrees among TCR (16.12%)
Income Levels (P/C)	Majority reported income above £40,001 (63.1%)
	21.1% preferred not to disclose income
Years of Experience	1–5 years: 29.1% in teaching roles
	Over 20 years: 20.0% in teaching roles.
Child's age (years) & level teaching	6-7 years: 26.1% & P1: 23.07%

Part 2: Efficiency in Using Technology

Category	Key Finding
Training on Technology Use	78.7% of teaching staff received technology training (TCR: 87.1%, TA: 62.5%).
Sources of Learning Technology	Most used: Self-learning (74.5%), followed by seminars/conferences (29.8%) and school training (29.8%)
Frequency of Technology Use	TCR/TA: At least once a day (40.4%) or all lessons (25.5%).
	P/C: At least once a day (36.3%), frequent use (29.9%).
Preferred Devices for Teaching	Tablet is the most favoured device in schools (TCR/TA: 37.0%) and homes (P/C: 48.8%).
technological devices do children commonly use for learning	Tablet is the most favoured device in schools (TCR/TA: 47.6%) and homes (P/C: 45.6%).
Preferred Technological Resources	Most popular: Games-based learning (TCR: 34.7%, P/C: 42.4%)
Subjects for Technology-Assisted Learning	Math and Science are the top subjects for both TCR/TA (Math: 70.2%, Science: 68.1%) and P/C (Math: 82.2%, Science: 59.9%).
Impact of Technology on Teaching Outcomes	Generally positive impact: HT: 75%, TCR/TA: 59.6%, P/C: 47.8%

Part 3: Attitudes Toward Technology Use

Perspective Holders	Key Finding
Parental (P/C)	General agreement on positive impact of technology on learning (mean = 3.91, WM = 74.44)
	Strongest agreement: Children can develop and learn (WM = 86)
	Moderate concerns: Digital content limits interaction (WM = 57.8, item 10) and is ineffective (WM = 42.6, item 11)
TCRs and TAs	General agreement on Positive impact of technology on learning (mean = 3.77, WM = 75.4)
	High agreement on facilitated interactions and skill acquisition (WM = 98.0, item 6)
	Moderate concerns: Design and limitations of digital content (WM = 62.2, item 14).
HTs	General agreement on benefits of technology (mean = 3.64, WM = 72.8).
	Strongest agreement: Children receive technology positively (WM = 95.0, item 8).
	Moderate challenges: discomfort among teachers (WM = 57.4, item 11)
General Observations	All groups recognize the positive role of technology in learning environments
	Common concerns include cost, design, and discomfort in using technology effectively

Part 4: Barriers and Challenges Toward Technology Use

Perspective Holders	Key Finding
Parental (P/C)	Overall barriers rated as moderate (mean = 3.15, WM = 63.06).
	Top Barrier: High cost of technology and devices (WM = 71.54, item 4).
	Other Challenges: Lack of curriculum-aligned designs (WM = 66.42, item 1) and limited experience (WM = 51.67, item 2).
TCRs and TAs	Barriers seen as significant challenges (mean = 3.52, WM = 71).
	Top Barrier: High cost of designs and devices (WM = 82.6, item 4).
	Other Challenges: Lack of training courses (WM = 77, item 5) and limited curriculum-aligned designs (WM = 71 item 1).
HTs	Barriers seen as significant challenges (mean = 4.04, WM = 81.76).
	Top Barrier: Lack of courses in technology-related subjects (WM = 88.6, item 5).
	Other Challenges: High costs (WM = 88.6, item 4) and unavailability of curriculum-aligned designs (WM = 85.8, item 1).

