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Identifying the factors impacting the uptake of educational technology in South African schools: A systematic review

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The South African education system is considered one of the most unequal in the world. Providing learners with quality education and equipping them with the digital skills required for the Fourth Industrial Revolution is essential. To achieve this, plans are in place to incorporate educational technology in schools. However, it is important to understand the factors and conditions which have had the greatest impact on this process. This systematic review outlines 5 aspects that have been found to influence the use of educational technology in South African schools: access to technical resources; skills, training and competence; efficacy and efficiency beliefs; pedagogical compatibility; and a supportive leadership and management structure. Recommendations based on these findings are provided which can inform policy and practice.

Keywords: access; educational technology; ICT; SA schools; UTAUT

Introduction

The education system in South Africa, rooted in the historic legacy of apartheid, is considered one of the most unequal in the world (Spaull, 2015). When looking at the current education levels in South Africa, the consequences of educational inequality become apparent, with poor learners generally performing worse academically as a result of the quality of education they receive (Spaull, 2015). South African schools face numerous challenges, with class size, poor infrastructure, inadequate facilities and a lack of skilled educators being listed among the most important (Amnesty International, 2020). The learner-to-educator ratios in South Africa are very high, with the recommended ratio being a staggering 40:1 but the actual figures are sometimes double this (Department of Basic Education [DBE], 2015). It is often the case that educators in disadvantaged schools are less qualified and less experienced, further contributing to inequalities in education (Organisation for Economic Co-operation and Development [OECD], 2018).

The challenges faced in education are evident in the most recent Trends in International Mathematics and Science Study (TIMSS) results which found that the average performance of South African Grade 4 and Grade 8 learners in mathematics and science was among the three lowest countries globally, with only one quarter of learners at public no-fee schools achieving the minimum level of competency (Mullis, Martin, Foy, Kelly & Fishbein, 2020). Similarly, results from the Progress in International Reading Literacy Study (Mullis et al., 2020) indicate that South Africa achieved the lowest score among the 50 countries that participated in the study. Seventy-eight per cent of Grade 4 learners were found to be unable to read for understanding in any language. Despite the increased access to and use of educational technology (EdTech), the Progress in International Reading and Literacy Study (PIRLS) reports from 2011 to 2016 indicate that South Africa's performance has remained unchanged (Mullis, Martin, Foy & Hooper, 2016).

In 2019, 81.3% of matric learners attending public schools passed Grade 12 (Matric). While that seems impressive at face value, the reality is that only 38.9% of learners who enter Grade 10 complete Grade 12. For those who pass Matric, only 44.6% pass well enough for admission to bachelor's degrees. On the other hand, in the private school sector, where this attrition in learners entering Grade 12 is not witnessed, a Matric pass rate of 98.8% was achieved, with 89.5% of these learners qualifying for entry to bachelor's degrees, further highlighting the inequalities present in education in South Africa (South African Market Insights, 2019).

The education system in South Africa, which is hindered by this inequality in terms of class size, infrastructure, facilities, and a lack of skilled educators could benefit greatly from technological advancements in schools (Spaull, 2015). While it is vital that we provide quality education to all South African learners, it is equally important to equip learners and educators with the digital skills required in the Fourth Industrial Revolution (4IR). In President Cyril Ramaphosa's State of the Nation address (Ramaphosa, 2019), he highlighted the need for an improved education system to develop the skills we need now and for the future, with new technology subjects and specialisations being introduced, such as technical mathematics, technical sciences, coding, data analytics and robotics. Several ordinary public schools will be transformed into technical high schools to develop a technical vocational education stream and an occupational vocational stream (Ramaphosa, 2019). Ramaphosa stated that a framework has been developed which aims to develop skills for a changing world among both learners and educators.

Digital connectivity is a core facilitator of the 4IR and, while technology has the potential to mitigate the effects of inequality, there is also a great risk that it could widen the existing economic and social disparities (Chetty, Aneja, Mishra, Gcora & Josie, 2017; Martin, Samans, Leurent, Betti, Drzeniek-Hanouz, Geiger, Aurik, Zuazua, Schulz & Blaylock, 2018).

One of the ways of reducing the digital divide is through technology. Twenty-first century skills is a complex term which encompasses the skills deemed necessary to achieve success in the modern world (Lewin & McNicol, 2015). While numerous skills can be considered, critical thinking, creativity, collaboration and communication are typically considered as core competencies (Voogt, Pareja & Roblin, 2012). These are referred to as the "learning skills" which are centred around developing the mental abilities to thrive in the modern way of working. The key driver of 21st century skills is the shift seen in the 4IR (Lewin & McNicol, 2015) and EdTech can facilitate the development of 21st century skills (Ananiadou & Claro, 2009).

The ability of technology to reduce the digital divide depends largely on everyone having the capabilities to access and use technology. Hence, enabling school learners to attain digital literacy has the potential to provide them with the necessary digital skills required, as well as improving the access to and quality of education simultaneously (Chetty et al., 2017).

Learning with EdTech

Teaching with EdTech is believed to be a more effective pedagogy as it can provide a more collaborative and interactive learning environment (Enriquez, 2010; Lee, Yoon & Lee, 2009; Ludwig & Mayrberger, 2012). The use of EdTech has been found to improve learners' achievements, increase their attentiveness while, at the same time, offering a better system for the organisation of learning materials (Enriquez, 2010; Liaw & Huang, 2016; Ludwig & Mayrberger, 2012; Ongoz & Baki, 2010). In addition, the use of tablets to provide e-textbooks in place of multiple textbooks is both a cost effective and convenient solution (Liaw & Huang, 2016; Ludwig & Mayrberger, 2012).

