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Understanding the influence of Teachers' Beliefs and Professional Dispositions on Technology use in South African Secondary Schools before and during COVID

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Abstract

Those advocating for technology integration within education claim that teachers need to reform their pedagogic practices to make learning more engaging and relevant. While educational technology researchers claim teachers are primarily responsible for these failures, it seems teachers do not embrace technology unquestionably. This paper aims to develop an understanding of how teachers' beliefs and professional dispositions (PDs) influence technology use within different social and educational contexts. A set of three interviews were conducted at four South African secondary schools with vastly different social contexts, over different periods of time (before and during COVID) with cross-case analyses. Findings show that the provision of technology does not guarantee integration as use varies amongst teachers within technology-rich schools, with teachers who hold more positive Internal Beliefs (IBs) of technology not only focusing less on External Structure (ES) barriers, but also utilising technology in more varied ways, even to enhance and transform their pedagogic practices. Furthermore, teachers' PDs seem to exist on a continuum and do not appear to be the sole influencer of technology use, with the context alongside the school's technology policy and related technology structures influencing teachers' IBs and resulting technology use. In addition, while mandatory use of technology during COVID led to more positive IBs as teachers understood the value of the technology, this only appears to be true if external structures (ESs) supported the learners as well. Moreover, all teachers expressed their belief that technology is no replacement for face-to-face teaching. Finally, the rich data from the interviews underlined the intricacies of factors influencing the use of technology in classrooms, indicating a need for a meta-theory to gain a holistic understanding of technology use by teachers.

Keywords
Teacher beliefs; professional disposition; pedagogic practices; technology use; South African secondary schools

1 Introduction

Advocates claim that technology only enhances education and are frustrated by the current lack of technology integration (Bladergroen & Buckley, 2016; Chigona et al., 2014). Teachers are claimed responsible for the lack of technology integration due to a misalignment between their beliefs and associated pedagogic practices (Ertmer, et al., 2015), the perceived external and internal barriers to technology integration (Sherman & Howard, 2012), and the inability to respond to current educational requirements (Prensky, 2010). Vandeyar (2014) contends that technology initiatives which undervalue the importance of teachers' beliefs are ineffective. According to Tondeur et al. (2017), teachers do not unquestioningly embrace technology, as their beliefs about what constitutes "good" education are not based on technology use, but rather on the beliefs and perceived values guiding their pedagogic practice.

Altan et al. (2019) claim one's disposition, which is influenced by motivation and internal beliefs (IBs), and which describes subsequent behaviour and professional conduct, may be a reason for this misalignment. While some teachers' dispositions may promote technology integration, others may act as inhibitors (Vannatta & Fordham, 2004) and thus for technology initiatives to be successful, Altan et al. (2019) and Hoadley and Ensor (2009), contend that it is essential to understand the relationship between teachers' professional dispositions (PDs) and their resulting pedagogic practice. Consequently, Earle (2002) argues that incorporating technology in the classroom does not automatically occur when technology is present, rather a teacher's positive orientation towards technology is needed to actively incorporate it into their pedagogic practices (Tondeur et al., 2017). However, Ertmer et al. (2001) state that even when teachers believe using technology is valuable, their espoused beliefs do not always align with their observed pedagogic practice due to external and internal constraints.

While concerted efforts have almost eliminated external constraints in many developed countries (Ertmer et al., 2012), in emerging economies like South Africa, technology initiatives tend to mainly focus on removing or reducing external constraints by providing access to technology, training and support (Van Der Ross & Tsibolane, 2017). With the recent shift to remote education due to the COVID-19 pandemic, these differences have been amplified (Mhlanga & Moloi, 2020; Le Grange, 2020). Sherman and Howard (2012) and Padayachee (2017) contend simply focusing on providing teachers with technology without considering internal constraints, may also hamper technology initiatives. Giovannella et al. (2020) argue that many teachers were unable to exploit the full range of technology affordances during COVID-19, due to a lack of skills, limited time, and a belief that face-to-face teaching is important. According to Mama and Hennessy (2013) much of the research findings on technology integration within education are inconsistent, contradictory, or unconvincing. This is due to: many educational technology studies claiming that technology can only benefit education (Lim et al., 2013; Nkula & Krauss, 2015); little attention being paid to the underlying reasons for teachers' choices not to integrate technology (Lawrence & Tar, 2018); South African educational researchers focusing mainly on first-order barriers (infrastructure, access, hardware and software (Sherman & Howard, 2021); and a scarcity of literature dealing with technology integration within an educational context during a pandemic (Ash & Davis, 2009; Mhlanga & Moloi, 2020). Most studies are based on the premise of teachers' optional and voluntary use of technology (Mailizar et al., 2020), leaving many unanswered questions about the complexities encountered when moving to a setting where technology use becomes almost mandatory.