Statistical Analysis (TCRs and TAs)

Hypothesis	Key Results	Statistical Test Used
Reliability of Scales	Attitude scale: Cronbach's α = 0.728, good internal consistency. Barriers scale: Cronbach's α = 0.651, acceptable.	Cronbach's Alpha
Attitudes Toward Technology	Mean: 3.71, indicating a moderately positive perception.	Descriptive Statistics (Mean, Median, CI)
Perceptions of Barriers	Mean: 3.517, showing moderately positive attitudes but with variability.	Descriptive Statistics (Mean, Median, CI)
H1: "Negative correlation between tech-based learning and perceived barriers"	Result: Positive correlation (r = 0.305, p = 0.037). Higher tech engagement correlates with greater perceived barriers.	Pearson Correlation Analysis
H2: "The average role of tech-based learning environments differs among groups with positive, negative, and medium perceptions of technology's impact"	Result: Significant differences (F = 3.996, p = 0.025). Group differences account for 15.4% of variance (Eta-squared = 0.154)	ANOVA
H3: Differences in education levels across teaching levels	Result: Significant association (Chi-square = 65.061, p = 0.013), though small, expected counts affected validity	Chi-Square Test
H6: Higher education levels reduce perceived barriers	Result: No significant differences (F = 1.459, p = 0.217). Moderate effect size (Eta-squared = 0.18)	ANOVA
H7: Gender differences in perceptions of technology's role	Result: Significant difference (t = 3.043, p = 0.004). Moderate effect size (Cohen's d = 0.881).	Independent Samples t-Test
H8: Gender differences in perceived barriers	Result: No significant difference (t= .314, p = 0.755). Small effect sizes (Cohen's d = 0.092)	Independent Samples t-Test
H9a: Average age of TCRs differs by teaching level	Result: No significant differences (F = 2.090, p = 0.068). Minimal practical significance (Eta-squared value = 0.273).	ANOVA

Statistical Analysis of Parents and Carers (P/Cs)

Hypothesis	Key Results	Statistical Test Used
Reliability of Scales	Attitude scale: Cronbach's α = 0.734, good internal consistency. Barriers scale: Cronbach's α = 0.737, acceptable.	Cronbach's Alpha
Attitudes Toward Technology	Mean: 3.72, indicating a moderately positive perception.	Descriptive Statistics (Mean, Median, CI)
Perceptions of Barriers	Mean: 3.18 indicating a moderately positive perception.	Descriptive Statistics (Mean, Median, CI)
H1: Negative correlation between tech-based learning and perceived barriers	Result: **Positive correlation** (r = 0.251, p = 0.022). Higher perceptions of technology's role associate with greater perceived barriers	Pearson Correlation Analysis
H2: The average role of tech-based learning environments differs among groups with positive, negative, and medium perceptions of technology's impact	Result: **Significant differences** (F = 16.477, p < 0.001). Group effects account for 18% of variance (Eta-squared = 0.180).	ANOVA
H4: Higher income levels reduce perceived barriers	Result: **No significant differences** (F = 0.004, p = 0.996). Effect size near zero.	ANOVA
H5: Relationship between income levels and tech-based learning role	Result: **No significant differences** (F = 2.313, p = 0.102). Small effect size (Eta-squared = 0.030).	ANOVA
H7: Gender differences in perceptions of tech-based learning	Result: **No significant differences** (t = -1.013, p = 0.313). Small effect sizes (Cohen's d = -0.174).	Independent Samples t-Test
H8: Gender differences in perceptions of barriers	Result: No significant differences (p = 0.075). Small to moderate effect sizes (Cohen's d = -0.400).	Independent Samples t-Test
H9: Relationship between child's age group and parent's age	Result: Significant association (Chi-square = 232.998, p = 0.010). Moderate correlation (Pearson's R = 0.395).	Chi-Square Test

Statistical Analysis of Headteachers (HTs)