The speed and scale of technological change is ever increasing, and we need to be prepared to fully benefit from these changes and ensure that they do not exacerbate existing inequalities or create new ones, especially in the South African context. Although the 4IR relies on technology, people are at the forefront of this development and the right skills need to be cultivated through educational outcomes. The government has put plans in place to incorporate EdTech in schools with the intention of improving learning outcomes while, at the same time, equipping learners and educators with digital skills. The DBE has put forward an action plan (DBE, 2015) with the following goals in mind:

- To enhance teaching and learning experiences of learners and educators through EdTech integration
- To ensure that learners have the ability to use digital technology and acquire 21st century skills
- To provide learners and educators with digital content pre-loaded onto appropriate devices
- To ensure that educators have the relevant training to integrate EdTech into teaching and learning
- To support learning and teaching in special needs schools

EdTech initiatives, such as the current smart school programme or paperless classroom project, have been implemented in an effort to meet these objectives (Lesufi, 2015). The smart school programme incorporates the use of interactive smartboards and mobile devices (such as tablets and laptops) equipped with internet connectivity, to conduct teaching and learning. It is the largest project to be undertaken by the Gauteng Department of Education to date and is crucial in transforming the current education system (Lesufi, 2015). The department had hoped to launch the project in all Gauteng townships and rural schools by 2018 at an estimated cost of R17 billion (Lesufi, 2015).

According to the 2019 Department of Education budget statement (Motshekga, 2019), this spend has been allocated to providing smartboards in classrooms, developing and pre-loading devices with e-content, digitising textbooks, upgrading software, training educators on how to use the technology and the roll out of broadband infrastructure to schools. The aim, by the end of 2019, was to have a total of 3,300 classrooms equipped with EdTech infrastructure and approximately 230,000 tablet devices distributed to learners. According to a briefing held by the Department of Education, as of October 2019, 4,697 schools had been equipped with connectivity, although it is important to note that 92% of these have only low speed connectivity. In addition, a total of 112,728 tablets had been provided to learners across South Africa, 3,000 of which were allocated to schools in Gauteng. This is an indication that the Department of Education still has a long way to go in achieving its EdTech roll-out goals (DBE, 2020).

Hence, with this study I sought to investigate the factors that influence the integration of technology using a systematic review method. The Unified Theory of Acceptance and Use of Technology (UTAUT) was used to ground this study. The UTAUT looks at four key constructs as determinants of behaviour, namely, Performance expectancy (PE), effort expectancy (EE), social factors (SFs) and facilitating conditions (FCs) (Venkatesh, Morris, Davis & Davis, 2003). The UTAUT posits that behavioural intention and FCs have a direct positive influence on technological usage. The variance explained by this model has been found to be significantly higher than that of previous models and hence it is considered to be a superior model (Venkatesh et al., 2003). It encompasses a wide array of factors effecting the use of technology among teachers and learners and has been used both internationally and in South Africa. The results of this review will be evaluated against the UTAUT model to propose recommendations in terms of ensuring the

successful integration of EdTech in schools in South Africa.

Methods

Research Design

Systematic reviews in educational research have much to provide the educational community by offering evidence from a broad selection of studies (Laher & Hassem, 2020). A qualitative systematic review was chosen for this study that was conducted on qualitative, quantitative and mixed methods studies.

The literature on the use of technology in education is diverse and multifaceted, containing a multitude of definitions for variables such as "access", "use" and even "technology" and includes both qualitative and quantitative studies. A review of the literature in this area would thus benefit from a methodological approach which does not over simplify and, therefore, lack applicability. For this reason, a critical interpretive approach was followed when conducting the review (Dixon-Woods, Cavers, Agarwal, Annandale, Arthur, Harvey, Hsu, Katbamna, Olsen, Smith, Riley & Sutton, 2006).

Review Process

This systematic review is based on the guidelines outlined by Khan, Kunz, Kleijnen and Antes (2003) which entail five key steps. The first step involves the framing of the research question. The primary question to be addressed in this review is "What are the inter- and intra-personal factors affecting the use of technology in schools in South Africa?" The second step is identifying the relevant literature in terms of search strategies and documenting findings. The third step is assessing the quality of the studies found and, interpreting and summarising the information are the fourth and fifth steps respectively.

Search Strategy and Study Selection

The review of the literature was carried out in April and May 2020. Articles were accessed through the university portal from PsychInfo, Research in Education Complete, Africa-Wide, Sabinet and Learning & Technology Library (LearnTechLib). These databases were selected as they covered a broad multidisciplinary collection of scholarly articles across various areas of study including education, EdTech, psychology and behavioural sciences, which are pertinent to this systematic review.

The search string combined relevant selected keywords and included Boolean operators and truncation to capture variations in the words: education OR school OR learning OR teaching OR class* OR education system AND technology OR ICT OR edtech OR educational technolog* AND South Africa. The PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) was used to record the articles that were found.

Three phases of screening were employed to refine the list of eligible articles. The initial screening was based on the title; thereafter, the abstracts were screened followed by the full article text. The PECO protocol (Higgins & Green, 2008) was used to facilitate framing the research question and determining the inclusion and exclusion criteria. To be included in the review, the articles needed to meet the following criteria: they were (1) published after the promulgation of the White Paper on e-Education between 2004 and the present; (2) written in English; (3) conducted with educators or learners in the schooling system in South Africa (primary and high school); (4) investigating the implementation of technology; and (5) published and peer reviewed.