2 Objective and Research Questions

The objective of this paper is to understand how teachers' technology beliefs, about internal (IB) and external structures (ES), and their PDs, influence their subsequent use of technology in the classroom over time and within different social contexts. To answer the main question, the following sub questions have been constructed:

1. What is the context at different schools?
2. What are the external technology structures (ESs) at different schools and how do they differ between technology-rich and technologically disadvantaged schools?
3. What are different teachers' external and internal beliefs (IBs) around technology?
4. What are different teachers' professional dispositions (PDs)?
5. How do different teachers use technology and how is this different for teachers at technology-rich and technologically disadvantaged schools?

3 Literature Review

Barriers to technology adoption have an influence on teachers' beliefs and will be discussed first, followed by the concept of Professional Disposition (PD).

3.1 Barriers

According to Ertmer (1999), both first-order and second-order barriers influence teachers' technology utilisation in the classroom. First-order barriers, caused by ESs, include factors such as: resources, training, support, and time. For resources, frequency, and length of access (Rogers, 2000; Johnson, et al., 2016), quality and suitability for educational activities (du Plessis, 2014), and physical arrangements (Tondeur et al., 2008) need to be considered. For training and support, the frequency, extent and the nature of pre-service training and professional development (Ertmer et al., 2012; Schrum, 1999; Johnson et al., 2016), and the technical and institutional support offered to them, are important (Rogers, 2000; Hadijah & Shalawati, 2017). Insufficiency in either the quantity, quality, or nature of either technical or institutional support will inhibit technology integration (Rogers, 2000). Technology integration time has two dimensions: familiarity and feasibility (Karasavvidis, 2009). Teachers need enough time to effectively plan for and integrate it into their classrooms (Rogers, 2000; Ertmer et al., 2012). Although first-order barriers seem to have a larger influence on the incorporation of technology, Ertmer et al. (2012) claim access is not enough. Teachers' beliefs and attitudes around technology also influence its effective incorporation in the classroom. These second-order barriers are intangible, personal, and deeply entrenched (Ertmer, 1999) and are often believed to present a greater integration challenge than first-order barriers (Fisher et al., 1996; Ertmer, 1999). These include: pedagogy which relates to the teacher's personal views and experiences about teaching and learning (Denessen, 2000); norms which are shaped by the cultural, societal and organisational contexts in which the teacher lives and works (Somekh, 2008; Windschitl & Sahl, 2002); knowledge which includes beliefs about its nature, utilisation (Ertmer & Ottenbreit-Leftwich, 2010) and types, sources and stability (Howard & Maton, 2011); value of technology which depends on the teacher being confident with technology (Watson, 2006); and self-efficacy which relates to the teachers' belief in their ability to effectively make use of the technology (Ertmer, 1999; Ertmer et al., 2015).

The relationship between first-order and second-order barriers is not simple as it operates bidirectionally and at multiple levels (Ertmer, 1999). Teachers' willingness to integrate technology is often influenced by multiple factors at the same time (Van Der Ross & Tsibolane, 2017). Dwyer (1996) claims utilising technology can influence second-order changes in beliefs and pedagogic practices as it

necessitates teachers to reconsider their views of teaching and learning. Kerr (1996) and Hannafin and Savenye (1993) therefore argue that second-order barriers need to be considered and dealt with before, or at least in parallel with first-order barriers, to achieve greater levels of technology integration.

Ertmer (1999) claims that considering the underlying rationale behind teachers' reasons for first-order frustrations, explains how teachers' aims and beliefs around the role of technology in the classroom may influence their opinions and responses to first-order barriers. It is not the barriers themselves, but rather the relative importance given to them by the teachers, that influence their incorporation of technology in the classroom (Ertmer, et al., 1999).