Hypothesis	Key Results	Statistical Test Used
Reliability of Scales	Attitude scale: High reliability (Cronbach's α = 0.819). Barriers scale: Moderate reliability (Cronbach's α = 0.530).	Cronbach's Alpha
Attitudes Toward Technology	Mean =3.64 indicated moderately positive attitude	Descriptive Statistics (Mean, Median, CI)
Perceptions of Barriers	Mean=3.51 indicated moderate barriers	Descriptive Statistics (Mean, Median, CI)
H1: Negative correlation between tech-based learning and perceived barriers.	Result: A positive correlation exists between perceptions of technology's role and barriers ($r = 0.552$), but this was not statistically significant ($p = 0.198$).	Pearson Correlation
H2: The average role of tech-based learning environments differs among groups with positive, negative, and medium perceptions of technology's impact"	No significant group differences were observed in perceptions of technology's role ($F = 0.035$, $p = 0.860$). eta-squared value is very low at 0.009	ANOVA
H3a: Differences in Perceptions by Experience	Pearson Chi-square: 4.667, $p = 0.323$. likelihood Ratio: 6.904, $p = 0.141$. Linear-by-Linear Association: 1.036, $p = 0.309$.	Chi Square
H6: Differences in Barriers Based on higher Education levels.	While not statistically significant ($F = 4.521$, $p = 0.094$), a large effect size (eta-squared = 0.693) suggests potential differences in barriers based on education level.	ANOVA
H7: Gender differences in perceptions of tech-based learning.	No significant gender differences were observed in perceptions of technology's role ($t = 0.583$, $p = 0.586$, Cohen's $d = 0.413$).	Independent Samples t-Test
H8: Gender differences in perceptions of barriers.	No significant gender differences were found in barriers ($t = 0.983$, $p = 0.395$), though effect sizes suggest minor practical impacts (Cohen's $d = 0.639$)	Independent Samples t-Test

Appendix G: Examples of Manual Coding of Interview Extracts

Parents/ Carers

Part No	Data Item	Themes	Sub-Themes
2: Efficiency	Participant 1: "iPad enhances engagement through interactive activities." Participant 2: "Technology motivates a dyslexic child by using text-to-speech and interactive apps." Participant 5: "Educational games like Sumdog make learning fun and interactive, which keeps the child interested in math and other subjects."	Engagement and Motivation.	1. Interactive Tools. 2. Motivation 3. Understanding. 4. Fun Learning Methods.
	Participant 1: "Importance of learning basic IT skills on laptops." Participant 3: "Use of smartphones and computers develops IT knowledge." Participant 5: "Technology-based homework supports various types of learners and teaches problem-solving skills independently."	Skill Development.	1. Basic IT Skills. 2. Critical Evaluation. 3. Problem-Solving Skills.
	Participant 2: "Technology tools like text-to-speech software improve accessibility for a dyslexic child, making learning less intimidating and more adaptive." Participant 4: "Apps that provide information about different places in the world offer accessible content that broadens a child's learning experiences."	Accessibility.	1. Adaptive Learning. 2. Tools Interactive Experiences.
	Participant 2: "Platform aligning with the local curriculum to track progress and local curricula to enhance the relevance and effectiveness of learning" Participant 4: "Real-world simulations and interactive learning opportunities." Participant5: Integration of technology in homework to enhance learning.	Content and Curriculum Integration.	1. Curriculum Alignment. 2. Practical Learning. 3. technology-based homework.

Part No	Data Item	Themes	Sub-Themes
	Participant 3: "Teaching children to critically evaluate online information."	Critical Thinking and Information Literacy.	1. Evaluating Information.
3: Attitude	Participant 1: "Technology makes learning more fun and interactive." Participant 4: "Interactive educational apps have helped my child understand difficult concepts more easily." Participant 1: "Getting used to tech now means she will be ready for whatever comes next, whether it's more school or her future job." Participant 5: "Technology helps my child learn better... and encourages them to be creative and think carefully." Participant 2: "Stuff like educational games and online resources can really help combined with regular teaching."	Perceived Role of Technology	1. Enhancement of Learning Experience. 2. Preparation for Future. 3. Supplement to Traditional Learning.
	Participant 1: *"I do have some concerns, like making sure online safety is taught properly."* Participant 2: *"I want to make sure the school's got all the right security stuff sorted out."* Participant 4: "Too much screen time can be a problem... We need to set rules for screen time and balance it with other activities."	Concerns About Online Safety.	1. Need for Online Safety Education. 2: Screen Time Management.
	Participant 1: "It makes learning more fun and interactive." Participant 2: "Educational games and online resources can really help make things more fun and interesting." Participant 3: "Educational apps have significantly improved their understanding and engagement with the subject." Participant 5: "Technology gives them lots of ways to learn and encourages them to be creative." Participant 3: "One concern is that children are writing less and less as a lot of work is done electronically."	Positive and Negative Impacts of Technology Use	Positive Impacts: 1. Enhanced Engagement. 2. Improved Learning Outcomes. Negative Impacts: 1. Reduced Traditional Skills. 2. Potential for Addiction.