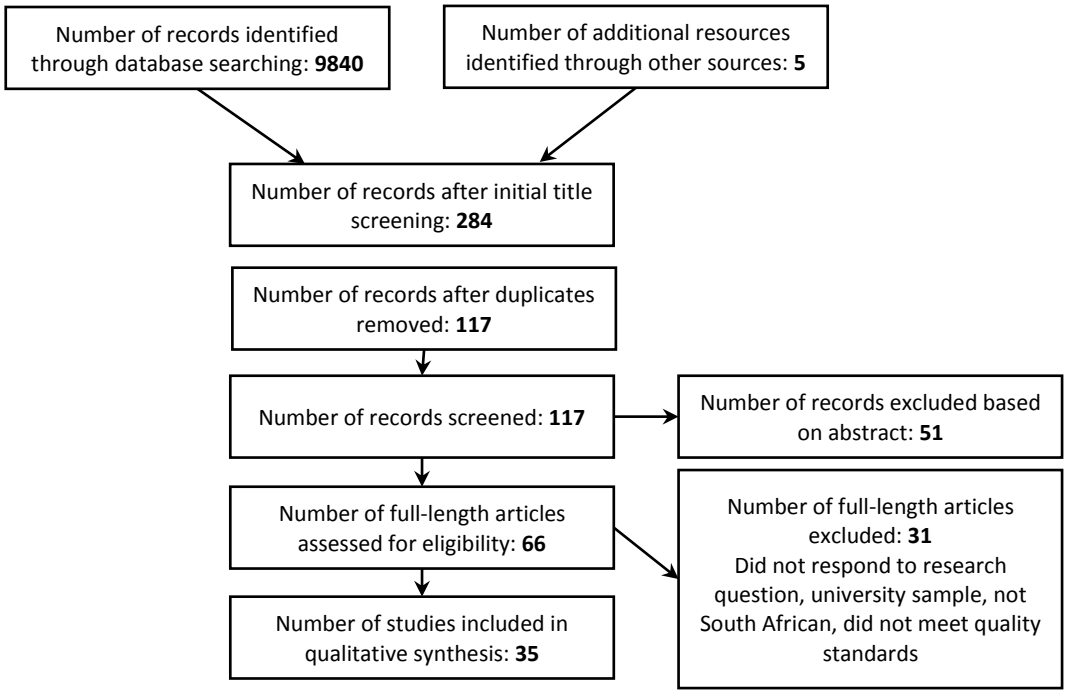

Figure 1 PRISMA flow diagram of article inclusion and exclusion

Quality assessment

To ensure that the screening process was correct and unbiased, a detailed record of the process was kept (see Figure 1). In the initial title and abstract screening, several articles were excluded as they did not investigate the use of technology in education. There were also a large number of articles which were excluded as the research was conducted in higher education facilities or pure online learning institutions. Research outside of South Africa was also excluded. Additionally, there were articles that contained information regarding theory and teaching practice but were excluded as they did not respond to the research question. Where there was uncertainty of a paper's relevance based on the information provided in the title and the abstract, these articles were retained for further inspection. The remaining 66 articles were then read in detail. During this process, notes were taken for each article including the title, aims and objectives, research questions, methodology, sample, analysis and findings. This was done to ensure that the articles in question included information relevant for this review. Each article was assessed based on the Critical Appraisal Skills Checklists for quantitative and qualitative studies to identify internal validity, external validity, relevance, originality and assess ethics compliance (see Laher & Hassem, 2020). Appraisal scores can be found in Table 1; articles with a CASP score lower than 8 were excluded from the systematic review.

Data Analysis and Synthesis

Thematic synthesis was conducted on the final sample of articles using the three steps outlined in Thomas and Harden's thematic synthesis (2008). The first step was to create "free codes" while going through the data line by line. Next, these "free codes" were grouped into related constructs to develop "descriptive themes" which summarised and described the findings, and then into "analytical themes" which went beyond the context and provided an interpretation of the results.

Results

The results section is arranged as follows: firstly, the articles which were included are presented, thereafter, the themes identified are described. A total of 35 articles were included in the final analysis. Of these, 10 were qualitative, 15 were quantitative and 10 used a mixed methods approach. Table 1 below contains the details of each of the articles.

Table 1 Summary of articles and Critical Appraisal Skills Programme Checklists (CASP) score

1	Van Niekerk & Blignaut	2014	A framework for Information and Communication Technology integration in schools through teacher professional development	Four rural and three urban schools	Principals	Qualitative	Semi-structured in-depth interviews	8
2	Govender	2012	A model to predict educators' attitudes towards technology and thus technology adoption	191 secondary schools within the Ethekwini region of KwaZulu-Natal (KZN)*	Educators	Quantitative	Questionnaire	9
3	Chigona, Chigona, Kayongo & Kause	2010	An empirical survey on domestication of ICT in schools in disadvantaged communities in South Africa	Three disadvantaged schools in the Western Cape* (Khanya Project)	Khanya Project manager, principals, educators	Qualitative	In-depth interviews	9
4	Ramorola	2013	Challenge of effective technology integration into teaching and learning	Gauteng*, Northern Tshwane, one public and one private senior secondary school	Educators and learners	Qualitative	Interviews, focus-group discussions, observations and document review	10
5	Bester	2016	Challenges in the integration of multimedia by History teachers in the North West Province of South Africa	North West* primary school township and rural areas Klerksdorp, Rustenburg and Vryburg	Educators	Mixed methods	Questionnaire, workshops	10
6	Roberts & Vänskä	2011	Challenging assumptions: Mobile Learning for Mathematics Project in South Africa	Phase 1: 25 schools (using the Nokia Mobile Learning for Mathematics project) Phase 2: seven schools from three different provinces and diverse contexts (quintiles 2, 3 and 5) high schools	Learners, educators and principals	Mixed methods	Usage data, learner questionnaire, learner focus groups, interviews and questionnaires from principal and teachers, mathematics marks	9
7	Bladergroen, Chigona, Bytheway, Cox, Dumas & Van Zyl	2012	Educator discourses on ICT in education: A critical analysis	Under-resourced primary schools in Cape Town, Western Cape* (Khanya Project Schools)	Educators	Qualitative	Semi-structured open-ended interviews	10
8	Chigona, Chigona & Davids	2014	Educators' motivation on integration of ICTs into pedagogy: Case of disadvantaged areas	Disadvantaged schools the Western Cape	Educators and project personnel	Qualitative	In-depth semi-structured interviews	10
9	Gelderblom, Matthee, Hattingh &Weilbach	2019	High school learners' continuance intention to use electronic textbooks: A usability study	High school urban	Learners	Mixed methods	Eye-tracking data, post-test interviews and focus groups	10
10	Chigona	2011	ICTs for curriculum delivery: Understanding educator's perceptions and experiences of the technology in disadvantaged high schools	Disadvantaged high schools (Khanya Schools)	Educators	Qualitative	In-depth interviews	10
11	Adegbenro, Gumbo & Olakanmi	2017	In-service secondary school teachers' technology integration needs in an ICT-enhanced classroom	Two Gauteng secondary schools	Educators	Mixed methods	Questionnaire and focus groups	10