3.2 Beliefs

Beliefs are defined as "psychologically held understandings, premises, or propositions about the world that are felt to be true" (Richardson, 2003:2) and "cognitive structures that an individual develops after collecting, processing and synthesising information" (Lewis, et al., 2003:658). According to Ertmer (2005), core beliefs are formed over many years, have multiple connections to other beliefs, and are hard to change, while peripheral beliefs are recently formed, more flexible and inclined to change. Core beliefs are most often associated with factors intrinsic to the teacher, and peripheral beliefs with extrinsic factors, but Mama and Hennessy (2013) state that both these beliefs influence teachers' technology integration. While the nature of external barriers is well established, teachers still believe that first-order barriers hinder their technology use in the classroom (Taylor & Todd, 1995; Hsu, 2016). This might be because a connection exists between teachers' technology use in the classroom and their beliefs about external barriers. Although Rogers (2000) argues that as teachers become more familiar with technology, their focus on external barriers is reduced, Karasavvidis (2009) contends that teachers' beliefs about these external barriers are still important, as they are often cited by them as the primary reasons for not integrating technology. While Kopcha (2012) states the link between teachers' beliefs about external barriers and actual barriers is still not well understood, Tondeur et al. (2017) argue that more research is needed as this relationship is complex, bidirectional, and multifaceted.

According to Liu (2011), teachers' IBs around technology are no different to their beliefs about external barriers. Firstly, pedagogical beliefs, which relate specifically to teachers' understanding, experience, or the ideas they hold about teaching and learning (Denessen, 2000), and general beliefs, are both complex and multifaceted (Ertmer & Ottenbreit-Leftwich, 2010). Teachers with learner-centred pedagogical beliefs do not automatically integrate technology more effectively or employ the technology in less traditional ways than teachers who hold more teacher-centred views (Teo et al., 2008). Secondly, teachers' normative beliefs are shaped by their cultural, societal, and organisational learning and work environments (Windschitl & Sahl, 2002). They are influenced about technology use by the school's set of norms that direct their activities. Their peers and their beliefs about the value of technology and its use, may also influence this (Somekh, 2008; Hennessy et al., 2010). Thirdly, teachers' value beliefs around technology depend on whether they feel confident that it can facilitate their instruction goals (Watson, 2006). They often feel exposed due to the unpredictability of technology and their lack of competence with it (Zhao et al., 2002). For teachers to incorporate technology into their classroom, its perceived benefits must be significant (Ertmer & Ottenbreit-Leftwich, 2010). Those who believe the affordances of technology can support their current teaching practices, offering them possibilities of enhancing their professional practice, and assist them to provide more engaging learning contexts, are more likely to integrate it into their classrooms. Lastly, self-efficacy (a person's belief in their own ability to perform a certain action to achieve a goal), motivates and influences people's actions (Bandura, 2000). Believing in one's own abilities to achieve instructional goals using technology may be more significant than actual technological skills and knowledge as confidence, not competence, shapes a teacher's self-efficacy beliefs (Ertmer & Ottenbreit-Leftwich, 2010). Categorised features which shape teachers' technology self-efficacy beliefs into work-related factors include a teacher's perception of local technology support; a teacher's beliefs about their subject area; the amount of time

technology is used at work; opportunities provided to gain technology skills; personality traits; home access and time needed to learn a new technology; the belief of technology's value in the educational environment; perception of ease of use; and fears of using technology in practice (Farah, 2011).

As teachers' beliefs do not exist in isolation, it is necessary to explore their view of pedagogy and professional practice (their professional disposition).

3.3 Professional Dispositions (PDs)

Dispositions refer to the underlying motivations by which a person organises intelligent behaviour and subsequent professional conduct (Altan et al., 2019). It is a summary of observed behaviour that can be used to describe current and future actions (Katz and Raths, 1985). Dewey (1938) uses a theory of experience to explain how dispositions develop through cognitive processes, influenced by the social context and experiences. According to Altan et al. (2019), clarifying the nature and meaning of teachers' dispositions makes the relationship between teachers' PDs and their resulting pedagogic practice more explicit. Hoadley and Ensor (2009) provide Bernstein's pedagogic device as a powerful framework to empirically study these.

3.3.1 Bernstein's Pedagogic Device

Bernstein's (2000) theory of pedagogic discourse consists of a set of interrelated hierarchical rules, which offers a powerful language for methodically describing and exploring the complex relationship between where knowledge is produced, recontextualised and reproduced. A teacher's pedagogic discourse is a specialised form of communication that transmits uncommon sense or school knowledge to learners (Hoadley, 2007) and consists of a collection of rules regulating the transmission and acquisition of knowledge by teachers and learners (Morais, 2002). According to Bernstein (1986) the pedagogic discourse consists of two analytically distinct but interrelated discourses: instructional (the rules of a specific discipline and its related content knowledge) and regulative (the rules for appropriate school behaviour and the approach of both teacher and learner within the classroom) (Singh, 2002).