Part No	Data Item	Themes	Sub-Themes
	Participant 4: "24-hour access can be addictive. We need to set rules for screen time."		
4: Challenges and Barriers in Technology Integration	Participant 1: "Parents can really help out with their kids' tech learning by checking out the same stuff online. That way, they can see what their kids are up to and step in to lend a hand if they need it." Participant 2: "Parents can really help their kids with tech stuff by being open and honest about it... We gotta talk to them about all the cool ways they can use tech for learning and keep it real about the not so great stuff too." Participant 3: "We set limits on technology use and use parental controls to manage what our child can access." Participant 5: "To support my child's technology use, I set clear rules, monitor their online activity, and encourage open communication." Participant 4: "Parents can help their children with technology by using it together for learning and fun, doing hands-on activities like exploring educational apps."	Parental Involvement	1. Access to Online Materials. 2. Open and Honest communication. 3. Setting Limits and Monitoring. 4. Encouraging Educational and Recreational Use.
	Participant 1: "Primary schools can keep parents in the loop by sending emails or using an online app to provide updates on what kind of tech the kids are using." Participant 5: "Primary schools can talk about using technology by sending emails, using group chats, and sending letters or having meetings with parents." Participant 2: "It would be awesome if schools hosted some chill meetings to talk about all this tech stuff with parents." Participant 4: "Schools can send newsletters or reports outlining the most recent technological updates and projects."	Effective Communication Between Schools and Parents.	1. Use of Digital Communication Tools. 2. Organising Meetings and Workshops. 3. Regular Updates and Reports.

Part No	Data Item	Themes	Sub-Themes
	Participant 3: “Schools need to give adequate information on how technology is being used in school, what the plan for the term/year is, and how this can be supplemented at home.”		
	Participant 1: “We keep things balanced at home by limiting screen time and encouraging other activities, like reading books and doing hands-on projects.” Participant 4: “We have rules for using technology, like only one hour of screen time each day.” Participant 2: “We mix it up between traditional and technology-based learning at home by following a schedule with specific times for screens and other activities.” Participant 5: “We balance how my child learns by using both traditional methods like books and newer things like educational apps.” Participant 3: “One suggestion is to set a daily schedule that includes time for both traditional activities like reading and outdoor play, as well as technology-based learning.”	Balancing Traditional and Technology-Enhanced Learning.	1. Setting Time Limits. 2. Using a Scheduled Approach. 3. Mix Learning Methods.

Teachers and Teaching Assistants

Part No	Data Item	Themes	Sub-Themes
2: Efficiency	Participant 1: “Using Google for research on interesting topics to keep students engaged and excited about learning.” Participant 2:” Interactive lessons using a Promethean board where students interact with the content, enhancing engagement.” Participant 4: “Using iPads for game-based learning to keeps children’s interest through interactive and enjoyable educational games.” Participant 1: “Educational apps like "Teach Your Monster to Read" make learning enjoyable and engaging.” Participant 3: “Using technology to explore musical examples from different cultures makes learning more immersive and enjoyable.” Participant 5: “Smart boards help visualize concepts in a way that is engaging for students.”	Engagement and Motivation	1. Interactive Technology Integration. 2. Fun and Enjoyable Learning.
	Participant 1: “Students learn to research and analyse information online, improving their research skills.” Participant 4: “Researching price differences using websites helps students develop analytical skills related to real-world applications.” Participant 2: “Use of various tools on the Promethean board to improve mathematical understanding and skills.” Participant 5: “Smart boards help in explaining complex concepts like prisms, aiding in skill development in visual and spatial reasoning.”	Skill Development	1. Improving Research and Analytical Skills. 2. Enhancing Technological Proficiency.
	Participant 2: “Promethean board allows for interactive participation and use of built-in tools for geometry.” Participant 4: “Interactive whiteboards and iPads are used extensively for hands-on learning.” Participant 3: “Technology used to present musical examples and diverse cultural content, creating an interactive learning experience.” Participant 6: “Using smart boards, Google Classrooms, and Seesaw for interactive and blended learning experiences.”	Interactive Learning	1. Interactive Tools and Applications. 2. Technology-Enhanced Lessons.