12	Fleischmann, Van der Westhuizen & Cilliers	2015	Interactive-GIS-Tutor (IGIST) integration: Creating a digital space gateway within a textbook-bound South African Geography class	Rural school	Educators and learners	Mixed methods	Questionnaire and semi-structured interview	10
13	Muwanga-Zake	2007	Introducing educational computer programmes through evaluation: A case in South African disadvantaged schools	Disadvantaged High Schools - rural (five) and township (18) in the Eastern Cape*, KZN and Mpumalanga*	Educators	Mixed methods	Questionnaires, interviews, class visits	10
14	Jantjies & Joy	2016	Lessons learnt from teachers' perspectives on mobile learning in South Africa with cultural and linguistic constraints	Urban and rural schools in North West* and Gauteng	Educators	Qualitative	Semi-structured interviews	10
15	Hart & Laher	2015	Perceived usefulness and culture as predictors of teachers attitudes towards educational technology in South Africa	12 Gauteng public and private schools, across foundation, intermediate and senior phase	Educators	Quantitative	Questionnaire	10
16	Stols, Ferreira, Pelser, Olivier, Van der Merwe, De Villiers & Venter	2015	Perceptions and needs of South African Mathematics teachers concerning their use of technology for instruction	Resource constrained public secondary schools in the Eastern Cape	Educators	Mixed methods	Participatory reflection and action workshop and questionnaire	10
17	Mihai	2017	Success factors and challenges of an Information Communication Technology network in rural schools	Six rural high schools in Mpumalanga	School governing body members, principals, project manager, heads of department	Qualitative	Interviews	10
18	Graham, Stols & Kapp	2020	Teacher practice and integration of ICT: Why are or aren't South African teachers using ICTs in their classrooms	Primary and secondary schools, predominantly urban with some rural and township schools	Educators	Quantitative	Questionnaire	9
19	Kriek & Stols	2010	Teachers' beliefs and their intention to use interactive simulations in their classrooms	Semi-urban and urban high schools in Gauteng	Educators	Quantitative	Questionnaire	9
20	Dlamini & Mbatha	2018	The discourse on ICT teacher professional development needs: The case of a South African teachers' union	Rural, urban, semi-urban and township schools across South Africa	Educators	Quantitative	Questionnaire	10
21	Ojo & Adu	2018	The effectiveness of Information and Communication Technologies (ICTs) in teaching and learning in high schools in Eastern Cape Province	10 Public high schools in the Eastern Cape	Educators and learners	Quantitative	Questionnaire	10
22	Hart & Laher	2019	The role that access and attitudes toward tablets have on learners' achievement in a Johannesburg school	Private high school, Gauteng, urban	Learners	Quantitative	Questionnaire	10
23	Wilson-Strydom, Thomson & Hodgkinson-Williams	2005	Understanding ICT integration in South African classrooms	Schools in rural and urban township areas	Educators	Quantitative	Questionnaire	10
24	Laher & Boshoff	2017	Understanding learner attitudes towards the use of tablets in a blended learning classroom	Private primary and high school, Gauteng	Learners	Quantitative	Questionnaire	10

25	Gudmundsdottir	2010a	When does ICT support education in South Africa? The importance of teachers' capabilities and the relevance of language	Three disadvantaged schools (Khanya Project) and one ex Model C school, Western Cape	Learners, educators, principals	Mixed methods	Classroom observations, in-depth interviews	10
26	Padayachee	2017	A snapshot survey of ICT integration in South African Schools	34 high achieving schools in Gauteng	Educators	Quantitative	Questionnaires	9
27	Bovée, Voogt & Meelissen	2007	Computer attitudes of primary and secondary students in South Africa	Eight primary and secondary schools in Gauteng and the Western Cape. Upper/middle class and township schools	Learners, educators, principals and parents	Mixed methods	Questionnaire, focus groups	10
28	Gudmundsdottir	2010b	From digital divide to digital equity: Learners' ICT competence in four primary schools in Cape Town, South Africa	Three disadvantaged schools (Khanya Project) and 1 ex Model C school, Western Cape	Learners, educators, principals	Mixed methods	Classroom observations, in-depth interviews	10
29	Blignaut, Hinostroza, Els & Brun	2010	ICT in education policy and practice in developing countries: South Africa and Chile compared through SITES 2006	495 primary and secondary schools across South Africa	Principals, technology coordinators, educators	Quantitative	Secondary analysis	10
30	Mostert & Nthetha	2008	Information and communication technologies (ICTs) in secondary educational institutions in the uMhlathuze municipality, South Africa: An insight into their utilisation, impact, and the challenges faced	Urban and rural secondary schools, KZN	Learners	Quantitative	Questionnaire	10
31	Assan & Thomas	2012	Information and communication technology Integration into teaching and learning: Opportunities and challenges for commerce educators in South Africa	Six urban and rural high schools in North West	Educators, principals, school governing body members	Quantitative	Questionnaire	10
32	Howie & Blignaut	2009	South Africa's readiness to integrate ICT into mathematics and science pedagogy in secondary schools	Secondary schools across South Africa	Principals, technology coordinators, educators	Quantitative	Secondary analysis	10
33	Msila	2015	Teacher readiness and information and communications technology (ICT) use in classrooms: A South African case study	Primary and secondary schools in Gauteng	Educators	Qualitative	Semi-structured interviews	10
34	Govender & Maharaj	2005	The attitudes of educators to information technology adoption in school settings	93 secondary schools across KZN	Educators	Quantitative	Questionnaires	10
35	Chigona	2017	Western Cape subject advisors' perception of their preparedness for connected classrooms	Schools across the Western Cape	Educators (subject advisors)	Qualitative	In depth interviews and focus groups	10

Note. *Provinces in South Africa.

Thematic Synthesis

With this review I identified the various inter- and intra-personal factors affecting the uptake of technology in South African schools which can be classified into five categories. The articles covered in the review focus on principals and management, educators and learners and thus each category below is described in relation to each of these key stakeholders, where applicable. A summary of the descriptive and analytic themes appears in Table 2.