The combination of these discourses dictates the transmission of knowledge rooted within a specific moral order that shapes teachers' pedagogic practices (Hoadley & Muller, 2010). Collection and integrated codes are defined to describe the strengths of boundaries of knowledge and power (Bernstein, 2000). Collection codes allow for the development of more specialised knowledge through the construction of solid boundaries (Morais, 2002) whereas integrated or combined codes allow for little separation between subjects through the blurring of boundaries (Morais, 2002) and with teachers organising and arranging the learning content primarily in relation to the learner.

4 Research Method

A qualitative case study approach was used, with a combination of Yin's (2014) descriptive and explanatory case study approaches, and a blend of Merriam's (1985) ethnographic, psychological, and sociological perspectives. Data was collected at three different instances over a period of eight months to explore: the initial educational context; the change to remote teaching and learning; and the subsequent change to a hybrid approach. Initial interviews were conducted in January 2020, while the second round of telephonic interviews was conducted between May and June 2020, and the third round between July and August 2020. As teachers' individual technology integration was studied within the context of their respective schools (together with differences between technology integration at various schools), an embedded multiple-case study was employed with the units of analysis being both the individual teacher and the school.

4.1 Embedded Multiple Case Study

Due to the size of the learner population and the continued focus of technology integration initiatives within the Gauteng province, it was decided to only select schools within the province. Potential schools were identified and contacted from a list obtained from the Gauteng Education Department (GDE) and the Gauteng branch of the Independent Schools Association of South Africa (ISASA). Schools who responded and used technology in their teaching and learning, were identified as the target population. Using purposive and snowball sampling, four schools with vastly different contexts were chosen: one independent school with numerous technology resources and advantaged learners; one independent school with some technology resources and disadvantaged learners; one government school with many technology resources and disadvantaged learners; and one government school with few technology resources and disadvantaged learners.

Once schools agreed to take part in the study, willing teachers were interviewed on a first-come-first-serve basis. Initially 19 teachers were interviewed face-to-face, interviews at each school were conducted until data saturation was reached, resulting in a different number of teachers being interviewed at each school. The second and third round of interviews (both conducted telephonically) consisted of the same teachers, with only 16 being available for these rounds. Semi structured interviews were used to gather teachers' self-reports of their beliefs and experiences (Creswell & Creswell, 2018). Rich data on ideas, beliefs, and thoughts were collected before and during lockdown.

4.2 Data Analysis

Qualitative content analysis was used to analyse the data. The initial coding frame was created in relation to the theories reviewed on Beliefs and PDs. Once interviews were transcribed and analysed, the coding frame was expanded through inductive reasoning by creating subcodes drawn from the data. Findings were interpreted in relation to the theories reviewed and the additional codes, per school, and then combined to understand the relationships being studied, using the participants' quotes as evidence.

To analyse the date, within-case analyses, which are crucial to understand the case as they facilitate the identification and analysis of key elements (Ayres et al., 2003), were used. In addition, cross-case analyses were used to identify commonalities and differences between cases, resulting in a synthesis of participants' experiences across different contexts (Ayres et al., 2003; Yin, 2014). The five research questions mentioned in Section 2 were used to provide perspectives on teachers' experiences within different school contexts.

The study maintained credibility by ensuring the interview questions and initial coding frame were drawn directly from the theoretical frameworks and then checked and aligned with the research questions. Transferability was ensured by using a purposive sampling strategy with maximum variation to locate diverse schools, while dependability was gained by transcribing all interviews verbatim. All participants were allowed to check recordings, transcriptions, and subsequent data. An audit trail was maintained to document the processes throughout the research process. Confirmability was ensured by using member checks of interview recordings and transcriptions to ensure that conclusions and interpretations were drawn from the data (Lincoln & Guba, 1985). Ethical clearance was granted for the study and confidentiality was ensured by using numbers for schools and pseudonyms for teachers.

5 Findings

5.1 School contexts

To provide a holistic understanding of each school's technology structures and teachers' beliefs and dispositions, a cross-case analyses was used. Table 1 summarises the different schools' contexts to contextualise each case study site and to describe teachers' lived experiences within the schools.

