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The Use of ICT: The Mediating Role of Attitudinal Beliefs, Subjective Norms, Behavioral Control and Behavioral Intentions among Saudi Elementary Teachers

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Abstract

The present investigation explored behaviours towards Information and Communication Technology (ICT) among 239 primary teachers (59.4% male, 40.6% female) in Dammam, Saudi Arabia. A convenience sampling technique was used to choose the sample. Based on the Decomposed Theory of Planned Behaviour (DTPB) model, the study addressed a research gap investigating technology adoption in a centralised education system. The analysis employed Partial Least Squares Structural Equation Modelling (PLS-SEM) and the mediating effects of attitudes on the path between perceived ease of use towards ICT ($\beta = 0.131$, $p = 0.003$) and perceived usefulness of ICT ($\beta = 0.386$, $p < 0.001$) and behavioural intention towards ICT was statistically significant. Subjective norms mediated peer ($\beta = 0.128$, $p < 0.001$) and superior ($\beta = 0.070$, $p = 0.001$) influences on behavioural intention; however, student influence was not significant, contrary to a similar Western investigation. The results indicate that behavioural intention significantly predicts actual use ($\beta = 0.305$, $p < 0.001$). Contrary to DTPB theory, the results indicate that perceived behavioural control did not mediate any relationships. The model explained 26.1% of the variance in ICT use ($R^2 = 0.261$), lower than that identified in a related Western investigation. A notable distinction with differences identified in explanatory power (R^2) and predictive relevance (Q^2) indicated some theoretical constraints. The findings highlighted the compatibility assumptions associated with technology adoption in a centralised education system. The recommendations highlighted the importance of modifying teachers' attitudes and developing peer networks, rather than providing resources, to increase technology use within the Saudi educational system. Keywords: ICT usage, attitudinal beliefs, subjective norms, perceived behavioural control, the DTPB model, Saudi primary education.

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Introduction

Globally, there has been a shift towards utilising Information and Communication Technologies (ICT) in primary schools as a key priority, which is documented to positively impact students' learning and motivation (Gnambs, 2021). Several monetary initiatives have been implemented in the Kingdom of Saudi Arabia (KSA), including the Tatweer Project, which aims to develop an ICT-ready public primary education environment (Albugami & Ahmed, 2015). However, teachers' use of ICT in teaching practices is still behind available resources, and the gap is even more significant when considering primary education more broadly (Alharbi, 2019). This gap between available resources and the degree to which they are fully used suggests a greater need for teachers to empirically examine these cognitive and social resources and their willingness to adopt them.

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The Decomposed Theory of Planned Behavior (DTPB) offers a comprehensive framework for studying ICT usage, comprising three primary constructs (Taylor & Todd, 1995). First, attitudinal beliefs refer to teachers' judgments of the intention and perceived utility of using technology to enhance teaching practices, the perceived ease of integrating technology into their classroom practice, and its compatibility with their current teaching approach (Davis, 1989). Second, subjective norms highlight the social influences of administrators, colleagues, and students that motivate or discourage teachers from using technology (Fishbein & Ajzen, 1977).

Ultimately, perceived behavioural control is defined as the teacher's perceived confidence in their technical skills (self-efficacy), access to resources and support from the institution (Ajzen, 1991). Although each of these dimensions is acknowledged, the literature thus far has shown limited evidence of the interplay and relationship between the three concepts and teacher behaviour regarding ICT use (Scherer et al., 2019). No evidence exists of the relationships and mediating pathways between teacher beliefs, social context, and resource use, especially in centralised educational systems like KSA. The study aims to address the research gap by examining a) the role of attitudinal beliefs in mediating ICT uses intention perceptions, b) the role of subjective norms in mediating social behaviours to the use of ICT, and c) the role of perceived control as a pathway to enact intention and build classroom practice for ICT use.

The findings of this research point in the direction of policymakers' and educators' evidence to assist in creating teacher training, peer-supportive networks, and deployment of resources associated with ICT usage. Utilising the DTPB model will provide an academic understanding of teachers' practices with ICT in KSA primary schools. It will provide a theoretical understanding of educational technology usage, begin to support teachers and reveal non-traditional opportunities available for educational development in Saudi Arabia's educational modernisation Vision 2030 framework.

Literature Review

Theoretical Background

Decomposed Theory of Planned Behavior (DTPB)

The DTPB model proposed by Taylor and Todd (1995) expands Ajzen's (1991) Theory of Planned Behavior by decomposing belief structures into multidimensional belief constructs. It yields a more robust examination of technology adoption. According to the Theory of Planned Behaviour (TPB), behavioural intentions—the proximal antecedent to behaviour—are influenced by three main factors: attitudinal beliefs (AB), subjective norms (SN), and perceived behavioural control (PBC). DTPB is unique in that it draws on aspects from several theoretical structures. For example, it outlines constructs from aspects of Diffusion Theory (Rogers, 2003), the Theory of Reasoned Action (TRA) (Fishbein & Ajzen, 1977), and the Technology Acceptance Model (TAM) (Davis, 1989).

The DTPB's most valuable input to the technology acceptance paradigm is the systematic breakdown of belief structures, ultimately leading to a better understanding of the structure that determines technology use. In addition to a broad endorsement of attitudes toward technology beliefs, the DTPB identifies multiple beliefs associated with SN and PBC. AB can be divided into several beliefs regarding (1) perceived usefulness (similar to relative advantage), (2) perceived ease of use (similar to the inverse of complexity), and (3) compatibility. SN can also be divided into influences or beliefs about whether colleagues, supervisors, and students affect an educator's decision to use technology in the classroom. Lastly, PBC can also be subdivided

into several components, including (1) self-efficacy, (2) technology-facilitating conditions, and (3) resource-facilitating conditions.

The DTPB theorising has several advantages over other technology acceptance models. First, compared to TAM, the DTPB offers a more nuanced explanation of technology adoption, as normative and control beliefs are explicitly articulated and advanced. Compared to the original TPB, DTPB offers greater diagnostic value and precision by presenting different belief constructs that suggest an understanding of behavioural antecedents for technology adoption.

DTPB in Educational Technology Research

Previous studies utilising the DTPB model to examine technology adoption for educational purposes have provided evidence across various contexts. Atsoglou and Jimoyiannis (2012) conducted a qualitative study examining Greek secondary teachers' perceptions of using ICT in the classroom. Teachers explained that while ICT had the potential to enhance student interaction and learning opportunities in the classroom, they faced barriers to its use due to their low self-efficacy with technology and a lack of institutional support. Sadaf et al. (2012) empirically examined pre-service teachers' usage of Web 2.0 technologies in their courses, utilising the DTPB. The authors found that pre-service teachers' perceived usefulness was the strongest predictor of adoption. Ajjan and Hartshorne (2008) also confirmed these findings when exploring faculty's adoption of Web 2.0 tools in instruction. They found that faculty's attitudes toward adoption and perceived behavioural control significantly impacted their intentions to adopt.

The various studies collectively endorse the significance of individual-level attitudes and factors considered at an institutional level that impact technology adoption. Studies in the KSA have examined the topic of ICT usage, as seen in works by Alsuhaymi (2018) and Alashwal (2019). However, they have been limited to faculty and higher education studies. The focus on technology usage has not yet extended to primary education. Specifically, Alsuhaymi (2018) examined faculty perceptions of social media platforms, while Alashwal (2019) examined faculty perceptions of Web 2.0 technologies. The significant findings included educators' attitudes towards technology and their technological competence. Although the results support the broader conversation on technology use in education, the focus on faculty and higher education limits the generalizability of the findings across all levels of education. Additional research is needed to focus on primary school teachers' ICT use, with a particular emphasis on the DTPB's variables of attitudes, subjective norms, and perceived behavioural control, especially since the existing body of knowledge is lacking in contexts such as the KSA. Addressing the current gaps in research will also provide a comprehensive understanding of the factors influencing technology adoption in diverse educational contexts.

Factors Influencing Technology Adoption in Education

Attitudinal Beliefs

Attitudinal beliefs (AB) encompass the evaluative assessments that teachers make regarding the use of technology in their teaching practices. These beliefs are a component of the DTPB, which incorporates beliefs around perceived usefulness, perceived ease of use, and compatibility (Taylor & Todd, 1995). Perceived usefulness reflects teachers' beliefs that ICT will enhance their teaching performance (Davis, 1989). Research demonstrates its strong role in shaping attitudes toward technology (Mailizar et al., 2021). Perceived ease of use reflects teachers' beliefs about the effort needed to adopt ICT (Davis, 1989). While there are documented findings

to show its effect on attitudes (Chien et al., 2014), the strength of this relationship varies across studies. Compatibility describes how ICT is compatible with teachers' pre-existing values, experiences, and needs (Rogers, 2003). A study by Sadaf et al. (2012) demonstrated that compatibility contributed significantly to teachers' attitudinal beliefs toward technology.

Subjective Norms

Subjective norms (SN) within primary education comprise various institutional, peer, and student influences that shape teachers' behaviours when adopting educational technology. Pressure from the administration, in most cases from school leaders and policymakers, becomes the most prevalent normative force, especially in educational systems, such as primary education, where authority and control structures are often hierarchical, thus empowering pressure or expectations from above to dictate classroom standards and practice strongly (Tondeur et al., 2017). However, through professional socialisation, school colleagues establish their powerful informal norms for instructional technology use through collaborative planning, co-teaching, and modelling the use of ICT in the classroom (Koh et al., 2017). Cohort dynamics often mediate student expectations; even considering primary students, they exert a lesser normative force on teachers. However, recent research is identifying evidence that teachers are beginning to consider even their young learners' digital capabilities and their role in their perceptions of technology, especially when providing for student-centred learning (Sadaf & Gezer, 2002). As noted, this complex social ecosystem can create unique adoption pressures dependent on each school's culture, leadership style, and pedagogy. However, ultimately, each adaptation comes into play, mediating how primary educators transform SN emanating from external sources, such as the school and administration, and internal forces, including teachers and students, into practices for using educational technology within the classroom.

Perceived Behavioral Control

Perceived Behavioral Control (PBC) regarding educational technology adoption is a multifaceted concept determined by a combination of self-efficacy, institutional support, and access to school resources for teachers. Understanding all these dimensions is necessary to fully determine PBC (Bandura, 1986; Sadaf et al., 2012). At the individual level, regarding PBC for educational technology, self-efficacy in education technology serves as the psychological basis for PBC (Bandura, 1986; Sadaf et al., 2012), representing the individual's confidence in their ability to use technology effectively. At the institutional level, technology-facilitating conditions (e.g., quality of infrastructure, user support, and access to digital technology) create the foundations for implementation, while resource-facilitating conditions (e.g., allocated time, training opportunities, and budget) represent the clarifying character for practical feasibility in adopting technology (Taylor & Todd, 1995). PBC is a dynamic relationship here because defining each PBC as static would create contradiction—highly confident teachers may be apprehensive about acting without institutional support, and while you may have adequate infrastructure, low levels of self-efficacy would be overwhelming. That is why professional development approaches for PBC in primary education have to develop competencies, provide support, and align with school policies simultaneously.

Research Gap

While significant studies exist on the diffusion of educational technology, we still lack a comprehensive understanding of the interaction between psychological, social, and organisational factors that mediate the use of ICT in primary schooling. Primary schools have

been understudied, especially regarding attitudinal beliefs, subjective norms, and perceived behavioural control, which collectively mediate teachers' adoption behaviours, compared to studies focused on higher education contexts.

This current study addresses the gap in the literature regarding the mediating role of factors conceptualised in the DTPB approach while considering mediated contextual factors specific to the primary context, such as the developmental appropriateness of technology, classroom management, and pedagogical approaches to early years teaching and learning.

In conclusion, this study thoroughly examines how teachers utilise ICT. It examined the contexts, applications, possibilities, and mediating factors that impact primary school teachers' decision-making about using ICT in their teaching practices.