Table 2 Thematic synthesis – summary of the descriptive and analytic themes

Descriptive themes	Analytic themes
Access to suitable EdTech at school	Access to technical resources
Financial resources/funding (insufficient)	
Class size and computer: Learner ratio	
Access to technology outside of school	
Improper maintenance	
Technical issues	
Inconsistent electricity supply	
Internet access/coverage	
Theft/safety/security	
Lack of general technical skills/training among educators	Skills, training and competence
Lack of general technical skills/training among learners	
Educator's technophobia/lack of confidence	
Age of educators	
Professional development programmes inadequate	
Insufficient knowledge/exposure of how to incorporate EdTech	
Management's EdTech knowledge/skills	
Perceptions that EdTech will add value and improve teaching and learning	Efficacy and efficiency beliefs
Belief that it will increase workload/preparation (prep) time	
Belief that it will save time (decreased workload and prep time)	
Perceptions that EdTech distracts learners	
Perceptions that it will result in an overreliance on EdTech	
Easier access to knowledge	
Way in which EdTech is used	Pedagogical compatibility
Other priorities (curriculum change)	
Pedagogical preference	
Subject content	
No relevant curriculum-based online resources	
Preference for pen and paper (learners)	
Pedagogical shift required	
Principals' attitudes	Supportive leadership and management structure
Principals' attitudes and EdTech knowledge	
Strategic thinking/strong management and leadership	
Prioritising the use of information and communications technologies (ICT)	
"Champions"	
School level EdTech policy	
Motivation from management	

Access to technical resources

Access to technical resources was mentioned in 60% of the reviewed articles. Research has shown that, while access is a necessary component, it is not sufficient to ensure the successful use of EdTech (Bester, 2016; Hart & Laher, 2015; Wilson-Strydom et al., 2005). That being said, South African schools face several challenges in terms of access to technology which need to be addressed first for the successful uptake of technology at a school level to occur.

Many studies point out the lack of access to suitable technology or limited and infrequent access to technology (Bovée et al., 2007; Mostert & Nthetha, 2008; Ramorola, 2013; Roberts & Vänskä, 2011; Wilson-Strydom et al., 2005) as well as learners not being given permission to use the EdTech which is available (Muwanga-Zake, 2007). Another challenge mentioned in one study was that technology is not always equally allocated between subjects and so not everyone has the opportunity to use it (Assan & Thomas, 2012). Insufficient resources were also linked to overly large class sizes where the learner-to-EdTech ratio is very high (Chigona et al., 2014; Mihai, 2017; Muwanga-Zake, 2007; Ojo & Adu, 2018; Ramorola, 2013). It was also noted that access to technology at home plays a large role as it gives both learners and educators time to practice their skills (Gudmundsdottir, 2010a).

A lack of financial resources is one of the most commonly cited barriers for the use of EdTech (Assan & Thomas, 2012; Chigona et al., 2010; Mihai, 2017; Muwanga-Zake, 2007; Padayachee, 2017; Ramorola, 2013; Van Niekerk & Blignaut, 2014). EdTech is often prohibitively expensive and, as such, some schools do not have the funds needed to equip their classrooms (Van Niekerk & Blignaut, 2014). In some schools, which implemented

technology early on, these systems are now outdated and, due to a lack of funds, it is not possible to replace the old technology (Assan & Thomas, 2012).

The lack of funding or financial resources leads to the improper management of the systems (Chigona et al., 2010; Muwanga-Zake, 2007; Ramorola, 2013). It also means that having dedicated onsite technical support is not possible in these schools (Ramorola, 2013). Educators are deterred from using technology in their lessons if technical support is not readily available as schools are not able to deal with technological issues themselves, should they arise (Blignaut et al., 2010; Chigona et al., 2014; Padayachee, 2017).

Access to secondary technology tools in schools, such as electricity and internet connectivity, are also major barriers to the use of EdTech. An unreliable electricity supply (Assan & Thomas, 2012; Mihai, 2017; Mostert & Nthetha, 2008; Muwanga-Zake, 2007; Padayachee, 2017; Stols et al., 2015) and internet connectivity (Muwanga-Zake, 2007; Padayachee, 2017; Stols et al., 2015) were mentioned as major problem areas and, in one school, even though the school had the physical infrastructure available for internet use, they lacked the funds to pay for it and so it was disconnected (Muwanga-Zake, 2007).

Funds for the insurance and security of EdTech are also difficult to obtain (Mihai, 2017). Equipment is often stolen by people from outside the school structure who target the schools (Dlamini & Mbatha, 2018; Muwanga-Zake, 2007), as well as from within by educators, learners or school technicians (Dlamini & Mbatha, 2018). To prevent the theft of equipment, stricter controls of the use of technology are implemented, inadvertently limiting access to the EdTech (Dlamini & Mbatha, 2018).

Skills, training and competence

Around 60% of articles discussed the skills, training and competence of both educators and learners in the context of EdTech use. Difficulty in understanding and using EdTech affects educators' attitudes towards technology (Govender, 2012) and studies show that educators can, at times, find the use of EdTech to be overwhelming, highlighting the need for further educator training (Bovée et al., 2007; Ramorola, 2013; Stols et al., 2015).

The vast majority of studies mention the importance of skills and training for educators to successfully integrate technology within the teaching and learning environment. While numerous studies highlight the need for general technology training (Adegbenro et al., 2017; Chigona, 2011; Chigona et al., 2010; Dlamini & Mbatha, 2018; Gudmundsdottir, 2010b, Howie & Blignaut, 2009; Jantjies & Joy, 2016; Mihai, 2017; Mostert & Nthetha, 2008; Ojo & Adu, 2018; Ramorola, 2013; Roberts & Vänskä, 2011; Stols et al., 2015; Van Niekerk & Blignaut, 2014), some articles delve deeper into the type of training that is needed, finding that training, which details how to use EdTech effectively in lessons, is required (Chigona, 2011, 2017). There is a feeling that the training which has been received is inadequate and does not address educators' needs as it does not equip them with the pedagogical understanding and skills on how to incorporate EdTech into curriculum delivery effectively (Adegbenro et al., 2017; Chigona, 2017). Educators, therefore, need more exposure to technology-integrated teaching approaches (Stols et al., 2015) or training in situ (Adegbenro et al., 2017). Without this deeper knowledge, EdTech is likely to be seen as an add-on, rather than something which can enhance teaching and learning (Chigona, 2011; Dlamini & Mbatha, 2018).