School 1
Technology-rich school; mainly advantaged learners; extensive technology infrastructure; pro-technology views; strong school; peer support, and technical assistance – almost seamless move to remote and hybrid with significant investment made in training and resource access. Learners grouped according to age.
School 2
Independent e-learning with more disadvantaged learners; limited technology infrastructure; mandatory technology use policy; sufficient school and technical assistance – moved platforms and trained teachers for remote and hybrid approaches. Learners grouped according to age.
School 3
Government school with e-learning strategy; mainly disadvantaged learners; teachers very committed to mentoring learners; good technology infrastructure; peer and technical support available – move to remote and hybrid hampered by learners' technology issues. Learners grouped according to age.
School 4
Non-ICT designated government school with mainly disadvantaged learners; limited government subsidies; very limited technology infrastructure; minimal support, training, and technical assistance –technology issues caused the academic project to cease when moved remotely - resumed to some degree when a hybrid approach was used as extra technology infrastructure was provided. Learners grouped according to age; strong discipline code and hierarchical structure based on race and position

Table 1: Summary of School and Teacher contexts

5.2 Technology Structures

Although the technology infrastructure of Schools 1 to 3 differs, teachers from these schools who believe technology simply supports their teaching activities, appear to be more focused on technology barriers, while teachers who believe technology can greatly enhance the educational experience, seem to find ways to work around these barriers. Even though most teachers in School 4 feel technology is essential to prepare and empower learners, they believe the lack of sufficient ESs makes it impossible to incorporate technology. Yet, the CAT teacher (with better access to technology resources), seem to find ways to overcome most external barriers. School 1 and School 4's provision of additional ESs, when using a hybrid and remote approach, seemed to result in more positive teachers' beliefs of ESs. Although providing better ESs may have resulted in more positive technology beliefs, the inverse may not be true, as teachers at School 3 still held positive ES beliefs despite very limited ESs when they operated remotely. Furthermore, even though School 2 provided additional ESs when the schools closed due to COVID, teachers who previously focused on external barriers only, seemed to be less concerned, as they spent more time exploring and utilising technology while appreciating its affordances.

5.3 Internal Beliefs (IBs)

Teachers' beliefs of ESs and IBs at School 1 are aligned. Those who believe first-order barriers are present at the school also appear to hold less positive IBs. However, while the shift to remote and hybrid teaching and learning resulted in more positive beliefs regarding the value of ICT and self-efficacy for all teachers at the school, even teachers who previously held pro-technology pedagogical beliefs now feel technology cannot replace face-to-face teaching. Teachers' ES beliefs and IBs at School 2 are also aligned, with improved provision of ES when using remote and hybrid approaches, positively influencing some teachers' IBs. However, teachers at School 2 report that despite their IBs being more positive, ES barriers for learners are limiting their technology integration. The same applies in School

3 where although teachers' beliefs of ESs and IBs also appear to be aligned, teachers report that despite their positive IBs of high technology self-efficacy and an appreciation of ICT, ES barriers hinder their technology integration efforts when off campus. Likewise, teachers' beliefs of ESs and IBs at School 4 seem to be aligned because whether on campus or remote, beliefs of insufficient and inadequate ESs appear to negatively influence their IBs. When back on campus with the provision of additional technology resources and training, their IBs seem to be more positive. However, in accordance with Schools 2 and 3, teachers at School 4 report that despite now holding more positive IBs, persistent and pervasive ES barriers are influencing their technology integration efforts.

Overall, findings indicate that any IB cannot be understood in isolation. For example, while teachers at School 1 and School 3 report that the school's pro-technology policy positively influences their other IBs, teachers at Schools 2 and 4 report a code clash with the school's normative beliefs which seem to affect their other IBs negatively. In addition, findings suggest even though teachers' IBs are mainly aligned, this may not hold for all teachers and schools. For example, at School 2 teachers with strong teacher-centred beliefs report having high technology self-efficacy and value for ICT, while a teacher who holds more learner-centred pedagogical beliefs feels technology has limited value.

5.4 Technology use

The school context and the school's technology policy are important in shaping teachers' technology use and related technology activities. Teachers who believe the school is not supportive of technology or monitors its use, tend to limit its use. Furthermore, the surrounding educational context also appears to be influencing teachers' technology use and adoption activities, with the change to remote and hybrid teaching and learning resulting in all teachers using technology for a wider range of supportive activities. However, due to the immediate need to accommodate off-campus approaches, for most teachers who previously used technology for activities to enhance and transform their practices, their current use of technology seems to be only supporting their teaching and administrative activities.

5.5 Professional Disposition (PD)

It is not always possible to neatly define and categorise teachers PDs as the difference between collection and integrated codes is not distinct, since most teachers (Schools 1–4) who appear to possess mainly collection codes, also have parts of integrated codes present in their PDs. Inversely, teachers who possess more integrated codes also have aspects of collection codes present. It also seems as if teachers' PDs can change, depending on the social and teaching context. For example, some teachers at Schools 1 and 4 report they possess collection codes for younger grades and more integrated codes for senior learners. The move to remote teaching and learning has also resulted in teachers who (on campus) mainly or only possessed collection codes, now also having greater aspects of integrated codes. The subject taught may also play a role in shaping teachers' PDs (Schools 1–4). Table 2 provides a cross-case analyses summary of the findings.