Model Hypotheses and Development

Hypothesis Development for Attitudinal Beliefs

As outlined in the DTPB model, attitudinal beliefs (AB) represent teachers' evaluations of their use of ICT in their teaching practices, indicating whether it has a positive or negative effect (Fishbein & Ajzen, 1977). AB is a primary mediator of the relationship between ICT usage and behavioural intention (BI), as it connects perceptions of ICT and BI (Taylor & Todd, 1995). The DTPB further argues that perceived usefulness (PU), perceived ease of use (PEOU), and perceived compatibility (COMP) all comprise teachers' attitudinal beliefs (AB), which influence their intention to use ICT (BI). Evidence also supports the positive influence of PEOU on AB. Researchers have found that teachers tend to exhibit more positive attitudes toward using ICT when they perceive it as easy to use (Mailizar et al., 2021; Chien et al., 2018; Mashroofa et al., 2019). The overall strength of the effect can vary based on the context (e.g., Sadaf & Gezer, 2020 report a moderate effect). However, ICT being easy to use positively affects teachers' use of ICT in their teaching.

H1a: Ease of use has a significant and positive direct effect on attitudinal beliefs.

Considerable empirical evidence indicates a robust association between perceived usefulness (PU) and attitudinal beliefs (AB) among teacher adopters of educational technology. The literature consistently finds that teachers develop positive attitudes toward using ICT when they find it useful for teaching effectiveness. For instance, Mashroofa et al. (2019) and Mailizar et al. (2021) found a robust and positive relationship between pupil-teacher relationship (PU) and academic behaviour (AB), suggesting that teacher-PU influences their academic behaviour. This relationship has been examined across various user contexts. Chien et al. (2018) discovered that when users recognised educational technologies as applicable, they had more favourable attitudes toward use regardless of frequency. In addition, the data support the broader argument that PU could be a particularly salient predictor for producing positive AB, suggesting strong relationships with positive AB. In the literature, the more teachers believe that ICT is to their instructional effectiveness, the more they will demonstrate positive AB toward use. Thus:

H1b: Usefulness has a significant and positive direct effect on attitudinal beliefs.

Research has consistently shown that perceived compatibility (COMP) with educational technology can positively predict AB toward educational technology usage. For example, Leejoeiwa (2013) found that COMP was an important predictor of a positive attitude toward using an online learning platform. Sadaf et al. (2012) found that COMP for using educational technology by teachers was strongly and positively correlated with favourable AB. Chien et al.

(2018) also found that COMP strongly predicted formulating AB regardless of the user's technology experiences.

H6c: Compatibility has a significant and positive direct effect on attitudinal beliefs.

The link between AB and behavioural intention (BI) has robust empirical support from various studies (e.g. Sadaf & Gezer, 2020). Sadaf and Gezer (2020) identified AB as the most influential mediator in predicting interest in using technology. Capo and Orellana (2011) revealed that AB was the strongest predictor of BI in the educational dimensions they identified. Chien et al. (2018) found that AB significantly affected BI for frequent and occasional users, explaining almost 70% of the variance for each category. Other researchers agree with these findings (Mailizar et al., 2021; Teo, 2016; Mashroofa et al., 2019). Therefore, when teachers developed positive AB towards ICT, they were more likely to develop a greater intention to use ICT. Therefore:

H1d: Attitudinal beliefs have a significant and positive direct effect on behavioural intentions.

Studies in various educational settings have consistently shown a strong positive correlation between PEOU and the intention to engage in adoption. In Malaysian universities, for instance, Goh et al. (2020) found a significant relationship between PEOU and adoption intention. Yim et al. (2019) confirmed the relationship between PEOU and continuance intention in sustaining technology use. PEOU has continued to be cited in the academic research literature as a significant factor in predicting the continued acceptance of educational technologies, particularly by Weng et al. (2018) and Chien et al. (2018). Across studies, we see that when teachers perceive ICT tools as user-friendly and easy to adopt, they have a stronger intention to adopt and continue using them in their practices. This common thread across the studies adds to the evidence that a teacher's perception of a user-centric design is a critical factor in the design and development of educational technology. A user-centric design would point to teachers' intended use of a system.

H1e: Perceived ease of use has a significant and positive direct effect on behavioural intentions.

Studies of educational technology continually demonstrate a clear positive association between perceived usefulness and behavioural intention to use technology. Sanchez-Prieto et al. (2015) found a related association between pre-service teachers' intention to use mobile technologies and the finding that perceived usefulness is one of the strongest predictors of behavioural intention. These findings have been replicated repeatedly in educational settings, including Yim et al. (2019), who found perceived usefulness significantly influenced continuance intention, as have other researchers (Cheon et al., 2012; Goh et al., 2020). These outcomes support the theoretical assumption that teachers are more likely to adopt a technology if they can be convinced it will improve their teaching. The stronger the teacher believes technology will improve instructional outcomes, the greater the intention to use it to support their practice.

H1f: Usefulness has a significant and positive direct effect on behavioural intentions.

The impact of compatibility (COMP) on behavioural intention (BI) is important in adopting educational technologies, especially in primary schools. A study by Capo and Orellana (2011) provided empirical evidence that COMP significantly predicted teachers' intention to adopt technologies, demonstrating that the extent to which technology aligns with existing pedagogical

practices and curricular needs directly influences the likelihood of adopting technology. This relationship is significant in primary education, as the effective use of practical technology depends on the continued alignment of teacher practice with developmentally appropriate pedagogy, classroom routines, and learning goals. Teachers are more likely to incorporate technology when it aligns with or complements existing educational practices.

H1g: Compatibility has a significant and positive direct effect on behavioural intentions.

The mediation of attitudinal beliefs (AB) occurs through direct and indirect cognitive pathways, as noted in the literature on technology adoption. Perceived ease of use (PEOU) affects behavioural intention (BI) through multiple pathways, both direct, based on utilitarian evaluation, and indirect, through AB toward the technology (Davis, 1989). This mediating pathway occurs when an educator's perception of the usability of a system (for example, an online collaborative platform) increases their positive AB toward it and, therefore, increases the teacher's BI to use it. Empirical evidence for the mediating effect of AB is demonstrated in the research conducted by Sadaf and Gezer (2020) in their cross-cultural study with educational technology, which indicated that about 34% of PEOU's total effect on BI was mediated through the influence of AB. The validity of this pathway is evident in culturally compatible settings, underscoring the importance of AB in a teacher's decision-making process regarding the adoption of technology within their pedagogical practices.

H1h: Attitudinal beliefs mediate the relationship between perceived ease of use and behavioural intentions.

The mediating effect of attitudinal beliefs (AB) has been tested many times through empirical research and verified as part of the relationship underlying perceived usefulness (PU) and behavioural intention (BI) for educational technologies. Moreover, the mediating relationship is effective when a teacher believes that digital technology can facilitate curriculum preparation and enhance classroom effectiveness (PU); this belief creates a positive attitude toward using technology in the classroom, ultimately leading to behavioural intentions for the routine use of educational technologies. The mediated relationship has been statistically verified through quantitative research, including the work by Sadaf and Gezer (2020), who reported a significant mediated relationship. Likewise, Sadaf and Johnson (2017) found that AB mediates the relationship between PU and BI for individual teachers, as the context and experiences based on an individual teacher's teaching role must be accounted for when measuring AB and the mediating effect on increased ICT use. AB provides a cognitive bridge from valuable perceptions of educational technology to the intention to adopt.

H1i: Attitudinal beliefs mediate the relationship between usefulness and behavioural intentions.

The effect of compatibility (COMP) on behavioural intention (BI) is mediated by attitudinal beliefs (AB), especially when educational technologies align with accepted pedagogical practices. A good example of this mediation is when a digital assessment creates continuity with a traditional assessment. In this case, the teacher's positive AB toward educational technology would be increased by the COMP, leading to an increased intention to use BI. Sadaf and Gezer (2020) provided quantitative support for this mediation pathway, finding that AB partially mediated the effect of COMP on BI. More specifically, their results indicated that COMP increased intended use only if teachers perceived educational technologies as compatible with their teaching and assessment practices. Specifically, teachers who perceived COMP were more

likely to develop positive attitudes toward the technology and, ultimately, a higher intention to use it for assessment purposes. This supports the additional attribute of educational technology, compatibility, which is not just a direct predictor, but compatibility may influence teachers' underlying AB toward educational technologies.

H1j: Attitudinal beliefs mediate the relationship between compatibility and behavioural intentions.

Hypothesis Development for Subjective Norms

Subjective norms (SN)—the extent to which teachers perceive that they are experiencing social pressure from their school administrators about using technologies—are strongly associated with teachers' behavioural intentions (BI) for using technology. Studies have indicated that when school leaders explicitly articulate expectations or show administrative support for using technology, normative pressure influences teachers' use. Inan and Lowther (2010), Tondeur et al. (2017), Sadaf and Gezer (2020), Tonukari and Anyigba (2021), and Alazemi (2017) consistently recognised that strong administrative expectations and normative beliefs influence teachers' use of technology in the classroom, particularly for pre-service teachers. Subjective norms (SN)—the extent to which teachers perceive that they are experiencing social pressure from their school administrators about using technologies—are strongly associated with teachers' behavioural intentions (BI) for using technology. Research has shown that when a school leader explicitly states expectations or shows administrative support for technology application, normative pressure shapes teachers' use of technology. Inan and Lowther (2010), Tondeur et al. (2017), Sadaf and Gezer (2020), Tonukari and Anyigba (2021), and Alazemi (2017) all indicated that strong administrative expectations and normative beliefs shape teachers' use of technology, particularly for pre-service teachers.

H2a: Superior influence has a significant and positive direct effect on subjective norms.

Peer Influence (PI) contributes to the SN by establishing professional practice within primary schools. For those who feel pressured by colleagues, for example, senior or more experienced teachers, provide an example of effectively using interactive whiteboards to pressure the other teachers to show similar behaviour in their location. Given this, PI did add a positive perceived contribution to SN for Tonukari and Anyigba (2021). Sadaf and Gezer (2020) found even more significant contributions. The work of Leejoeiwara (2013) and Alazemi (2017) specifically identified their PI pressure as one of the most significant contributors to perceived SN in primary education. Again, collegial attitudes, behaviours or practices offer a social environment that stimulates or prohibits the use of ICT (Ertmer et al., 201

H2b: Peer influence has a significant and positive direct effect on subjective norms.

The literature reveals student influence (SI) as an important factor influencing teachers' subjective norms (SN) regarding the use of ICT, which reflects that students implicitly pressure teachers by their familiarity with digital tools. Research evidence suggests SI is a strong predictor of SN and is a crucial component of motivation for teachers to engage with technology in their teaching practice. Sadaf and Gezer (2020) found SI among the strongest influences of SN, which Alazemi (2017) also supported in the literature. Chien et al. (2018) also found that SI directly influenced teachers' technology intentions and behaviours, showing that SI influenced teachers' decisions.

H2c: Student influence has a significant and positive direct effect on subjective norms.

Several studies have supported the direct effects of SN on behavioural intentions (BI) in contexts of technology adoption behaviour. Specifically, research conducted by Cheon et al. (2012) and Alazemi (2017) showed a significant relationship between SN and BI. CAPO and Orellana (2011) explored the influence of SN on BI and found them to be a strong predictor, though secondary to attitude. Teo (2016) enhanced our understanding of this relationship by showing consistently positive effects of SN on teacher BI. These studies indicate that subjective norms positively and significantly influence teachers' BI towards technology use. This only makes sense, as teachers may consider the expectations of important social influences on their desire to use ICT in their teaching practice. This could be most apparent in education settings described before, where, for example, primary school teachers who feel strongly expected by their professional peers to try to include technologies will use ICT.