Several studies found that older educators were more hesitant to use EdTech (Bester, 2016; Msila, 2015; Padayachee, 2017; Roberts & Vänskä, 2011). These educators felt that they were too old to acquire the necessary skills to apply EdTech in their teaching (Bester, 2016). Frustration at lagging behind younger colleagues was expressed by some (Roberts & Vänskä, 2011) and, as a result, older educators tended to isolate themselves and avoid using EdTech as they did not want to expose their incompetence (Msila, 2015).

Learners' competence is also an important consideration and, in some studies, was found to be inadequate (Graham et al., 2020; Mostert & Nthetha, 2008; Padayachee, 2017). When learners possessed the skill to adapt EdTech to suit their needs, they had greater satisfaction when using it (Chigona, 2011; Chigona et al., 2014; Gelderblom et al., 2019).

Furthermore, management (specifically school principals and subject advisors) need to have the necessary skills and knowledge to direct the use of EdTech and how it can be effectively integrated into curriculum delivery (Chigona, 2017; Van Niekerk & Blignaut, 2014). While principals may not use EdTech in the classroom themselves, their knowledge influences their ability to motivate educators (Van Niekerk & Blignaut, 2014).

Efficacy and efficiency beliefs

Efficacy and efficiency beliefs were addressed in just over half of the articles. Some studies identified that educators and learners are more likely to integrate EdTech if they believe it is beneficial and that it will ultimately make things more efficient or more effective (Bladergroen et al., 2012; Chigona et al., 2010, 2014; Gelderblom et al., 2019; Govender, 2012; Govender & Maharaj, 2005; Hart & Laher, 2015, 2019; Kriek & Stols, 2010).

Bladergroen et al. (2012) found that educators who appreciate the value of EdTech in education are willing to adopt it, while Kriek and Stols (2010) found that educators believed that the use of EdTech could improve teaching and learning and that this predicted intentions and the actual use of EdTech.

Furthermore, Govender (2012) found that perceptions of technology in terms of its ease of use, its ability to enhance job performance, as well as the belief that technology makes schools a better place, are predictive of technology integration.

Hart and Laher (2015) reiterate that attention must be paid to educators' perceptions of the use of EdTech as they need to understand that it will add value to the teaching experience for it to be successful. Chigona et al. (2014) also found that educators' expectations that technology makes teaching easier and more interesting are important determinants of the use of technology. While Govender (2012) found that, if educators perceive that it is instrumental in achieving valued outcomes, such as improved job performance, they will have more positive attitudes towards EdTech. Two studies also investigated learners in this regard and found that learners' expectations and how useful they perceived it to be influenced their intentions to continue using technology (Gelderblom et al., 2019; Hart & Laher, 2019).

Most studies found that educators felt that the use of EdTech was beneficial (Chigona, 2011; Fleischmann et al., 2015; Kriek & Stols, 2010; Msila, 2015; Stols et al., 2015). Chigona et al. (2014) note that some educators perceive EdTech as tools that make pedagogy easier and more interesting. It has also been found to save prep and teaching time (Fleischmann et al., 2015; Govender & Maharaj, 2005) while some studies found that educators felt technology could be helpful in integrating new curricula (Fleischmann et al., 2015; Msila, 2015). In the study by Bladergroen et al. (2012), educators felt that the use of EdTech was beneficial as it provided easier access of knowledge to both learners and educators and allowed learners to become independent thinkers. In the study by Adegbenro et al. (2017), educators believed that using computers for teaching and learning would have a positive impact on their teaching strategies and enhance the learning process.

Nine of the 35 studies included in this review report that learners and/or educators saw the value of EdTech, while in eights studies the opposite was found to be true. Thus, from the studies evaluated, it is evident that not all educators and learners appreciated the value offered by technology and did not see the benefit of using it (Chigona, 2011). In some studies it was found that both educators (Padayachee, 2017) and learners (Laher & Boshoff, 2017) believed that the use of EdTech was too distracting, and that educators believed that an overreliance on technology could create complacency among learners (Padayachee, 2017).

There is also the perception that educators spend too much time teaching technical skills rather than teaching with technology (Chigona et al., 2014), and that there is too little prep time to make the use of EdTech beneficial (Wilson-Strydom et al., 2005). Jantjies and Joy (2016) note that some educators felt that they did not have time to use technology and that it merely created more work for them.

Gudmundsdottir (2010a) found that educators, for the most part, did not believe that it would enhance admin and management skills, help them to acquire suitable knowledge or promote quality teaching. While Chigona et al. (2010) also report that educators were not all aware of the benefits of using technology and perceived it as something for office work, and not something one would use in the classroom.

Pedagogical compatibility

Aspects relating to pedagogical compatibility such as pedagogical preference, how the EdTech is used and how it aligns with the curriculum was mentioned in 40% of studies. It was found that pedagogical knowledge was required before educators could successfully integrate EdTech (Graham et al., 2020), with educators highlighting that a pedagogical shift was required and that new teaching methods needed to be developed and practiced to make the most of EdTech (Assan & Thomas, 2012; Howie & Blignaut, 2009). However, in some cases, there was a hesitance (or even resistance) to move from traditional methods of teaching to more modern practices where the use of technology enhanced the teaching and learning process (Chigona, 2017; Stols et al., 2015).

Educators mentioned that, as a result of the constant curriculum changes which they were still trying to grasp, the use of EdTech was not their top priority (Jantjies & Joy, 2016; Mihai, 2017). Educators also highlighted the fact that there were limited curriculum-based online resources available for them (Stols et al., 2015).

Pedagogical incompatibility can have an impact on how educators feel about the use of EdTech (Kriek & Stols, 2010), as well as how difficult they feel it is to integrate into lessons (Wilson-Strydom et al., 2005). Linked to the traditional method of teaching is the idea of "educator as expert"; EdTech has the potential to overturn this classroom dynamic and some educators express fears that it will replace their role in the classroom and it will put them in a situation where learners know more than they do, hence it is sometimes met with resistance (Chigona, 2011; Hart & Laher, 2015; Msila, 2015). Hart and Laher (2015) found that this was an important predictor of educators' attitudes towards technology and thus its actual use.