Part No	Data Item	Themes	Sub-Themes
3: Attitude	Participant 1: "I keep an eye on how into the lessons the kids are when we use tech compared to the old-school way. I throw some quizzes and assignments at them to see if they're getting the hang of things, and I ask the kids what they think about using tech in class." Participant 2: "I assess the effectiveness of technology integration through student performance data, feedback, engagement levels, which is then used to check against learning objectives to ensure technology positively impacts understanding and skill development." Participant 5: "If students can show me that they understand the lesson aims and I can point to technology as having helped me in getting the children to that point, then I know it's working. I'm always looking to improve and find new ways to make sure the tech we're using is really making a difference." Participant 4: "Students are highly engaged using technology. I assess this by comparing progress to historical data that was collected without the use of technology." Participant 3: "I see if the kids are remembering what they've learned. I use quizzes or assignments to check if they've got it down. If tech helps them remember or understand concepts quicker, then it's working well." Participant 6: "I see a noticeable increase in engagement, and the work completion can be drastically different."	Assessment of Technology Effectiveness	1. Methods of Evaluation. 2. Indicators of Success.
	Participant 1: "I can see every kid having their own tablet or laptop to use both at school and home. Lessons could get way more interactive and personalized, with tons of stuff available online. We might see more mixed or fully online classes, especially for subjects that do well with visual and interactive tools." Participant 2: "The future involves personalized learning, increased use of AI technologies, immersive tools like AR/VR, and enhanced digital literacy, creating engaging learning environments for pupils."	Future Perspectives on Technology Integration.	1. Anticipated Changes. 2. Role of Technology

Part No	Data Item	Themes	Sub-Themes
	Participant 6: "I see the use of AI and changes in our teaching of many curricular subjects as a result." Participant 3: "Tech's gonna keep playing a big role in our classrooms, but not necessarily taking over completely. It's going to be more like a trusty sidekick, enhancing what we're already doing rather than becoming the main method of teaching." Participant 5: "I think technology could be used more in all aspects, including learning at home. More interactive learning games, technology for assessments, and teaching kids how to use search instruments and the internet to widen their knowledge."		
	participant 1: "I think it's crucial to find a balance between old-school ways and all this tech stuff. Pen and paper are still super important for honing skills, but tech can make learning more fun and interactive. So, I try to mix it up in my lessons." Participant 2: "Balancing technology-based learning with traditional methods is very important. Combining both approaches ensures diverse skill development, maintains student engagement, and addresses differing attention spans, providing an educational experience that utilizes the strengths of each method." Participant 4: "There is a place for both. Children are engaged by technology but pencil and paper often offer more scope for accuracy and focus in learning." Participant 3: "Traditional methods are great for building foundational skills, like writing and problem-solving. Tech can add some spice to the mix and make learning more fun and interactive, helping to develop different skills." Participant 5: "I believe in a good mix of technology and pen-and-paper. Very few jobs will require absolutely no technology in the future. Our job is to prepare kids for that future by using technology effectively."	Balancing Technology-Based Learning and Traditional Methods	1. Importance of Balance. 2. Educational Outcomes