H2d: Subjective norms have a significant and positive direct effect on behavioural intentions.

Empirical evidence lends compelling support for behavioural intentions (BI) being particularly significant in technology adoption, especially when reinforced by institutional authority. Reports from research studies demonstrate that when school administrators make decisions that prompt teachers to utilise learning management systems (LMS), they result in much higher engagement than administrators who do not. Capo and Orellana (2011) showed that BI was the most significant predictor of teachers adopting Web 2.0 tools. Sadaf and Johnson (2017) also found that administrative expectations represented the most significant normative influence and directly impacted the usage intention of 84% of participating educators. Leejowa (2013) replicated these original findings within an elementary educational context.

H2e: Superior influence has a significant and positive direct effect on behavioural intentions.

Research shows that peer influence (PI) significantly impacts teachers' behavioural intention (BI) about technology use, particularly in collaborating with colleagues in professional networks in primary schools. When grade-level teams do a good job with a digital tool—e.g., in assessment using digital portfolios—an individual teacher can be expected to have a much greater likelihood of using similar tools. Evidence to corroborate that PI impacts BIs is substantial. Sadaf and Johnson (2017) found that PI accounted for 46% of the variance in teachers' BI related to technology use in their educational context, which points to the considerable influence of PI. Evidence is also found in other research, such as Sadaf et al. (2012) and Alazemi (2017), indicating a relationship between PI and BI and technology use in primary education.

H2f: Peer influence has a significant and positive direct effect on behavioural intentions.

Studies indicate that student influence (SI) is an important determinant of teachers' behavioural intentions (BI) towards educational technology, with student engagement acting as an important mediator. When teachers see students express a positive reaction and increase their participation during technology-enhanced lessons, they are more motivated to use educational technology in their courses. Chien et al. (2018) found that teachers' perceptions of student learning outcomes strongly influence the intention to use technology, particularly for teachers who regularly use digital technology. Sadaf et al. (2012, 2017) found student influence to be one of the most robust predictors of teachers' intentions to use Web 2.0 technologies, and Alazemi (2017) also showed

similar findings. Together, these findings represent student influence as mediating motivation in the direction of teachers' technology adoption intent through observable engagement in the classroom. Thus, it emphasises the social and experiential aspects of technology usage in education.

H2g: Student influence has a significant and positive direct effect on behavioural intentions.

Subjective norms (SN) play an important mediating role in the relationship between superior influence (such as school leadership) and teachers' behavioural intention (BI) to use ICT in primary education. When school principals promote and encourage technology use through resource funding, learning and development, and establishing clear expectations, they shape teachers' perceptions of organisational norms, reinforcing their intention to utilise digital technologies. As noted by Sadaf and Gezer (2020), there is a mediating role of SN in the effect of administrative influence, while Alazemi (2017) found that superiors' influence through subjective norms accounted for 51.5% of the variance in teachers' BI. The different levels of influence from leadership through normative pressures aid in understanding the effects of leadership on individual decisions to adopt, which speaks to the importance of SN as a link from the institutional level expectations to individual practice within the classroom.

H2h: Subjective norms mediate the relationship between superior influence and behavioural intentions.

Professional social networks and collaborative environments mediate between peer influence (PI) and teachers' intentions to adopt and use technology. When teachers see others successfully implement technologies like interactive whiteboards, they develop subjective norms (SN) associated with the appropriateness of technology, shaping their behaviour intentions (BI). Research overwhelmingly supports this mediation effect; Sadaf and Gezer (2020) analysed PI and found significant mediation effects of peer influence through social networks. Chien et al. (2018) found that peer influence operates through normative beliefs to affect intentions to adopt technologies. Further, Leejoeiwara (2013) found that peer influence through SN strongly predicted teachers' intentions to use technology. This research illustrates how professional social networks operationalise peer modelling to develop normative expectations for decision-making regarding technology usage in educational contexts.

H2i: Subjective norms mediate the relationship between peer influence and behavioural intentions.

In primary education, students' excitement about digital resources affects teachers' subjective norms (SN), which mediates their impact on behavioural intention (BI) to adopt technology. When young learners are meaningfully immersed in educational technology, they develop normative beliefs that push teachers to utilise those resources. The literature supports this mediation pathway, as Sadaf and Gezer (2020) indicated that students' influence was the most potent mediator among all reference groups, and Sadaf and Johnson (2017) and Chien et al. (2018) indicated the degree of influence was consistent across the three groups of teachers studied. It is evident from previous research that students' digital engagement is influential and is perceived by teachers to affect their perceptions of adoption differently through normative social pressure in the primary classroom.

H2j: Subjective norms mediate the relationship between student influence and behavioural intentions.

Hypothesis Development for Perceived Behavioral Control

The significance of perceived behavioural control (PBC) in technology adoption involves complex theoretical processes. Building on Ajzen's (1991) characterisation of PBC as "the perceived ease or difficulty of executing the behaviour," Taylor and Todd (1995) divided this construct into three components: self-efficacy beliefs (SELF), technology-facilitating conditions (TFC), and resource-facilitating conditions (RFC).

The relationship between SELF and PBC has been consistently supported in educational technology research. Khasawneh (2015) found a strong positive correlation between academic staff's SELF and their PBC. Chien et al. (2018) demonstrated that SELF was a significant determinant of PBC for frequent and occasional technology users, while Sadaf et al. (2012) identified SELF as the most influential component in PBC. Leejoeiwara (2013) and Cheon et al. (2012) further supported this relationship. When teachers feel confident in their ability to use ICT effectively, they perceive themselves as having more significant control over these technologies. Therefore:

H3a: Self-efficacy significantly and positively influences Saudi primary teachers' perceived behavioural control.

Several studies have investigated the connection between technologically facilitating conditions (TFC) and PBC. Khasawneh (2015) found a strong positive correlation, indicating that technological infrastructure support significantly affects teachers' PBC. Leejoeiwara (2013) determined TFC to be a significant predictor of PBC. Nevertheless, Chien et al. (2018) stated that the technological infrastructure is not a significant direct predictor of controlling frequently used TFC. However, it does affect the control perceptions of users with no experience. Sadaf and Gezer (2020) demonstrated that TFC is the weakest mediator of control compared to other factors. Teachers perceive greater confidence in utilising the technology with steady technical support and infrastructure. Hence:

H3 b: Technologically facilitating conditions significantly and positively influence Saudi primary teachers' perceived behavioural control.

There is evidence highlighting the connections between resource-facilitating conditions and PBC. Khasawneh (2015) reported a significant positive relationship between the two dimensions and noted that time and money are important resources for implementing technologies. Leejoeiwara (2013) reported that RFC was a significant predictor of PBC, explaining 29% of its variance. Sadaf and Gezar (2020), Tonukari and Anyigba (2021), and Cheon at el. (2012) also supports the significance of the relationship between RFC and PBC for teachers. Teachers have more PBC when they have sufficient resources, such as time to prepare for ICT and financial resources to implement proper technology use. Therefore:

H3c: Resource-facilitating conditions significantly and positively influence Saudi primary teachers' perceived behavioural control in ICT teaching practices.

The relationship between PBC and behavioural intention (BI) has been consistently supported across studies in educational technology. Tonukari and Anyigba (2021) found that PBC positively influences e-learning adoption intentions. Cheon et al. (2012) demonstrated that PBC significantly impacted the intention to use m-learning. Alazemi (2017) and Teo (2016) further

confirmed this relationship. When teachers feel they have control over ICT, they are more likely to develop a strong belief in using these technologies. Therefore:

H3d: Perceived behavioural control has a significant and positive influence on the intention of Saudi primary teachers to use ICT in their teaching practices.

Research has extensively examined the direct relationship between Self-efficacy (SELF) and BI in educational technology contexts. Chien et al. (2018) demonstrated that SELF directly influenced BI for frequent and occasional technology users. Sadaf et al. (2012) identified SELF as a critical determinant of teachers' intentions to use technology. When teachers possess strong SELF regarding the use of ICT, they are more likely to form positive intentions to utilise these technologies. Therefore:

H3e: Self-efficacy has a significant and positive direct effect on the behavioural intentions of Saudi primary teachers to use ICT in their teaching practices.

Several studies have documented the direct influence of TFC on BI. Tonukari and Anyigba (2021) found that TFC directly impacted e-learning adoption intentions, while Khasawneh (2015) demonstrated strong correlations between TFC and BI. When schools provide adequate technical support and infrastructure, teachers are more likely to develop strong intentions to use these technologies. Therefore:

H3f: Technology-facilitating conditions significantly and positively impact Saudi primary teachers' behavioural intentions to incorporate ICT into their teaching practices.

Research has established the direct relationship between RFC and BI. Sadaf and Johnson (2017) found that RFC directly influenced BI, a finding supported by Leejoeiwara (2013), who demonstrated that resource availability significantly predicted usage intentions. When teachers access sufficient resources, they are more likely to form strong intentions to use ICT. Therefore:

H3g: Resource-facilitating conditions significantly and positively impact Saudi primary teachers' behavioural intentions to incorporate ICT into their teaching practices.

Research in educational technology has established PBC as a mediator between SELF and BI. Specifically, Sadaf and Gezer (2020) found that SELF was the most substantial mediating factor through PBC. Furthermore, Chien et al. (2018) demonstrated that SELF-determined PBC affected the intention of frequent or occasional users. As a result:

H3h: PBC mediates the relationship between self-efficacy and primary teachers' intention to use ICT in teaching practices.

Prior investigations have examined the mediating effect of PBC on the relationship between TFC and BI. For example, Tonukari and Anyigba (2021) discovered that TFC had a significant influence on PBC, and therefore, e-learning technologies have become a viable option. Non-users who received support from faculty to use e-learning technologies found that faculty support had a significant effect on PBC, influencing their intention to use e-learning technologies (Chien et al., 2018). In contrast, Sadaf and Gezer (2020) discovered that TFC was the weakest mediation effect through PBC. However, when schools provided appropriate and adequate technical support and infrastructure, teachers felt more in control of technology in their teaching practices or at least more in control of their ability to use technology in their classrooms. Either way, when offered, technical support from their schools alters teachers' mindsets towards technology in teaching. Consequently, it is expected:

H3i: PBC mediates the relationship between technology facilitation conditions and primary teachers' intention to use ICT in teaching practices.

The mediating effect of PBC on the relationship between RFC and BI has been reported. Sadaf and Johnson (2017) showed that control beliefs mediated the relationship between facilitating conditions and implementation intentions, while RFC showed moderate mediation effects. Sadaf and Gezer (2020), Khasawneh (2015), and Leejoeiwara (2013) also supported this effect. When teachers have adequate resources, they have more control over technology implementation, which enhances their BI to use technology in their teaching. Accordingly:

H3j: PBC mediates the relationship between resource facilitation conditions and primary teachers' intention to use ICT in teaching practices.

2.4 Hypothesis Development for Behavioral Intention

According to the DTPB framework, behavioural intention (BI) plays a crucial mediating role in the relationships between attitudinal beliefs (AB), subjective norms (SN), perceived behavioural control (PBC), and actual ICT use. Although PBC may directly influence behaviour, AB, SN, and PBC influence the actual use of ICT via their indirect influence on BI (Taylor & Todd, 1995).

Within the framework of the DTPB, AB refers to a teacher's overall evaluative appraisal of using technology in education (Ajzen, 1991). When teachers have a favourable AB toward using ICT, they are more likely to develop stronger intentions. There is now considerable empirical evidence to support this association. Sadaf and Gezer (2020) found that AB was the strongest predictor of teachers' beliefs about technology use; similar findings were reported by Capo and Orellana (2011) in various educational contexts. Thus:

H4a: Attitudinal beliefs significantly and positively influence the behavioural intention to use ICT in teaching practices.