External Structures (ES) and Beliefs
On Campus (prior to COVID)
School 1 - teachers tend to focus on barriers when they believe technology is supporting teaching/unsuited to specific subjects School 2 - teachers focus on barriers when they dislike technology/believe technology is unsuited to specific subjects School 3 - teachers who are competent in using technology/value ICT, focus less on barriers School 4 - teachers believe ICT has value, but still focus on barriers - with better access teachers are less focused on barriers
Hybrid and Remote (start and during COVID)
School 1 - teachers appears to hold more positive beliefs with the provision of additional ES School 2 - despite extra ES provided, more positive beliefs seem to be attributed to time spent using technology School 3 - teachers still hold positive beliefs of technology despite lack of ES School 4 - provision of extra ES when back on campus, resulted in more positive beliefs about ES
Internal Beliefs (IBs)
On Campus (prior to COVID)
Schools 1 & 2 – teachers' IBs aligned with their ES beliefs, and teachers with positive IBs less focused on ES barriers School 3 - school's pro-technology policy positively influences teachers' IBs School 4 - code clash between teachers' and school's normative beliefs, which negatively influences teachers' IBs
Hybrid and Remote (start and during COVID)
School 1 - teachers' IBs aligned with their ES beliefs, and IBs are mainly positive School 2 & 4 - teachers' IBs are more positive with better ES, but barriers for learners an issue School 3 - teachers' IBs are positive, but ES barriers hinder technology integration
Professional Dispositions (PDs)
On Campus (prior to COVID)
Schools 1 & 4 - combined codes exist, but more collection codes for science-type subjects and younger grades Schools 2 & 3 - combined codes exist but more collection codes with science-type subjects
Hybrid and Remote (start and during COVID)
For all schools - boundaries between teachers and learners have blurred due to any-time-any-place teaching/learning
Relationships
ES and IBs cannot be viewed in isolation from each other
School 1 - school's pro-technology beliefs are positively influencing other IBs School 2 - teachers' beliefs of insufficient ES is negatively influencing IBs School 3 - teachers with positive IBs, appear to focus less on ES barriers School 4 - school's technology policy is negatively influencing other IBs
IBs may not align with each other
School 1 & 4 - valuing ICT does not mean pedagogy beliefs will automatically support technology use School 2 & 3 - teacher-centred beliefs do not mean ICT is not valued and skills are poor

Table 2: Cross-case analysis summary of findings for Schools 1 – 4

6 Discussion

This paper contributes towards the call for understanding the underlying reasons for teachers' technology use and beliefs (Lawrence & Tar, 2018). The complex relationship between barriers caused by ESs, IBs and PDs and its influence on technology use is considered. Existing literature which has been confirmed, include: IBs are aligned with the perception of external barriers caused by external structures (ES); teachers with positive IBs tend to regard ES barriers as less influential, whereas teachers with negative IBs tend to focus more on ES barriers; teacher-centered beliefs do not imply that ICT is not valued, and valuing ICT does not imply that pedagogical practices beliefs support technology use. These findings are consistent across the different school contexts with different ICT infrastructures. School policy also seems to influence the IBs of teachers as was illustrated in Schools 1 and 4.

A further contribution lies in the opportunity to study these factors when technology use is mandatory (as was the case during the COVID-19 pandemic). During this time, where schools who could afford to provided teachers with better ESs, IBs improved. However, even though technology

was almost the only way to continue with the academic project, most teachers, even those with positive IBs, contended that technology cannot replace face-to-face teaching. Also, while operating in crises mode, most teachers, who previously used technology for activities to enhance and transform their practices, reverted to using technology for only supporting their teaching and administrative activities. The mandatory use of technology furthermore resulted in blurred boundaries between learners and teachers and school and everyday life.

Due to the disparities between technology-rich and technology-disadvantaged schools and learners, South African research studies on the use of technology by teachers tend to focus on first-order barriers caused by ESs only. This study confirms that simply addressing external constraints, even when first-order barriers are significant, does not automatically result in technology integration in the classroom. Consideration of second-order barriers, teachers' beliefs, and school context are also crucial for technology integration initiatives.