Part No	Data Item	Themes	Sub-Themes
4: Challenges and Barriers in Technology Integration	Participant 1: "One of the biggest challenges I face is kids using the tech for stuff they shouldn't be doing, like playing games or checking out stuff that's does not age appropriate. It's a real hassle sometimes! But I try to stay on top of it by setting up restrictions and guidelines for how they can use the tech." Participant 5: "When using personal devices, some children will switch off what they are meant to be doing to play games. Even with school internet blocks on certain websites, the kids sometimes find a way around them. I use a trust and reward-based system, and breaking the trust means that you are only allowed to access technology when being monitored." Participant 3: "Keeping the kids focused is another issue. With all the cool material available on tablets, it's easy for them to get distracted and wander off task. Ensuring that everyone is using technology for learning and not simply for fun requires a bit of balancing."	Student Misuse and Distractions	1. Misuse of Technology. 2. Distractions.
	Participant 1: "What I really need are more devices for the kids. It'd be awesome if each of them had their own device. That way, we could do all sorts of cool stuff in class, from research to interactive lessons." Participant 4: "We need higher quality and more reliable laptops. Our current batch is at the end of their lifespan and is very unreliable and slow." Participant 6: "Availability, Wi-Fi, and the condition of technology can be an issue. Children also do not have enough literacy skills to log in, and losing passwords and login information are additional problems."	Access and Availability	1. Insufficient Devices. 2. Connectivity Issues.
	Participant 2: "I would need ongoing professional development, access to updated devices and software, reliable internet, technical support, and collaboration opportunities with other educators to share their ideas."	Professional Development and Collaboration	1. Professional Development Needs. 2. Collaboration with Colleagues.

Part No	Data Item	Themes	Sub-Themes
	Participant 5: "More CPD (Continuous Professional Development) would be great, like workshops or training sessions where I can learn about the latest tech tools and how to use them in my teaching." Participant 1: "We just chat about stuff during breaks or team meetings. If someone's got a cool idea or found a new app that works well, they'll mention it to the rest of us. We also share information via email." Participant 2: "I collaborate with colleagues via staff meetings weekly, social media (group chats), and through general chat pre-during-post workday." Participant 3: "We share tutorials on how to use different tech tools and apps. If someone discovers a useful online instruction, they'll share it with the rest of us." Participant 4: "I plan lessons with my stage partner. We work together to design lessons that are engaging and match the standards." Participant 6: "I'm tech support for some teachers who have low confidence with technology. I share advice, show them how to use tech, and help them build their confidence with using technology in the classroom."		

Headteachers

Part No	Data Item	Themes	Sub-Thems
2: Efficiency	Participant 1: "We evaluate the effects of technology integration using different techniques. Observations by teachers are essential because they offer instant insights into how well technology is being used in the classroom. Additionally, we can assess and consider our practices as a group through professional discussions and learning rounds that involve both staff and students." Participant 2: "We closely monitor engagement and attendance levels, as these are strong indicators of how well students are responding to technology-enhanced learning environments. Additionally, we collect and analyse data to measure progress and outcomes, ensuring that technology is contributing positively to student achievement." Participant 3: "We benchmark each pupil according to our agreed set of outcomes—logging in, saving files, entering text, creating a bitmap image, coding, etc. We measure engagement levels with a RED, AMBER, GREEN system and also measure each child at the end of the school year to identify progress."	Methods of Assessment	1. Observations and Feedback. 2. Data and Engagement Metrics. 3. Benchmarking and Evaluation.
	Participant 2: "One of our main strategic priorities is upgrading our technology infrastructure, including both the hardware and the network, to minimize downtime and obstruction caused by outdated or slow systems. Another key priority is the professional development of our staff. We are committed to providing continuous training to ensure that teachers are always up to date with the latest technological advances and pedagogical strategies." Participant 1: "One of our key strategic priorities is the creation of student files that can be shared with parents. These portfolios will not only showcase the student's work and progress but also enhance communication and engagement with parents."	Strategic Priorities	1. Technology Infrastructure and Professional Development. 2. Student Portfolios and Independent Learning.