The construct of the subjective norm (SN) captures the perceived social influence that teachers feel regarding the use of technology (Ajzen, 1991). Previous research on educational technology has consistently supported the correlation (Alazemi, 2017; Cheon et al., 2012). The more students perceive that important others expect them to use ICT, the more intuitive the intention to act (i.e., the use of ICT is more likely to occur). Thus:

H4b: Subjective norms significantly and positively influence behavioural intention to use ICT in teaching practices.

PBC represents teachers' global judgment of their BI and resources to implement technology successfully (Ajzen, 1991). This relationship has been supported considerably in the literature. For example, Cheon et al. (2012) found that PBC had the most significant effect on BI of all the predictors, as confirmed by Alazemi (2017). When teachers feel confident about their capacity to implement ICT successfully, they can form stronger intentions to use the technology. Consequently:

H4c: Perceived behavioural control significantly and positively influences behavioural intention to use ICT in teaching practices.

Based on the DTPB, the most immediate influence on the use of technology is BI (Taylor & Todd, 1995; Scherer et al.,2019). This relationship has been supported consistently in educational contexts. Weng et al. (2018) found that BI strongly predicted technology use, and

Sadaf et al. (2012) confirmed that stated intentions represented reasonable measures of classroom use. A strong intention significantly increases the likelihood of actual ICT use. Accordingly:

H4d: Behavioral intention significantly and positively influences ICT use in teaching practices.

In contrast to the antecedents of AB and SN, PBC may influence actual behaviour without intentions (Ajzen, 1991). This direct indication suggests that potentially strong intentions to utilise technology may or may not translate into actual use if teachers believe their intention to use the technology has been either enabled or constrained by their perceptions of control over its use. In support of this concept, Khasawneh (2015) found strong positive associations between teachers' perceived behavioural control over technology use and actual technology usage. Hence:

H4e: Perceived behavioural control significantly and positively influences ICT use in teaching practices.

The DTPB suggests that BI mediates between attitudes toward technology and technology use. This would mean that BI would mediate teachers' evaluations of technology and their use of technology through their BI. Sadaf and Gezer (2020) found strong empirical evidence for the mediation of BI within the DTPB framework. Thus:

H4f: Behavioral intention mediates the relationship between attitudinal beliefs and ICT use in teaching practices.

Regarding SN, BI mediates how social influences translate into technology usage. Sadaf and Johnson (2017) found that BI significantly mediated the relationship between SN and technology usage. Therefore:

H4g: Behavioral intention mediates the relationship between subjective norms and ICT use in teaching practices.

The dual-process framework demonstrates that PBC influences actual technology usage behaviours in two ways: (1) a direct influence and (2) an indirect effect on actual technology usage through BI. Khasawneh (2015) and Tonukari & Anyigba (2021) supported the role of BI as a significant mediator of the PBC-usage relationship. These results indicate that teachers' sense of control over technology (PBC) promotes classroom implementation but becomes compounded by their intentions to adopt. Thus, the framework highlights BI's unique role as an independent motive and a mediation mechanism for technology acceptance.

H4h: Behavioral intention mediates the relationship between perceived behavioural control and ICT use in teaching practices.

Methodology

Research Design

This research employed a quantitative, cross-sectional survey design to examine the ICT usage of primary school teachers in Saudi Arabia. A cross-sectional design was selected for the research as it permits the examination of data at a single point in time to determine the targeted population's current behaviours, attitudes, and beliefs (Mills & Gay, 2016). The research design follows Sekaran and Bougie's (2011) recommendations for hypothesis testing, which provides an understanding of the relationships of variables that account for the ICT usage patterns of

Saudi primary teachers.

Sample and Participants

The target population for the present study comprises male and female teachers teaching public primary schools in Dammam, Eastern Province, Saudi Arabia. According to the General Authority of Statistics (2023), there were 3,238 teachers in Dammam, of whom 1,591 were males and 1,647 were females, working at 148 public primary schools. The sample size needed for the current investigation was determined using G*Power analysis, with a statistical power of 0.95, an effect size of 0.15 and a confidence level of 0.05; the final sample size was 217. Because of limited access time and financial constraints, it was decided to use the convenience sampling method. Being a non-random method, convenience sampling allowed the researcher to have a larger sample than random sampling. A total of 239 teachers comprised the final sample of primary teachers. The sample comprised 142 male teachers (59.4%) and 97 female teachers (40.6%), thus providing a good representation of the population by gender.

Data Collection Methods

The approach utilised for data collection occurred via an online, semi-structured questionnaire, targeting primary school teachers in Dammam as the sampling population from May 8 to June 28, 2022-2023. The questionnaire included developed items from literature measures, a choice to ensure reliability and validity, and specifically to the position of primary education in Saudi Arabia. The measurement toolbox included seven sections, and among the seven sections were (1) socio-demographics, (2)-(6) the constructs used in the DTPB (two constructs were measured on one measure). The measurement toolbox utilised a five-point Likert-type scale (1= strongly disagree to 5 = strongly agree) during rating of the items which were taken and adapted from literature (Hartshorne et al., 2010; Davis, 1989; Fishbein & Ajzen, 1977; Atsoglou & Jimoyiannis, 2012) on ICT use in teacher practices.

Measurement Instruments

This study employed a theoretically grounded instrument incorporating 14 validated constructs from educational technology literature. Key measures included: actual ICT usage (Atsoglou & Jimoyiannis, 2012), behavioural intentions (Hartshorne et al., 2010; Alshmrany, 2018), attitudinal beliefs (Fishbein & Ajzen, 1977), compatibility (Rogers, 2003), and the TAM core constructs of perceived usefulness/ease of use (Davis, 1989). Social influence was operationalised through subjective norms (Venkatesh et al., 2003) with three referent groups (peers, superiors, students), while control factors incorporated perceived behavioural control (Hartshorne et al., 2010), self-efficacy (Bandura, 1986), and facilitating conditions (Alsuhaymi, 2018).

Data Analysis

The research utilised a multi-phase analytical technique consistent with Partial Least Squares Structural Equation Modeling (PLS-SEM) via SmartPLS version 4.0 (Ringle, Wende, & Becker, 2022). PLS-SEM was appropriate because this study is exploratory, with a complex model structure focused on prediction rather than model goodness-of-fit indices. This study screened preliminary data to assess missing data, detect outliers, and test data normality before undertaking the primary analysis. The analytical procedure applied in the study followed a two-phase framework, first assessing the measurement model and then the structural model.

The assessment of the measurement model considered factor loadings (threshold ≥ 0.60),

Cronbach's alpha, and composite reliability (threshold ≥ 0.70), average variance extracted (AVE) for convergent validity (threshold ≥ 0.50) among other tests of reliability and validity like three approaches of discriminant validity verified with Fornell-Larcker criterion, Heterotrait-Monotrait ratio, and Cross-Loadings. The assessment of the structural model involved evaluating path coefficients (β), t-values, p-values, and coefficients of determination (R^2), among other tests and analytics, such as predictive relevance (Q^2). Statistical significance for path coefficients was assessed with bootstrapping involving 5,000 resamples.

Mediation effects were evaluated with a specific indirect effect estimator to test the mediation effects of attitudinal beliefs, subjective norms, perceived behavioural control, and behavioural intention. This two-phase analytical technique thoroughly evaluated the proposed hypotheses and developed the rigour to assess the complicated relationships among the study variables.

Results

Descriptive Statistics

The demographic characteristics of the sample are illustrated in Table 1. The sample consists of 239 participants; the majority were male (n = 142, 59.4%) compared to females (n = 97, 40.6%). In terms of years of experience, the most significant number of participants fell within the group 21-30 years (30.5%), and in the 16-20 years (21.7%), with some reporting less years in 11-15 (14.2%), 6-10 (13.8%), 1-5 (12.6%), and finally 31-40 years of experience (7.2%). In terms of professional rank, most of the sample were practitioners (n=160, 66.9%), followed by advanced practitioners (20.1%), expert practitioners (8.8%), and two assistants (4.2%). The subject area for Arabic was the most significant number (n=62, 25.9%), followed by Islamic Studies (n=43, 18.0%), Mathematics (n=30, 12.5%), and finally, Science (n=29, 12.1%). In terms of education, the sample was most significantly represented by those with a Bachelor's degree (n=156, 65.3%), which would indicate that about a quarter of the sample did complete their Master's degree (n=58, 24.3%), with very few reporting having an educational Diploma (n=17, 7.1%) or an educational PhD (n=8, 3.3%).

Characteristic	Category	Frequency	Percentage (%)
Gender	Male	142	59.4
	Female	97	40.6
Years of Experience	1-5 years	30	12.6
	6-10 years	33	13.8
	11-15 years	43	14.2
	16-20 years	52	21.7
	21-30 years	73	30.5
	31-40 years	17	7.2
Teacher Rank	Practitioner	160	66.9
	Advanced	48	20.1
	Expert	21	8.8
	Assistant	10	4.2
Subject Area	Arabic	62	25.9
	Islamic Studies	43	18.0
	Mathematics	30	12.5
	Science	29	12.1

	English Language	23	9.6
	Computer Science	15	6.3
	Social Science	15	6.3
	Art Education	9	3.8
	Physical Education	4	1.7
	Other	9	3.8
Qualification	Bachelor's Degree	156	65.3
	Master's Degree	58	24.3
	Diploma	17	7.1
	PhD	8	3.3

Table 1: Demographic Characteristics of Study Participants

Structural Equation Modeling

Structural Equation Modeling (SEM) was used to examine the proposed model. SEM is based on evaluating measurement and structural models. The measurement model is evaluated to assess quality criteria, including factor loadings for the indicators, reliability of the construct (as measured by Cronbach's Alpha and Composite Reliability), and validity of the construct (as demonstrated by Convergent and Discriminant Validity) (Hair et al., 2017). This is followed by evaluating the structural models that support the proposed hypotheses.

Measurement Model

The initial phase in assessing the measurement model involves analysing factor loadings, item loadings, or indicator reliability. Factor loading is important when assessing the reliability of each indicator. Hair et al. (2017) report that a factor loading of 0.6 or above for each indicator is a reliability marker. In exploratory research, it is recommended that both Cronbach's Alpha and composite reliability be equal to or greater than 0.6. Initially, a model of analysis was conducted using all constructs and items to assess factor loading, construct reliability, and construct validity. Several items were deleted from this study due to low factor loadings (< 0.40). Hair et al. (2017) report that item loadings are required to be over 0.70. However, an item with low loading shall only be removed if the removal improves the reliability and validity of the construct. Therefore, these items were removed from further analysis. After re-evaluating the measurement model, all items demonstrating poor performance were removed to establish improved reliability and validation of each construct. The PLS-SEM analysis results confirmed that all indicators met the requirements, with loadings greater than 0.40 for the study items (see Table 2).

Construct reliability was assessed using Cronbach's Alpha, and the result was found to be more significant than the required threshold of 0.70 (Hair et al., 2021); therefore, the construct reliability was established. Establishing the validity of the measures consisted of both construct validity, as demonstrated through convergent and discriminant validity. The average variance extracted (AVE) is the most common method to support convergent validity. A value of 0.50 or higher for AVE is acceptable (Hair et al., 2017). All constructs included in the study had an AVE value greater than 0.50, establishing convergent validity (see Table 2). It is noted, however, that most, but not all, of the constructs met this criterion, and some construct AVE values were slightly less than 0.50. However, this is consistent with the notion that a construct can still have sufficient convergent validity when the AVE is less than 0.50, provided the Composite Reliability (CR) score is 0.60 or greater (Fornell & Larcker, 1981).