Finally, the rich data from the interviews underlined the intricacies of factors influencing the use of technology in the classroom. The factors highlighted here are barriers caused by both ESs and IBs. IBs are influenced by a myriad of factors, such as pedagogical and normative beliefs, perceived value, self-efficacy, and PD. Future research should aim to develop a meta-theory to guide the gathering of empirical data to a provide a more holistic understanding of technology use by teachers in the ever-changing South African context. Furthermore, revisiting the schools within the study to collect additional data on teachers' technology at schools post-COVID, lockdowns, and closures may offer even greater insights into future 'hybrid' educational models.

7 Conclusion

This study provides a rich account of the technology use of 16 teachers from four different schools before and during the COVID-19 pandemic. It focusses on first-order barriers caused by ESs, second-order barriers (IBs) to technology use, and on Professional Disposition (the way in which a teacher conducts herself and sets boundaries in her profession and subject). The data gathered through the interviews underlined the intricacies of factors influencing the use of technology in classrooms. School contexts and sufficient ESs appear to be a necessary but not sufficient condition for positive IBs. This explains the similarity of the findings across the four vastly different school contexts. Teaching during COVID-19 underlined the value of technology in teaching, but even more so, the fathomless value of face-to-face teaching.

References

Altan, S., Lane, J. F. & Dottin, E., 2019. Using Habits of Mind, Intelligent Behaviors, and Educational Theories to Create a Conceptual Framework for Developing Effective Teaching Dispositions. Journal of Teacher Education, p. 169–183.

Ash, K. & Davis, M. R., 2009. E-Learning's Potential Scrutinized in Flu Crisis. Education Week, 28(31), pp. 1-12.

Ayres, L., Kavanaugh, K. & Knafl, K., 2003. Within-Case and Across-Case Approaches to Data Analysis. Qualitative Health Research, Volume 13, pp. 871-883.

Bandura, A., 2000. Exercise of human agency through collective efficacy. Current directions in psychological science, 9(3), pp. 75-78.

Bernstein, B., 2000. Symbolic Control and Identity: Theory, Research, Critique. Lanham, Maryland: Rowman & Littlefield.

Bernstein, B., 1986. On pedagogic discourse. In: I. J. Richardson, ed. Handbook of theory and research in sociology of education. Westport, CT, pp. 205-239.

Bladergroen, M. & Buckley, S., 2016. Management of ICT in education: A meta-study on the local South African and International research landscape. Paper 37, CONF-IRM 2016 Proceedings.

Chigona, A., Chigona, W. & Davids, Z., 2014. Educators' motivation on integration of ICTs into pedagogy: case of disadvantaged areas. South African Journal of Education, 34(3), pp. 1-8.

Creswell, J. & Creswell, J. D., 2018. Research Design: Qualitative, Quantitative, and Mixed Methods Approaches. 5th Edition ed. Thousand Oaks, United States: SAGE-Publications Inc.

Denessen, E., 2000. Beliefs about education. Apeldoorn: Garant.

Dewey, J., 1938. Experience and education. New York: Collier.

Du Plessis, P., 2014. Problems and Complexities in Rural Schools: Challenges of Education and Social Development. Mediterranean Journal of Social Sciences, 5(20), pp. 2039-2117.

Dwyer, C., 1996. The imperative to change our schools. In: C. Fisher, D. C. Dwyer & K. Yocam, eds. Education and technology: Reflections on computing in classrooms. San Francisco: Jossey-Bass, pp. 15-33.

Earle, R. S., 2002. The integration of instructional technology into public education: Promises and Challenges. ET Magazine, 42(1), pp. 5-13.

Ertmer, P. A., 1999. Addressing first- and second-order barriers to change. Strategies for technology integration. Educational Technology Research and Development, 47(4), pp. 47-61.

Ertmer, P. A., 2005. Teacher pedagogical beliefs: The final frontier in our quest for technology integration? Educational Technology Research and Development, 53(4), pp. 25-39.

Ertmer, P.A. and Ottenbreit-Leftwich, A.T., 2010. Teacher technology change: How knowledge, confidence, beliefs, and culture intersect. Journal of research on Technology in Education, 42(3), pp.255-284.

Ertmer, P. A., Ottenbreit-Leftwich, A T., Sadik, O., Sendurur, E. & Sendurur, P., 2012. Teacher beliefs and technology integration practices: A critical relationship. Computers and Education, Volume 59, pp. 423-435.

Ertmer, P. A., Ottenbreit-Leftwich, A. & Tondeur, J., 2015. Teacher beliefs and uses of technology to support 21st century teaching and learning. In: H. R. Fives & M. Gill, eds. International handbook of. New York: Routledge, Taylor & Francis., pp. 403-418.