	Participant 3: "We need to upskill staff in using coding languages (Scratch, microbits). We need to provide our students with opportunities for independent learning in relation to computational thinking and basic digital skills."		
	Participant 1: "We plan to stay ahead of emerging technologies and trends through continuous staff training. Sharing knowledge and skills within our school community is important. We also encourage our staff to observe technology integration in other educational settings, both locally and internationally." Participant 2: "I want to include artificial intelligence (AI) instruction in our curricula going forward. Our kids must acquire the skills necessary to accept and responsibly utilize this rapidly evolving technology." Participant 3: "We have started to introduce AI use in the classroom and it is a part of our School Improvement Plan. We think it could help with image creation, report writing, website text generation, and cleaning up images for our social media posts."	Adaptation to Emerging Technologies	1. Continuous Staff Training and Knowledge Sharing. 2. Integration of AI and Future Trends.
3: Attitude	Participant 1: "My vision is for technology to be used as a tool to enhance and share learning. It should not replace traditional methods but complement them, making learning more engaging and accessible for all students. By integrating technology thoughtfully, we can provide a richer educational experience that prepares our students for the future." Participant 2: "My vision is for every student to have access to personal, high-quality equipment that allows them to easily access the curriculum. Engagement and attendance is a top priority, and technology is at the forefront of achieving this." Participant 3: "All staff are trained and confident in its use. All students reach their true digital potential and their success in this area carries through to their school journey."	Vision for Technology Integration	1. Enhancing and Sharing Learning. 2. Access and Engagement. 3. Training and Digital Potential

	Participant 1: "We provide parent information sheets and ensure that up-to-date information is available on our school website and social media platforms. These efforts aim to keep parents informed and engaged in the decision-making process regarding technology integration." Participant 2: "We actively involve parents and the wider school community through regular emails and the school website. These allow us to gather insights and opinions on our technology initiatives. Additionally, we hold workshops that invite the community into the school." Participant 3: "We bring it up at the Parent Voice monthly meetings, especially when it comes to purchasing new tech and new software. We also have input from our parents when it comes to our School Improvement Plan (SIP)."	Involving Parents and the Wider School Community	1. Information Sharing and Communication. 2. Engagement Through Meetings and Feedback.
4: Challenges and Barriers in Technology Integration	Participant 1: "We support our teachers by sharing knowledge, skills, and strategies during regular staff training sessions. This combined approach ensures that our teachers feel confident and effective in integrating technology into their teaching practices." Participant 2: "We offer numerous chances for regular training and professional development. These sessions are designed to help teachers integrate technology effectively into their teaching practices. By staying current with the latest educational technologies and teaching methods, our teachers are better supplied to enhance their instructional practices and improve student learning outcomes." Participant 3: "We offer in-house training from other staff members. We also encourage all staff to partake and sign up for our local authority ICT training events."	Support and Empowerment for Teachers	1. Professional Development and Training.
	Participant 1: "To ensure fair access to technology, we supply all students with the same type of device. These measures help to create a fair learning environment where all students have the necessary tools to succeed." Participant 2: "Technology is timetabled to ensure equitable access to technology. Substantial investment in technology ensures that students progressively have more access to technology, and we frequently receive national and local funding to enhance their digital infrastructure."	Strategies for Fair Access to Technology	1. Equal Provision of Technology

	Participant 3: "We offer laptops to our poorest pupils. We gift mobile data cards and speak to parents who have a low SIMD about using our laptops at home."		
	Participant 1: "One of the main challenges we've faced is system failures when many users try to access technology at the same time. Additionally, upgrades and system changes, including password updates, can be time-consuming and disappointing. We address these issues through proactive planning and support, ensuring minimal disruption to the learning process." Participant 2: "Hardware and network failures have been a massive issue. I have addressed this by increasing substantial amounts of funding towards keeping up to date with the latest technology. Also, a dedicated member of staff is responsible for IT within the school, addressing issues quickly when they arise." Participant 3: "We regularly communicate with our local authority ICT lead for help and support and have a specialist ICT network representative who visits us fortnightly to fix any issues we have. Older teachers are the hardest to make engage with new digital techniques."	Overcoming Integration Challenges	1. Technical Issues and System Failures