The discriminant validity of the construct was verified using the Heterotrait-Monotrait Ratio of Correlations (HTMT), the Fornell-Larcker criterion, and cross-loadings. An HTMT value of 0.85 supports discriminant validity (Henseler et al., 2015). Discriminant validity using HTMT was not strictly established in the current study (see Appendix A). Discrimination validity was also established using the Fornell-Larcker criterion and the cross-loadings (Hair et al., 2017). The Fornell & Larcker criterion supports that discriminant validity is established when the square root of the AVE of the construct is greater than the correlation with the other constructs in the study; the findings indicated that the square root of the AVE for each construct moderated higher than its correlation with all other constructs in the study (see Appendix B). Cross-loadings were also employed to test the discriminant validity of the constructs. Cross-loading results demonstrated that each item loaded strongly with its underlying constructs compared to the other constructs included in the study. Thus, the items do not cross-load, supporting discriminant validity (see Appendix C) (Hair et al., 2017).

Constructs	**Cronbach's Alpha**	**Composite Reliability**	**Average Variance Extracted**
Attitudinal beliefs (AB)	0.786	0.877	0.707
Ease of use (PEOU)	0.795	0.867	0.625
Usefulness (PU)	0.907	0.925	0.606
Compatibility (COMP)	0.692	0.830	0.620
Subjective Norms (SN)	0.855	0.896	0.635
Superior (SUPER)	0.616	0.837	0.720
Peer influence (PI)	0.783	0.874	0.699
Perceived Behavioral Control (PBC)	0.674	0.801	0.515
Self-efficacy (SELF)	0.690	0.865	0.762
Technology Facilitation Condition (TFC)	0.813	0.890	0.730
Resource Facilitation Condition (RFC)	0.257	0.729	0.573
Behavioral Intention (BI)	0.799	0.871	0.631
ICT USE	0.792	0.859	0.604

Table 2: Measurement Model Results

Structural Model Assessment

After verifying the reliability and validity of the constructs, their interrelationships are generally understood. The structural model is particularly examined, which is mainly based on the path coefficients (β) and the coefficients of determination (R^2). The path coefficients (β) signify the degree of strength and direction of the relationships between the constructs in the structural model. The usual range of the path coefficients (β) is between -1 and 1; however, values below zero are represented as weak relationships, and those above zero indicate strong relationships (Hair et al., 2017, p. 145). In other words, values below 0 represent weaker relationships with

the constructs, while values above 0 represent stronger relationships with the constructs. The hypothesis was also tested using t-values, where values ≥ |1.96| are statistically significant at $p < 0.05$, with the most stringent criterion being a p-value of less than 0.05. Bootstrapping procedures have been a long-sought method for estimating stability coefficients (Hair et al., 2017, p. 145). The coefficients of determination (R^2) indicate the strength of the independent variables in explaining the variance of the endogenous variables, thereby assessing the predictive power of the models. R^2 values range from 0 to 1; the higher the R^2 value, the better the model's predictive ability. Specifically, Hair et al. (2017, p. 146) state that $R^2 = 0.75$ is considered substantial, $R^2 = 0.50$ is moderate, and $R^2 = 0.25$ is weak. This explains the independent variables that account for the number of dependent variables in the path models. The path model results concerning each hypothesis are reviewed later in this paper, focusing on the significance of the path coefficients and the explanatory power, as indicated by the R^2, and the application of these concepts in the real world.

Mediation Analysis Findings

Attitudinal Beliefs Mediation

Analysing attitudinal beliefs (AB) as mediators indicates significant relationships between teachers' perceptions and behavioural intentions (BI) towards ICT use in Saudi primary schools. The direct effects on AB revealed significant positive effects of perceived ease of use (PEOU) ($\beta = 0.219$, $t = 2.894$, $p = 0.002$) and perceived usefulness (PU) ($\beta = 0.647$, $t = 7.968$, $p < 0.001$), thus confirming the anticipated positive relationships. In contrast to the proposed relationships, there was no indication of an effect of compatibility (COMP) on AB ($\beta = -0.001$, $t = 0.011$, $p = 0.496$). AB influenced BI ($\beta = 0.598$, $t = 10.103$, $p < 0.001$), thus supporting this hypothesised direct effect. When evaluating the total number of BI direct effects, both PEOU ($\beta = 0.131$, $t = 2.722$, $p = 0.003$) and PU ($\beta = 0.387$, $t = 5.768$, $p < 0.001$) had significant positive relationships, indicating support for these hypothesised direct effects. In contrast, COMP did not indicate a direct effect on BI ($\beta = -0.000$, $t = 0.011$, $p = 0.496$), failing to provide support.

The mediation analysis revealed significant indirect effects of AB on both PEOU ($\beta = 0.131$, $t = 2.731$, $p = 0.003$) and PU ($\beta = 0.386$, $t = 5.782$, $p < 0.001$), confirming that AB mediates the relationship between these factors and BI. However, there was no indication of a significant mediation effect for COMP through AB ($\beta = -0.000$, $t = 0.011$, $p = 0.496$), suggesting no support for this proposed mediation pathway. These findings support the influence of PEOU and PU on BI through both mediations. On the contrary, COMP was shown to possibly have little effect on attitudes or teacher intentions regarding ICT use in the study context. (see table 3)

Subjective Norms Mediation

The analysis of the mediating role of subjective norms (SN) in technology adoption provided pertinent evidence toward the meaningful pathways relating social influence to teachers' behavioural intentions (BI) regarding ICT usage in Saudi primary schools. SN was significantly influenced directly by both superiors (SUPER) ($\beta = 0.338$, $t = 6.059$, $p < 0.001$) and peers' influence (PI) ($\beta = 0.612$, $t = 11.499$, $p < 0.001$), supporting the proposed direction of the relationships. Contrary to the proposed hypothesised relationship, no significant influence was determined from student influence (SI) toward SN ($\beta = 0.002$, $t = 0.042$, $p = 0.483$).

SN influenced BI with a significant positive relationship ($\beta = 0.209$, $t = 3.613$, $p < 0.001$). The direct effect on BI also provides evidence for the positive empirical relationships between SUPER ($\beta = 0.070$, $t = 3.018$, $p = 0.001$) and PI ($\beta = 0.128$, $t = 3.510$, $p < 0.001$), which support

the proposed relationships. As the data were consistent regarding SI, there was no significant influence on BI (β = 0.000, t = 0.041, p = 0.484), providing no support for the proposed relationship.

With the mediation analysis, the data did confirm the significant indirect effects through SN towards both SUPER (β = 0.070, t = 3.018, p = 0.001) and PI (β = 0.128, t = 3.510, p < 0.001) supported the mediating role of hypothesis SN between these social factors to BI. Contrary to our hypothesis, SI did not have a significant mediating influence, as indicated by SN (β = 0.000, t = 0.041, p = 0.484), providing no support for our proposed pathway. (see Table 3)**.**

Perceived Behavioral Control Mediation

The analysis of the mediating impact of perceived behavioural control (PBC) on technology acceptance suggested that control constructs possessed somewhat complex associations with teachers' behavioural intention (BI) toward ICT use in Saudi primary schools.

The direct effects on PBC indicated significant positive influences from self-efficacy (SELF) (β = 0.469, t = 6.082, p = 0.001), technology facilitation conditions (TFC) (β = 0.421, t = 5.549, p = 0.001), and resource facilitation conditions (RFC) (β = 0.108, t = 1.884, p = 0.030). All three hypothesised antecedents significantly influenced teachers' perceptions of control over using ICTs, confirming the first part of the proposed model.

While these three control factors produced strong relationships with the antecedent factors in this part of the model, the second part does not support the hypotheses. Specifically, PBC showed no significant influence on BI (β = 0.083, t = 1.508, p = 0.066) or actual ICT use (β = 0.042, t = 1.426, p = 0.077). Similarly, direct effects on BI from SELF (β = 0.039, t = 1.376, p = 0.084), TFC (β = 0.035, t = 1.516, p = 0.065), and RFC (β = 0.009, t = 1.089, p = 0.138) were also significant.

Corroborating these findings, no significant indirect effects through PBC were reported for any of the antecedents in the mediation analysis. Mediating paths were not supported for SELF (β = 0.039, t = 1.376, p = 0.084), TFC (β = 0.035, t = 1.516, p = 0.065), or RFC (β = 0.009, t = 1.089, p = 0.138). (see table 3)

Behavioral Intention Mediation

Examining the mediating role of behavioural intention (BI) found meaningful relationships in the ICT usage process for Saudi primary teachers. To summarise the results of direct effects on ICT usage, BI was significantly influenced by attitudinal beliefs (AB) (β = 0.598, t = 10.103, p < 0.000) and subjective norms (SN) (β = 0.209, t = 3.613, p < 0.000) but not by perceived behavioural control (PBC) (β = 0.083, t = 1.508, p = 0.066). Additionally, BI significantly influenced ICT use (β = 0.305, t = 7.114, p = 0.000), demonstrating the link between BI and behaviour. Regarding PBC, there was no significant direct effect on ICT use (β = 0.042, t = 1.426, p = 0.077).

The mediation analysis demonstrated important insights into the indirect pathways through which factors influenced ICT use. BI significantly mediated between AB and ICT use (β = 0.305, t = 7.114, p = 0.000), demonstrating that teachers' attitudes toward using technology influenced their behaviour by forming BI. Likewise, BI significantly mediated the relationship between SN and ICT use (β = 0.107, t = 3.275, p = 0.001), whereby social influence influenced technology use through BI. On the other hand, for PBC, BI did not demonstrate a significant mediation effect (β = 0.042, t = 1.426, p = 0.077), indicating that teachers' perceptions of control did not

influence their behaviour in using ICT by forming BI. (see table 3)

Relationship	Original Sample	Standard Deviation	T Statistics	P Values
PEOU -> AB	0.219	0.076	2.894	0.002
PU -> AB	0.647	0.081	7.968	0.000
COMP -> AB	-0.001	0.056	0.011	0.496
AB -> BI	0.598	0.059	10.103	0.000
PEOU -> BI	0.131	0.048	2.722	0.003
PU -> BI	0.387	0.067	5.768	0.000
PEOU -> AB -> BI	0.131	0.048	2.731	0.003
PU -> AB -> BI	0.386	0.067	5.782	0.000
AB -> BI -> ICTUSE	0.305	0.043	7.114	0.000
SUPER -> SN	0.338	0.056	6.059	0.000
PI -> SN	0.612	0.053	11.499	0.000
SI1 -> SN	0.002	0.042	0.042	0.483
SN -> BI	0.209	0.058	3.613	0.000
SUPER -> SN -> BI	0.070	0.023	3.018	0.001
PI -> SN -> BI	0.128	0.036	3.510	0.000
SN -> BI -> ICTUSE	0.107	0.033	3.275	0.001
SELF -> PBC	0.469	0.077	6.082	0.000
FCT -> PBC	0.421	0.076	5.549	0.000
FCR -> PBC	0.108	0.057	1.884	0.030
PBC -> BI	0.083	0.055	1.508	0.066
PBC -> BI -> ICTUSE	0.042	0.030	1.426	0.077
PBC -> ICTUSE	0.042	0.030	1.426	0.077

Table 3: Hypothesis Test Results

Model Explanatory Power and Predictive Relevance

Estimating R-square values informed assessments of the model's explanatory power or the proportion of total variance explained in the endogenous variables. Subjective norms (SN) accounted for the most significant level of explanatory power ($R^2 = 0.768$), indicating that these norms could explain more than three-quarters of the variance in the model. The results are shown in Table 3. The second highest was attitudinal beliefs (AB), which were explained by the model at 64.7%, followed by behavioural intention (BI) at 59.3%. Other variables that had relatively high explanatory power included compatibility (COMP, 53.3%), perceived behavioural control (PBC, 51.8%), and resource facilitation condition (FCR, 51.0%). The construct for actual ICT use had an R^2 value of 26.1%, indicating that the model explained about one-quarter of the variance in teacher technology usage behaviour. (see table 4)

The predictive relevance of the model was assessed using the Q^2 values, and the hierarchical pattern appeared distinctly different from R^2 values, with the most predictive relevance reported for compatibility (COMP = 0.500), followed by the resource facilitation condition (FCR = 0.467), and self-efficacy (SELF = 0.342). Subjective norms (SN) had the highest explanatory power among the constructs but showed a lower predictive relevance (Q^2 = 0.195). The difference between the R^2 and Q^2 values across the constructs would suggest that even though it has explanatory power, it does not translate into predictive relevance across the constructs or models. The tested model had the lowest predictive relevance value with ICT use (Q^2 = 0.090), indicating this model had limited predictive relevance for actual technology usage behaviour beyond the sample. (see table 4).