The impact of pedagogical preference is not limited to educators. In a study by Laher and Boshoff (2017), learners cited a preference for traditional pen and paper as the most common reason for not wanting to continue using EdTech. In addition, the pedagogical beliefs of principals were

found to be an important factor in the study by Blignaut et al. (2010).

Supportive leadership and management structure

The management structure of a school includes the principal, student governing body members, and senior management/head of departments (Mihai, 2017). A quarter of the reviewed articles considered the school management structure and studies have found that a supportive and positive leadership and management structure has an impact on the use of EdTech in the classroom (Blignaut et al., 2010; Chigona, 2011; Gudmundsdottir, 2010b; Mihai, 2017; Van Niekerk & Blignaut, 2014). Graham et al. (2020) found that social influence, that is, the opinion that technology is deemed necessary by important people, is found to predict behavioural intention to and actual use of technology in schools.

Not all principals prioritise the use of technology in schools, either due to their own attitudes or opinions on the matter, or due to factors outside of their control, such as the provision of basic educational infrastructure being the most important item on their agenda (Blignaut et al., 2010). Principals' attitudes and approaches, in terms of whether they take on a participative role or merely wait for a directive from the Department of Education (DoE), can influence how educators and ultimately learners use technology (Van Niekerk & Blignaut, 2014). One study, in particular, found that motivated and visionary leaders may compensate for learners' lack of access to technology and resulting lack of experience with technology by providing encouragement (Gudmundsdottir, 2010b).

Another display of supportive leadership is the appointment of "champions" in schools. This is a team of educators who are more proficient in the use of technology and who offer support and guidance to the other staff members. These individuals then share their knowledge at conferences and, in turn, learn from others on how best to incorporate technology (Dlamini & Mbatha, 2018).

Policy was mentioned in a few studies and can be considered as the pillar of supportive management structure. There is a general perception that the government does not have an adequate policy to guide the integration of technology into teaching and learning (Bladergroen et al., 2012; Ojo & Adu, 2018; Ramorola, 2013). Some schools have devised their own policies (Ramorola, 2013), while others are left without clear directives on future use and training (Bladergroen et al., 2012; Ojo & Adu, 2018).

Discussion

EdTech has the ability to improve the education system in South Africa while reducing the current disparities which exist. However, research has shown that the mere provision of EdTech is not enough to ensure successful integration in the classroom and that several factors should be considered in this regard. This systematic review outlines five categories of factors that have been found to influence the process: (1) access to technical resources; (2) skills, training and competence; (3) efficacy and efficiency beliefs; (4) pedagogical compatibility; and (5) a supportive leadership and management structure.

These results are discussed within the context of the UTAUT model in order to provide recommendations to guide more effective technology implementation in schools in South Africa. Figure 2 provides a visual summary of the findings discussed below.

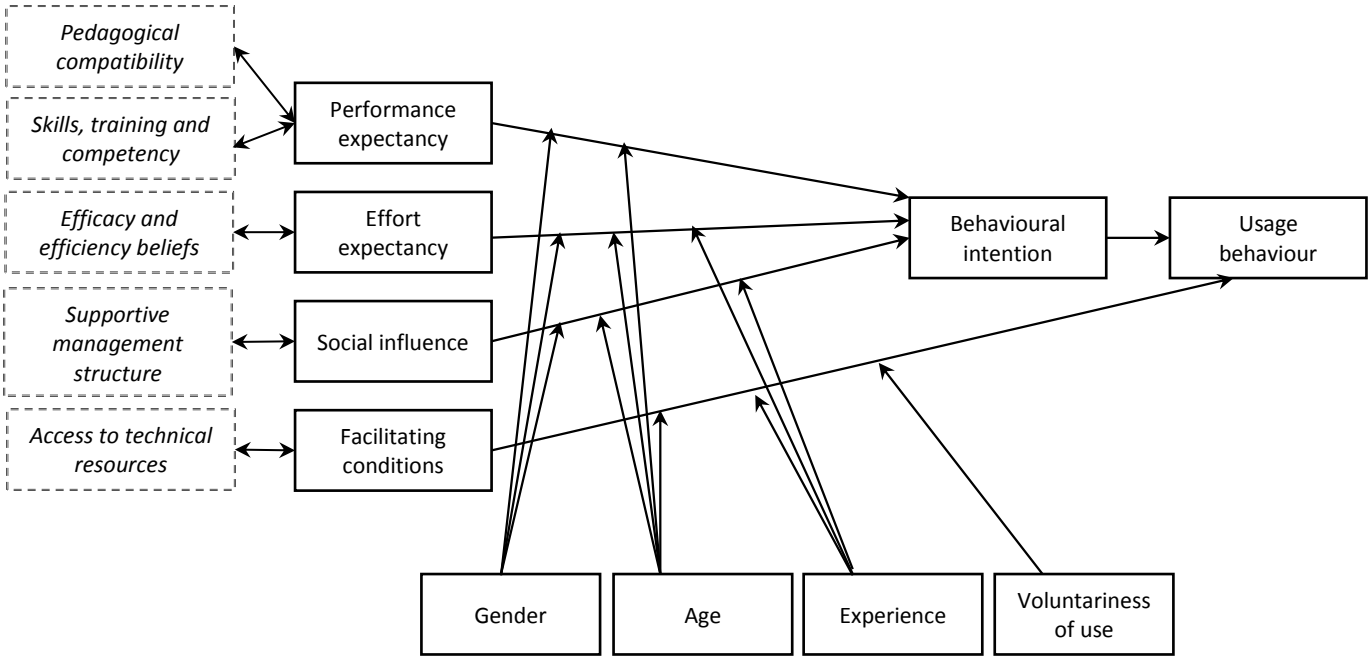

Figure 2 Findings mapped onto the UTAUT model (Venkatesh et al., 2003)