VARIABLES	**R-square**	**Q^2predict**
Attitudinal beliefs (AB)	0.647	0.234
Behavioral Intention (BI)	0.593	0.230
Compatibility (COMP)	0.533	0.500
Resource Facilitation Condition (FCR)	0.510	0.467
Technology Facilitation Condition (FCT)	0.169	0.103
ICT USE	0.261	0.090
Perceived Behavioral Control (PBC)	0.518	0.237
Ease of use (PEOU)	0.344	0.277
Peer influence (PI)	0.307	0.262
Usefulness (PU)	0.335	0.282
Self-efficacy (SELF)	0.395	0.342
Student influence (SI)	0.234	0.177
Subjective Norms (SN)	0.768	0.195
Superior influence (SUPER)	0.271	0.222

Table 4: Explanatory Power (R-Square) and Predictive Relevance (Q-Square)

Discussion

Interpretation of Findings

The findings reveal dissimilar outcomes for the principal constructs of DTPB regarding technology adoption behaviour. Specifically, attitudinal beliefs were the strongest predictors of behavioural intention ($\beta = 0.598$; $t = 10.103$; $p < 0.001$), accounting for 35.8% of the variance. Perceived usefulness ($\beta = 0.386$; $p < 0.001$) had nearly three times the effect of perceived ease of use ($\beta = 0.131$; $p = 0.003$) within this construct. Surprisingly, compatibility had no significant relation to attitudinal beliefs or behavioural intention, contrary to a central premise of diffusion theory (Rogers, 2003) and the original DTPB.

The pathways for subjective norms depicted a notable paradigm of social hierarchy, with peer influence demonstrating a substantial effect ($\beta = 0.612$ on subjective norms (SN); $\beta = 0.128$; $p < 0.001$ indirectly on behavioural intention (BI)) relative to superior influence ($\beta = 0.338$ on SN;

$\beta = 0.070$; $p = 0.001$ indirectly on BI), indicating that horizontal (collegial) relations exert more significant influence over ICT usage decisions than vertical (administrative) relationships. On the other hand, student influence indicated no significant effect on any path, which was unexpected. Perhaps more importantly, perceived behavioural control (PBC) was not significantly related to BI ($\beta = 0.083$; $p = 0.066$), despite significant antecedent constructs of self-efficacy ($\beta = 0.469$; $p < 0.001$), technology-facilitating conditions ($\beta = 0.421$; $p < 0.001$), and resource-facilitating conditions ($\beta = 0.108$; $p = 0.030$). This is noteworthy because it challenges DTPB's underlying premise that perceptions of control are the strongest predictors of intention to use.

BI also significantly predicted actual ICT use ($\beta = 0.305$; $p < 0.001$); however, the overall model to predict ICT use was modest ($R^2 = 0.261$), especially about commonly reported value ranges (0.67-0.89) in the West. Finally, Predictive relevance (Q^2) results were inconclusive about predictive relevance and explanatory power, producing further support for this idea.

Overall, the findings suggest strong attitude-related effects, moderate social influence effects, and weak control-related effects, suggesting that DTPB articulates the attitudinal and social dimensions of ICT usage. However, significant facilitation is necessary to fully account for the institutional constraints typical of centralised educational systems.

Comparison with Previous Studies

Overall, this investigation's results are consistent and inconsistent with existing research on educational technology adoption. For the attitudinal beliefs (AB) as mediators, we found significant relationships between perceived ease of use ($\beta = 0.131$, $p = 0.003$) and perceived usefulness ($\beta = 0.386$, $p < 0.001$) about behavioural intentions (BI). These findings are similar to those of Sadaf and Gezer (2020), who similarly found mediating effects of AB. The mediating effect of perceived usefulness was considerably more significant than that of perceived ease of use in our study, aligning with Mailizar et al. (2021), who found perceived usefulness to be more influential. The fact that there was no compatibility effect in our study was in contrast to Sadaf et al. (2012), who reported that teachers' compatibility belief is a significant consideration in their adoption of technologies. Rogers' (2003) diffusion theory also identified the importance of compatibility when individuals consider an innovation. Our study did not identify this compatibility relationship in the Saudi primary educational context.

In terms of our subjective norm (SN) results, we reported a moderate effect for SN ($\beta = 0.209$, $p < 0.001$), while higher than Cheon et al. (2012) ($\beta = 0.158$) but contrasted with findings from Teo (2016) which found negative influence of social influences for technology adoption. Furthermore, our finding of peers having high influence effects ($\beta = 0.612$ on the SN; $\beta = 0.128$, $p < 0.001$ on BI) correlates with Leejoeiwara's (2013) reported influence for Japanese instructors ($\beta = 0.28$), while superiority influences, demonstrated the influence that was not as strong ($\beta = 0.338$ on the SN; $\beta = 0.070$, $p = 0.001$ on BI). Overall factors regarding student influence were entirely missing in our study, which is one of the noticeable contrasts to the Western studies such as Sadaf and Johnson (2017), who reported that student expectations explained 40% of teachers' intention to adopt technology, and Sadaf et al. (2012) identified influence from students as the main factor paralleled in SN.

In terms of perceived behavioural control (PBC), we reported non-significant relationships between PBC and BI, which is significantly lower when compared to the more potent effects reported by Cheon et al. (2012) ($\beta = 0.501$) and Wu et al. (2022) ($\beta = 0.880$). Our study

demonstrated significant relationships between control antecedents and PBC, similar to those found by Khasawneh (2015) and Chien et al. (2018).

In terms of behavioural intention toward behaviour, our findings ($\beta = 0.305$, $p < 0.001$) exceed those from Weng et al. (2018) while weakening those reported by Sadaf et al. (2012). Most importantly, the overall explanatory power of ICT use in our study ($R^2 = 0.261$) was considerably lower compared to Western studies. Earlier findings from Almalki and Williams (2012) also observed that Saudi educational settings have structural limitations.

Practical Implications

The study's practical implications can be framed through understanding four process-oriented mediational paths that impact ICT use by Saudi primary teachers, each requiring contextual interventions specific to Saudi education practice to advance technology integration. The attitudinal beliefs mediation path illustrates how teachers' beliefs regarding the usefulness and ease of use of technology affect their intentions through teacher evaluation-oriented beliefs. The subjective norms mediation path presents how social supports, primarily from peers and superiors, influence teacher technology decisions. The perceived behavioural control mediation path, along with the strength of the antecedents, calls attention to paradoxes that exist in the limited impact on behavioural intentions. Finally, the behavioural intention mediation path illustrates that psychological precedents are followed for classroom technology usage.

For the mediation pathway of attitudinal beliefs, stakeholders should prioritise demonstrating clear pedagogical benefits of technology that align with Saudi curriculum objectives. Using culturally relevant examples, Professional development should emphasise how ICT enhances teaching effectiveness and student outcomes. The Ministry of Education should restructure training programs to emphasise educational value over technical features, acknowledging Saudi Arabia's achievement-oriented educational culture. School administrators should facilitate teacher evaluation of technology through structured assessment frameworks that help identify tools with genuine pedagogical benefits. This approach addresses the finding that perceived usefulness ($\beta = 0.386$) exerts nearly three times the influence of ease of use ($\beta = 0.131$) on behavioural intentions through attitudinal beliefs.

Concerning the mediating pathway associated with subjective norms, education systems should simultaneously utilise peer-based influence and respect hierarchies. The Ministry of Education should create formalised peer mentoring networks tailored to a potentially hierarchical structure that allows for sharing while not compromising authority relationships within the classroom. School administrators should develop formalised peer observation programs utilising rotating schedules to respect hierarchical influence, supporting a colleague-driven approach for deeper learning. Professional development providers should create a sense of community for learning and allow educators who are successful technology users to share their practice with their peers. The objective should be to recognise that peer influence ($\beta = 0.128$) mediated more strongly than superior influence ($\beta = 0.070$) in this capacity. Teachers should take action and look for opportunities to observe and collaborate with other teachers who effectively use technology in their classrooms. Learning opportunities should be structured and create a learning circle based on the hierarchy of organisations. However, the potential for both superior and peer-to-peer influence should be considered.

In order to resolve the discrepancy within the perceived behavioural control pathway mechanism, stakeholders must understand that developing enabling conditions is insufficient if

structural constraints are not also addressed. Ministry of Education leadership should establish implementation frameworks that develop a shared understanding of how Saudi Arabia's highly centralised education system impacts the degree of control decision-making around technology use. School administrators should create open committees that include teachers across the formal vertical hierarchy to collaboratively eliminate or minimise constraints that prevent teachers from acting upon their perceived behavioural control. Professional development might incorporate elements that support and scaffold teachers to act in centrally controlled aspects of considerable professional agency, mitigating institutional constraints. Teachers should identify implementation processes that recognise organisational limits or restrictions while identifying spaces for controlled innovations. Ultimately, these considerations relating to perceived behavioural control relations to technology and behavioural control pathways bridge the gap from substantial behavioural (self-efficacy: $\beta = 0.469$; technology facilitation: $\beta = 0.421$) control factors to a weak influence on technology intentions (behavioural control: $\beta = 0.083$).

In the mediation pathway from behavioural intention to actual use, stakeholders should implement guided support structures to overcome the intention-behaviour gap. The Ministry of Education should develop implementation protocols that clarify expectations for transforming intentions into practice while accommodating the realities of institutions. School administrators should establish protected implementation environments for teachers to engage with technology in approved ways. Professional development providers should include specific components for action planning and follow-up to assist with an implementation plan. In school, teachers should develop personal implementation plans that include step-by-step guidance, potential barriers, and strategies to overcome them. These recommendations help address the moderate relationship between intention and behavioural action ($\beta = 0.305$) and the low variance in explaining actual behaviour ($R^2 = .261$).

The practical implications, presented according to the four mediation paths, facilitate the development of targeted actions for stakeholders working with Saudi primary education's cultural and educational contexts. Given each mediated pathway's specific needs and limitations, educational leaders can respond and optimise strategic, meaningful ICT usage that promotes engaged learning and teaching in culturally relevant ways and utilises organisational structures in Saudi education.

Conclusion

Summary of Key Findings

This research examined the mediating influence of Saudi primary teachers' use of ICT through the DTPB framework on attitudinal beliefs, subjective norms, perceived behavioural control, and behavioural intention in using ICT. These outcomes show several important trends that help illuminate the technology adoption processes in this educational setting. The strongest predictor of behavioural intention was attitudinal beliefs ($\beta = 0.598$, $p < 0.001$). The findings show that perceived usefulness ($\beta = 0.386$, $p < 0.001$) was a lot more influential than perceived ease of use ($\beta = 0.131$, $p = 0.003$). This suggests that Saudi teachers prioritise pedagogical benefits over usability when evaluating technology. The relationship between compatibility, attitudinal beliefs, and/or behavioural intentions was insignificant.

The pathways for social influence exhibit a hierarchical trend in which peer influence has robust pathways ($\beta = 0.612$ on subjective norms; $\beta = 0.128$, $p < 0.001$ on behavioural intention), while superior influence contributes far less ($\beta = 0.338$ on subjective norms; $\beta = 0.070$, $p = 0.001$ on

behavioural intention). Not surprisingly, student influence had no direct path to either attitudinal belief or behavioural intention, a significant departure from DTPB's theoretical implications and described relationships in Western research.

Perhaps the most theoretically significant finding is that perceived behavioural control had no path to behaviour intention ($\beta = 0.083$, $p = 0.066$) while having significant antecedent factors of self-efficacy ($\beta = 0.469$, $p < 0.001$), technology-facilitating condition ($\beta = 0.421$, $p < 0.001$), and resource facilitating condition ($\beta = 0.108$, $p = 0.030$). Behavioural intention significantly influenced ICT use ($\beta = 0.305$, $p < 0.001$).

The overall model suggests modest explanatory strength ($R^2 = 0.261$), which is relatively low compared to typical values reported in Western research, ranging from 0.67 to 0.89. Predictive relevance (Q^2) highlighted the complexity of technology adoption, explaining some constructs but not predicting others.

The overall pattern is pronounced attitude-related effects, moderate social influences, and weak control-related effects; this suggests that although the DTPB had strong explanatory power related to attitudes and social-related effects, the model must change significantly to capture institutional barriers related to a centralised system.

Theoretical Contributions

This research makes theoretical contributions and moves beyond simply providing theoretical understanding. This study comprehensively explores four mediation mechanisms within the DTPB framework. It reports meaningful differences in the strength and significance of relationships that challenge traditional understandings of technology acceptance in educational contexts. Findings illustrate mediating mechanisms of attitudinal beliefs (AB), subjective norms (SN), perceived behavioural control (PBC), and behavioural intentions (BI), with varying levels of relevance and influence, which advance theoretical understanding of psycho-affective processes underlying educational technology acceptance.

The mediational analysis of AB demonstrates significant theoretical implications by showing that perceived usefulness ($\beta = 0.647$) considerably influenced attitudes toward ICT usage over perceived ease of use ($\beta = 0.219$). In addition, compatibility had no significant effect. This suggested a challenge to fundamental DTPB assumptions by showing that pedagogical effectiveness is more important in education than technical ease or relevance to previous experience. The strong mediational characteristics of attitudinal beliefs between perceptions and behavioural intentions ($\beta = 0.386$ usefulness; $\beta = 0.131$ ease of use) showed that acceptance of technology must follow a cognitive-affective-conative sequence that needs more precise modelling in theories about technology adoption. This pattern may also necessitate reconsidering how the DTPB conceptualises and weighs AB antecedents in professional educational settings, moving consideration of usefulness, ease of use, and compatibility beyond equal consideration toward frameworks more sensitive to context.

The findings related to SN mediation contribute original theoretical insights by revealing an order of social influence such that peer influence ($\beta = 0.612$) is significantly related to social influence compared to superior influence ($\beta = 0.338$). At the same time, there was no evidence of student influence. This order of influence contradicts DTPB assumptions about social referent groups. Instead, it offers evidence that professional colleague relationships provide the most forgiving influence on BI when adopting technology within educational contexts. The findings measured a significant mediation effect of SN between peer influence and BI ($\beta = 0.128$) in

contrast to the mediation of SN between superior influence and BI (β = 0.070), providing evidence that social influence may occur through different pathways of related pathways with varying strengths. The influence of students was not significant, nor did a non-significant outcome contradict the findings that may be adopted in other educational contexts and reinforce the need for theoretical models to address and possibly reflect on the specific institutional structures that may be effectively influencing some groups of stakeholders.

The PBC mediation analysis reveals the most important theoretical challenge for DTPB, finding that although self-efficacy (β = 0.469), technology-facilitating conditions (β = 0.421), and resource-facilitating conditions (β = 0.108) influence PBC, PBC does not affect behaviour intentions (β = 0.083) or ICT use (β =.042). This finding contradicts a central DTPB assumption that control perceptions will directly influence BI and behaviour. The findings indicate that in formal educational systems, teachers' perception of control may have limited influence on their intention to adopt technology due to the contextual frameworks which supersede teachers' agency. The pattern of PBC being related to all the control influences and the absence of PBC effects on intentions or behaviour indicates that DTPB needs to reassess how control constructs function in educational technology adoption. This finding suggests that these institutional structures inform a need for theoretical models to mediate or moderate the influences between control, intention, and behaviour.

The mediation analysis conducted for BI provides a rich theoretical contribution, as it helps to demonstrate that even when the relationships differ in strength across the pathways in DTPB, AB has the most substantial influence on BI (β = 0.598), followed by SN (β = 0.209), while PBC l had no effect. However, BI significantly predicts actual ICT use (β = 0.305), confirming its position as a proximal predictor of behaviour. The significant mediation effect of BI between AB and ICT use (β = 0.305) and SN and ICT use (β = 0.107) confirms that AB and SN influence ICT use through the formation of BI rather than a direct influence on behaviour. In contrast to the other two pathways, PBC had no mediation effect with ICT use, contradicting one of the key assumptions regarding DTPB. There are two pathways of influence for control factors. This pattern of findings suggests that DTPB warrants substantial modification to help explain the differential influence of the pathways for educational technology adoption, especially for the diminished influence of control factors in structured educational contexts.

Limitations of the Study

Several methodological and contextual limitations to this study must be considered when reading it. First, as the study was contextually limited to public primary schools in Dammam, Eastern Province, during the academic school year 2022-2023, the findings in this study might not be generalised across different periods or regions in the country. Educational resources, administrative practices, and culture can differ significantly across different areas of Saudi Arabia.

Secondly, the sampling approach had a significant limitation: 239 teachers were selected by convenience and voluntarily, which likely resulted in selection bias and selection of more technologically savvy or interested teachers. The sample demographics (59.4% of respondents were male; 40.6% were female) and distribution of participant-teachers across categories of teaching experience provided a reasonable representation of the population in Dammam. However, the approach represented a non-random sampling of primary teachers, limiting the generalisation of findings and conclusions to the broader population of Saudi primary teachers.

The cross-sectional design offers a brief view of teachers' perceptions and behaviours at one time, but concluding causation, advancement, or change in acceptance or use of technology is not straightforward. Further, data were not collected at one point, so it is difficult to ascertain how ICT use may have changed. It is pertinent to understand how adoption shifts as teachers get more accustomed to using technologies or if the conditions of the faculty (or institution) change.

Fourth, self-reported measures pose a further methodological limitation in the study. Although the instrument had established acceptable reliability and validity, the data whereby participants reported the use of an ICT, particularly as related to behaviour, is subject to social desirability bias whereby teachers may report their technology use on a spectrum that they believe to be acceptable, reasonable, or professionally desirable; this may have impacted the truth concerning ICT report.

Fifth, the statistical analysis is impaired due to the PLS-SEM (partial least squares structural equation modelling). This non-parametric approach is acceptable in the study and represents the complexity of the proposed model structure. Nonetheless, there are limitations to drawing statistical inferences. Future studies may also pursue retesting or confirming the study findings. Consideration should also be given to keeping exploratory and confirmatory studies relative to the reported findings and focusing clearly on predictive rather than causal relationships.

Ultimately, the R^2 did indicate some explanatory power for ICT use in this study ($R^2 = .261$). Thus, there was a potentially more significant categorisation of factors providing support for ICT use, which were absent from the analysis, reflection on the contextual variables for ICT use for primary schools in Saudi Arabia, which relates to the delimitations of the study, and contextual variables connected to context relevance factors. There are contextual limitations within all studies when considering the focus of this study on public primary schools under the governance of a Ministry of Education; results may and will differ in private schools or other educational areas within Saudi Arabia.

Additionally, the situation could be related to the pandemic, with such a growing education sector adjusting to a post-pandemic experience that could limit understandings of perceptions of technology use and access in another time and potentially contextually similar (less representative) situation or time frame. Regardless of the above limitations, the current study does provide significant considerations for observing the adoption of technology, establishing a baseline understanding of technology use for Saudi primary teachers, and informing future studies on ICT use in central education systems.

Future Research Directions

The present investigation explored ICT usage among Saudi primary teachers through the DTPB framework and highlighted several directions for future research. Longitudinal research would help document the development of teachers' technology adoption behaviours over time, particularly following professional learning activities or as teachers have more experience with educational technologies. This line of research would draw attention to the development of the technology integration processes within Saudi primary education and to the points in time that matter for the success of the intervention.

In response to the sample conditions that limited this study, I would encourage researchers to use better sampling techniques from multiple regions (states) within Saudi Arabia in the future. This extended period would allow for each area while still allowing researchers to determine whether the results from Dammam are longstanding across different administrative districts with

various resources and educational contexts in the Saudi educational policy landscape.

However, the finding that perceived behavioural control did not significantly affect behavioural intentions had forward, antecedent correlations among the groups studied, which tends toward interesting research avenues. Research explicitly looking to understand the impact of institutional barriers on Saudi primary education helps to understand why teachers' self-efficacy and access to facilitating conditions did not lead to intentions to use technology. This relates directly to the key theoretical inconsistency in this study using the DTPB model.

Further study is warranted, as it is associated with the absence of influence on students' decisions to use technology, as reported in other studies conducted as part of the students' perspectives. Research on the students' and teachers' relationships in the primary classroom context would provide helpful information to understand better whether the relationships' influences were embedded in the characteristics of the relationship and the context of age/social factors of primary classroom contexts in Saudi Arabia.

Given the reported and substantial impact of peer relationships on subjective norms and behavioural intentions, research conducted as part of peer-based professional development among collegial districts or other ways to utilise collegial networks in the existing structures of the Saudi primary education system might be the most helpful for future research.

Lastly, the $R^2 = 0.261$ limited explanatory power in the model utilised for actual ICT use suggests that additional factors beyond those in the DTPB framework may influence technology adoption in Saudi primary education. Research on additional constructs within centralised education systems may extend the model's explanatory data and provide a rich understanding of technology adoption in this educational context.

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Heterotrait-Monotrait Ratio (HTMT) Results

	AB	BI	COMP	FCR	FCT	IC	ICTUSE	LVSO	MF	PBC	PD	PEOU	PI	PU	SELF	SI1	SN	SUPER	UA
AB																			
BI	0.936																		
COMP	0.646	0.596																	
FCR	0.972	0.965	1.372																
FCT	0.290	0.233	0.243	0.689															
ICTUSE	0.513	0.579	0.170	0.454	0.676	0.375													
PBC	0.592	0.599	0.461	1.042	0.764	0.472	0.855	0.756	0.358										
PEOU	0.784	0.811	0.709	1.295	0.275	0.426	0.423	0.417	0.372	0.721	0.328								

PI	0.592	0.658	0.474	1.069	0.463	0.485	0.608	0.523	0.144	0.789	0.169	0.611							
PU	0.923	0.927	0.697	0.993	0.276	0.498	0.408	0.409	0.252	0.615	0.246	0.735	0.603						
SELF	0.875	0.952	0.703	1.342	0.229	0.621	0.490	0.511	0.305	0.796	0.297	0.902	0.758	0.895					
SI1	0.418	0.493	0.563	0.830	0.099	0.292	0.252	0.289	0.261	0.395	0.334	0.543	0.568	0.479	0.573				
SN	0.590	0.653	0.393	0.862	0.442	0.421	0.521	0.451	0.104	0.695	0.159	0.578	1.019	0.603	0.680	0.565			
SUPER	0.572	0.691	0.631	1.127	0.441	0.537	0.466	0.592	0.384	0.736	0.461	0.674	0.938	0.649	0.797	0.823	1.005		

Appendix B

Fornell-Larcker Criterion Results

	AB	**BI**	**COMP**	**FCR**	**FCT**	**IC**	**ICTUSE**	**LVSO**	**MF**	**PBC**	**PD**	**PEOU**	**PI**	**PU**	**SELF**	**SI1**	**SN**	**SUPER**	**UA**
AB	0.841																		

BI	0.737	0.794																	
COMP	0.472	0.436	0.787																
FCR	0.433	0.428	0.570	0.757															
FCT	0.164	0.179	-0.190	0.090	0.854														
ICTUSE	0.408	0.511	-0.030	0.216	0.523	0.257	0.777												
PBC	0.457	0.469	0.182	0.407	0.485	0.306	0.595	0.472	-0.092	0.717									
PEOU	0.632	0.649	0.527	0.583	0.019	0.378	0.326	0.300	0.314	0.495	0.301	0.791							
PI	0.469	0.527	0.353	0.481	0.359	0.373	0.475	0.409	0.073	0.584	0.113	0.493	0.836						
PU	0.78	0.79	0.5	0.48	0.09	0.45	0.352	0.34	0.16	0.45	0.15	0.63	0.51	0.77					

	6	1	53	0	9	6		0	0	2	1	9	5	8					
SELF	0.645	0.707	0.477	0.557	0.115	0.473	0.391	0.386	0.161	0.577	0.153	0.676	0.564	0.721	0.873				
SI1	0.369	0.442	0.468	0.416	0.083	0.280	0.233	0.299	0.248	0.339	0.326	0.492	0.507	0.460	0.476	1.000			
SN	0.488	0.545	0.304	0.407	0.361	0.352	0.440	0.368	0.020	0.540	0.091	0.493	0.839	0.542	0.532	0.529	0.797		
SUPER	0.396	0.485	0.385	0.432	0.305	0.369	0.340	0.390	0.163	0.496	0.208	0.462	0.669	0.490	0.518	0.641	0.748	0.849	

Note: Bold and Italicized Values represent the square root of AVE.