One of the most significant barriers discussed in the majority of articles is access to technology and technical resources. This includes the lack of hardware (Assan & Thomas, 2012; Chigona et al., 2010; Mihai, 2017; Mostert & Nthetha, 2008; Muwanga-Zake, 2007; Padayachee, 2017; Ramorola, 2013; Roberts & Vänskä, 2011; Van Niekerk & Blignaut, 2014; Wilson-Strydom et al., 2005) and having an unreliable electricity supply and internet access (Assan & Thomas, 2012; Mihai, 2017; Mostert & Nthetha, 2008; Muwanga-Zake, 2007; Padayachee, 2017; Stols et al., 2015). Furthermore, inadequate maintenance and a lack of onsite technical support were also found to be hindrances to the effective implementation of effective (Chigona et al., 2010, 2014; Muwanga-Zake, 2007; Padayachee, 2017; Ramorola, 2013). According to the UTAUT, facilitating the conditions or the degree to which an individual believes that there is support from technical and organisational infrastructure has a significant and direct impact on the integration of technology (Venkatesh et al., 2003). FCs are thought to be particularly important whenever there are resource constraints (Venkatesh et al., 2003) as is the case in the South African context.

EE, as per the UTAUT, is the degree of ease which is associated with the use of technology (Venkatesh et al., 2003). This factor encompasses two categories which are identified in this review – skills, training and competence, and pedagogical compatibility. This review shows that there are shortcomings in terms of both learner and educator training (Adegbenro et al., 2017; Chigona, 2011; Chigona et al., 2010; Dlamini & Mbatha, 2018; Gudmundsdottir, 2010a, 2010b; Howie & Blignaut, 2009; Jantjies & Joy, 2016; Mihai, 2017; Mostert & Nthetha, 2008; Ojo & Adu, 2018; Ramorola, 2013; Roberts & Vänskä, 2011; Stols et al., 2015; Van Niekerk & Blignaut, 2014). Beyond basic skills training, it was found that in situ training is required, not on how to use technology, but on how to teach with technology (Adegbenro et al., 2017; Chigona, 2011, 2017; Dlamini & Mbatha, 2018; Stols et al., 2015).

Skills training and competence is also closely related to pedagogical compatibility. Several studies reveal that a pedagogical shift is required and that new teaching methods need to be developed and practiced in order to fully utilise EdTech (Assan & Thomas, 2012; Howie & Blignaut, 2009) but, without proper training, educators may not have the skills required to make the necessary pedagogical shift. While there may be resistance to change (Chigona, 2011, 2017; Hart & Laher, 2015; Msila, 2015; Stols et al., 2015), aligning pedagogical practices with the use of technology can create a more beneficial learning environment (Herrington, Reeves & Oliver, 2010) and the right type of training can help in this regard.

PE, as per the UTAUT, is defined as the degree to which a person believes that using the technology will be beneficial (Venkatesh et al., 2003). In the context of using EdTech, this represents the degree to which learners and educators believe that using EdTech will have a positive impact on job performance, academic achievement and digital skills acquisition. From the studies presented here, efficacy and efficiency were identified as important factors in the South African context. While some studies found that EdTech was more effective and efficient (Adegbenro et al., 2017; Bladergroen et al.,

2012; Bovée et al., 2007; Chigona, 2011; Fleischmann et al., 2015; Govender & Maharaj, 2005; Kriek & Stols, 2010; Msila, 2015; Stols et al., 2015), it is apparent that not all educators fully endorse the use of technology (Chigona, 2011; Chigona et al., 2010, 2014; Gudmundsdottir, 2010a; Jantjies & Joy, 2016; Padayachee, 2017; Wilson-Strydom et al., 2005). This factor is frequently found to be the most significant predictor of behavioural intentions (Venkatesh et al., 2003) and, therefore, it is essential that PE among educators is improved in order to encourage the greater use of technology.

The last factor in the UTAUT is social influence, which refers to the idea that an individual's behaviour is influenced by the way in which they believe others will view them as a result of using the technology (Venkatesh et al., 2003). The opinions and priorities of principals and the school management team were found to be an important factor in South African schools, even having the potential to overcome other barriers (Blignaut et al., 2010; Chigona, 2011; Gudmundsdottir, 2010b; Mihai, 2017; Van Niekerk & Blignaut, 2014). EdTech champions serve as an important social influence, as they can help with skills training and competence and provide access to technical support. This construct is not significant in voluntary contexts and has been found to become insignificant in non-voluntary contexts over time (Oshlyansky, Cairns & Thimbleby, 2007). Since EdTech integration is mandatory but still in the early stages of integration in South Africa, it is reasonable that social influence is an important determinant of EdTech use.

Conclusion

This systematic review provides a snapshot of available research on the use of EdTech in schools in South Africa and offers recommendations that can inform policy and practice. The DoE has outlined various goals and, considering the findings of this study, the following is recommended to achieve these goals.

Ensure that Learners have the Ability to Use Digital Technology and Acquire 21st Century Skills

First and foremost, learners need to be provided with suitable EdTech. Formal training will ensure that all learners are equipped with basic digital skills and that educators do not need to spend valuable teaching time on ensuring that learners know how to use the devices.

Ensure that Educators have the Relevant Training to Integrate EdTech into Teaching and Learning

More comprehensive training for educators, focusing not only on the technical aspects of how to use technology but on how to teach with EdTech, is needed. This training should have a practical component to allow for more in situ training. Educators also need greater exposure to the types of EdTech tools available and how to use them.

Enhance the Teaching and Learning Experience through EdTech Integration

As evidenced in this review, educators need to be invested and see the value that EdTech can provide, and management needs to lead by example. Thus, a greater focus on getting principals and management upskilled and committed is required. In addition, where onsite technical support is not available, EdTech champions can assist with providing training, technical support and examples of how EdTech can be used in the classroom. Lastly, high speed internet is essential as it allows for faster access to information and the full use of EdTech.

The President's recent announcement (Ramaphosa, 2019) confirms the importance of using EdTech in schools. From this review, it is evident that South African schools face multiple challenges, which need to be addressed, in order to benefit from the use of EdTech that has the potential to improve access to quality education and reduce inequalities. However, if not properly implemented, it could widen the existing social disparities. This review has highlighted some of the challenges faced in South African schools and provides recommendations to ensure that EdTech uptake is successful and beneficial.

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