Appendix C

Cross-Loadings Results

	AB	**BI**	**COMP**	**FCR**	**FCT**	**IC**	**ICTUSE**	**LVSO**	**MF**	**PBC**	**PD**	**PEOU**	**PI**	**PU**	**SELF**	**SI1**	**SN**	**SUPER**	**UA**
AB3	0.890	0.623	0.363	0.376	0.186	0.388	0.451	0.300	0.038	0.394	0.105	0.502	0.396	0.668	0.528	0.284	0.409	0.310	0.412
AB4	0.717	0.565	0.511	0.377	-0.057	0.320	0.087	0.183	0.273	0.239	0.282	0.560	0.320	0.639	0.481	0.321	0.333	0.296	0.353
AB5	0.9	0.6	0.3	0.3	0.2	0.4	0.4	0.3	0.0	0.5	0.0	0.5	0.4	0.6	0.6	0.3	0.4	0.3	0.3

	03	65	23	38	68	26	70	07	03	05	76	31	58	72	10	25	80	88	64
BI1	0.502	0.832	0.174	0.268	0.279	0.295	0.616	0.355	-0.047	0.385	-0.033	0.481	0.460	0.570	0.527	0.383	0.455	0.419	0.253
BI2	0.626	0.872	0.468	0.421	0.007	0.348	0.314	0.294	0.223	0.316	0.272	0.603	0.397	0.641	0.604	0.393	0.392	0.374	0.422
BI3	0.598	0.646	0.347	0.293	0.211	0.352	0.340	0.308	0.068	0.455	0.100	0.452	0.406	0.610	0.531	0.304	0.482	0.402	0.297
BI4	0.615	0.808	0.416	0.385	0.043	0.299	0.313	0.270	0.155	0.318	0.182	0.523	0.395	0.686	0.577	0.313	0.387	0.331	0.339
COMP3	0.434	0.393	0.764	0.394	-0.091	0.195	0.084	0.251	0.339	0.243	0.328	0.437	0.340	0.483	0.413	0.394	0.298	0.379	0.517
COMP4	0.403	0.393	0.772	0.470	-0.192	0.298	-0.034	0.241	0.464	0.135	0.534	0.422	0.281	0.489	0.391	0.337	0.215	0.289	0.451
COMP5	0.276	0.241	0.824	0.480	-0.163	0.311	-0.118	0.139	0.487	0.052	0.576	0.385	0.212	0.329	0.322	0.376	0.207	0.243	0.503
FCR2	0.308	0.268	0.322	0.789	0.292	0.328	0.247	0.406	0.240	0.433	0.347	0.416	0.416	0.300	0.390	0.263	0.344	0.345	0.378

FCR3	0.351	0.389	0.557	0.724	-0.182	0.385	0.070	0.278	0.373	0.169	0.394	0.471	0.306	0.436	0.458	0.375	0.270	0.308	0.560
FCT1	0.192	0.194	-0.046	0.248	0.792	0.121	0.414	0.231	-0.126	0.431	0.023	0.120	0.370	0.119	0.143	0.158	0.393	0.357	0.016
FCT2	0.104	0.106	-0.237	0.004	0.918	0.080	0.496	0.144	-0.346	0.436	-0.225	-0.056	0.283	0.046	0.052	0.008	0.270	0.206	-0.113
FCT3	0.133	0.169	-0.187	0.003	0.849	0.165	0.426	0.009	-0.330	0.378	-0.247	0.003	0.279	0.098	0.111	0.062	0.277	0.236	-0.047
ICTUSE1	0.372	0.528	-0.013	0.142	0.385	0.186	0.8229	0.254	-0.193	0.436	-0.161	0.354	0.349	0.344	0.337	0.195	0.360	0.264	0.084
ICTUSE2	0.350	0.424	0.007	0.296	0.368	0.284	0.823	0.440	-0.138	0.520	-0.039	0.268	0.454	0.296	0.372	0.225	0.398	0.316	0.153
ICTUSE3	0.264	0.277	-0.125	0.060	0.512	0.176	0.774	0.301	-0.335	0.505	-0.283	0.155	0.319	0.211	0.260	0.124	0.309	0.226	0.025
IC	0.	0.	0.	0.	0.	0.	0.6	0.	-0	0.	-0	0.	0.	0.	0.	0.	0.	0.2	0.

TUSE4	234	250	018	1400	4441	137	74	265	.199	422	.183	152	360	186	199	158	284	45	094
PBC1	0.540	0.522	0.329	0.446	0.221	0.342	0.450	0.414	0.048	0.855	0.109	0.603	0.530	0.531	0.619	0.329	0.498	0.445	0.418
PBC2	0.406	0.404	0.287	0.479	0.109	0.341	0.364	0.376	0.138	0.777	0.208	0.500	0.418	0.405	0.596	0.308	0.368	0.365	0.417
PBC3	0.160	0.210	-0.186	0.059	0.706	0.080	0.568	0.212	-0.338	0.739	-0.249	0.110	0.440	0.157	0.226	0.161	0.401	0.335	-0.027
PBC4	0.052	0.075	-0.055	0.048	0.570	-0.009	0.360	0.399	-0.269	0.423	-0.176	0.009	0.228	0.060	0.015	0.125	0.240	0.255	-0.065
PEOU1	0.629	0.587	0.354	0.441	0.186	0.341	0.415	0.273	0.110	0.549	0.090	0.888	0.518	0.588	0.644	0.426	0.534	0.434	0.464
PEOU2	0.583	0.588	0.533	0.560	-0.144	0.402	0.152	0.217	0.391	0.348	0.371	0.899	0.416	0.597	0.632	0.488	0.434	0.420	0.574
PEOU3	0.397	0.430	0.207	0.328	0.192	0.162	0.408	0.244	0.089	0.469	0.032	0.663	0.355	0.364	0.414	0.316	0.303	0.321	0.275
PEO	0.33	0.42	0.5	0.50	-0.1	0.23	0.087	0.23	0.39	0.20	0.45	0.68	0.23	0.42	0.39	0.29	0.23	0.261	0.42

U4	3	2	61	2	47	5		5	7	0	6	2	7	7	5	2	6		4
PI1	0.422	0.473	0.306	0.345	0.299	0.342	0.373	0.276	0.043	0.495	0.052	0.452	0.903	0.470	0.511	0.497	0.807	0.619	0.381
PI2	0.269	0.289	0.114	0.353	0.442	0.235	0.512	0.452	-0.057	0.558	0.064	0.265	0.797	0.249	0.314	0.326	0.637	0.528	0.233
PI3	0.475	0.548	0.453	0.514	0.171	0.353	0.320	0.316	0.193	0.419	0.172	0.507	0.805	0.560	0.578	0.437	0.650	0.525	0.496
PU1	0.574	0.614	0.242	0.188	0.258	0.262	0.418	0.233	-0.108	0.471	-0.112	0.393	0.415	0.768	0.584	0.271	0.408	0.310	0.241
PU2	0.587	0.607	0.607	0.395	-0.158	0.355	0.092	0.192	0.329	0.216	0.313	0.554	0.345	0.751	0.538	0.388	0.319	0.374	0.466
PU3	0.543	0.528	0.327	0.288	0.221	0.205	0.348	0.241	-0.022	0.358	0.033	0.371	0.385	0.765	0.471	0.254	0.372	0.302	0.255
PU4	0.472	0.525	0.529	0.393	-0.099	0.292	0.092	0.204	0.279	0.205	0.225	0.515	0.401	0.734	0.420	0.389	0.365	0.362	0.425
PU5	0.658	0.648	0.347	0.354	0.268	0.360	0.463	0.340	-0.02	0.510	0.002	0.529	0.475	0.773	0.564	0.385	0.530	0.441	0.371

									0										
PU6	0.696	0.665	0.565	0.497	-0.074	0.497	0.159	0.263	0.299	0.315	0.276	0.631	0.390	0.837	0.690	0.444	0.438	0.401	0.515
PU7	0.701	0.644	0.319	0.387	0.268	0.461	0.450	0.343	-0.050	0.491	-0.070	0.470	0.491	0.824	0.633	0.351	0.544	0.463	0.411
PU8	0.606	0.663	0.508	0.449	-0.088	0.321	0.140	0.265	0.294	0.209	0.287	0.483	0.291	0.769	0.527	0.358	0.355	0.359	0.408
SELF1	0.582	0.645	0.309	0.427	0.217	0.392	0.454	0.365	-0.058	0.574	-0.068	0.542	0.538	0.677	0.891	0.417	0.535	0.480	0.406
SELF2	0.545	0.587	0.541	0.555	-0.032	0.437	0.214	0.306	0.368	0.426	0.365	0.648	0.442	0.576	0.855	0.415	0.385	0.422	0.561
SI1	0.369	0.442	0.468	0.416	0.083	0.280	0.233	0.299	0.248	0.339	0.326	0.492	0.507	0.460	0.476	1.000	0.529	0.641	0.434
SN1	0.366	0.410	0.317	0.407	0.225	0.265	0.246	0.237	0.073	0.385	0.132	0.415	0.677	0.388	0.382	0.320	0.739	0.443	0.309
SN2	0.304	0.379	0.135	0.262	0.353	0.264	0.351	0.269	0.001	0.387	0.035	0.327	0.606	0.370	0.336	0.352	0.829	0.672	0.217

SN3	0.386	0.452	0.227	0.310	0.304	0.309	0.386	0.274	-0.058	0.521	0.023	0.413	0.781	0.461	0.498	0.412	0.832	0.528	0.299
SN4	0.359	0.384	0.131	0.227	0.377	0.196	0.406	0.315	-0.067	0.434	-0.018	0.308	0.631	0.381	0.378	0.345	0.836	0.693	0.181
SN5	0.513	0.531	0.389	0.412	0.184	0.358	0.354	0.362	0.131	0.411	0.187	0.490	0.635	0.542	0.504	0.649	0.741	0.638	0.415
SUPER1	0.331	0.412	0.180	0.276	0.433	0.278	0.458	0.369	-0.065	0.516	-0.085	0.314	0.677	0.416	0.440	0.530	0.760	0.888	0.293
SUPER2	0.345	0.416	0.520	0.488	0.037	0.362	0.073	0.286	0.400	0.303	0.516	0.497	0.434	0.420	0.444	0.569	0.482	0.807	0.464