Farah, C. A., 2011. Factors Influencing Teachers' Technology Self-Efficacy. Lynchburg, VA: Liberty University.

Fisher, C., Dwyer, D. C. & Yocam, K., 1996. Education and Technology: Reflections on computing in classrooms. San Francisco: Jossey-Bass.

Giovannella, C., Passarelli, M. & Persico, D., 2020. Measuring the effect of the Covid-19 pandemic on the Italian Learning Ecosystems at the steady state: A school teacher's perspective. Interaction Design and Architecture(s) Journal, Volume 45, pp. 264 - 286.

Hadijah, S. & Shalawati, 2017. Investigating teachers' barriers to ICT in teaching english at senior high schools in PEKANBARU. Proceedings of the Fifth International Seminar on English Language and Teaching (ISELT-5).

Hannafin, R. D. & Savenye, W. C., 1993. Technology in the classroom: The teacher's new role and resistance to it. Educational Technology, 33(6), pp. 26-31.

Hennessy, S., Harrison, D. & Wamakote, L., 2010. Teacher factors influencing ICT classroom use in Sub-Saharan Africa. Itupale online journal of African studies, 2(1), pp. 39-54.

Hoadley, U. & Ensor, P., 2009. Teachers' social class, professional dispositions, and pedagogic practice. Teaching and Teacher Education, Volume 25, p. 876–886.

Hoadley, U., 2007. The reproduction of social class inequalities through mathematics pedagogies in South African primary schools. Journal of Curriculum Studies, 39(6), pp. 679-706.

Hoadley, U. & Muller, J., 2010. Codes, pedagogy, and knowledge: Advances in Bernsteinian Sociological approaches to education. In: M. Apple, S. Ball & L. Gandin, eds. The Routledge International Handbook of the Sociology of Education. Abingdon: Routledge, pp. 69-78.

Howard, S. & Maton, K., 2011. Theorising knowledge practices: A missing piece of the educational technology puzzle, Association for Learning Technology journal, 19.

Hsu, P., 2016. Examining current beliefs, practices, and barriers about technology integration: A Case study. Tech Trends, 60(1), pp. 30-40.

Johnson, A. M., Jacovina, M. E., Russell, D. E. & Soto, C. M., 2016. Challenges and solutions when using technologies in the classroom. In: S. A. Crossley & D. S. McNamara, eds. Adaptive educational technologies for literacy instruction. New York: Taylor & Francis, pp. 13-29.

Katz, L. G. & Raths, J. D., 1985. Dispositions as goals for teacher education. Teaching and Teacher Education, pp. 301-307.

Karasavvidis, I., 2009. Activity Theory as a conceptual framework for understanding teacher approaches to Information and Communication Technologies. Computers and Education, Volume 53, pp. 436-444.

Kerr, S. T., 1996. Visions of sugarplums: The future of technology, education, and the schools. In: S. T. Kerr, ed. Technology and the future of schooling: Ninety-fifth yearbook of the National Society for the Study of Education. Chicago: University of Chicago Press, pp. 1-27.

Kopcha, T. J., 2012. Teachers' perceptions of the barriers to technology integration and practices with technology under situated professional development. Computers & Education, Volume 59, pp. 1109-1121.

Lawrence, J. & Tar, U., 2018. Factors that influence teachers' adoption and integration of ICT in teaching/learning process, Educational Media International, 55.

Le Grange, L., 2020. Covid 19 pandemic and the prospects of education in South Africa. Prospects.

Lewis, W., Agarwal, R. & Sambamurthy, V., 2003. Sources of influence on beliefs about information technology use. MIS Quarterly, 27(4), pp. 657-678.

Lim, C. P., Zhao, Y., Tondeur, J., Chai, C. S. & Tsai, C. C., 2013. Bridging the Gap: Technology Trends and Use of Technology in Schools. Educational Technology & Society, 16(2), pp. 59-62.

Liu, S., 2011. Factors related to pedagogical beliefs of teachers and technology integration. Computers and Education, Volume 56, pp. 1012-1022.

Lincoln, Y. S. & Guba, E. G., 1985. Naturalistic Inquiry. Beverly Hills, CA: Sage.

Mama, M. & Hennessy, S., 2013. Developing a typology of teacher beliefs and practices concerning classroom use of ICT. Computers and Education, 68(October), pp. 380-387.

Mhlanga, D. & Moloi, T., 2020. COVID-19 and the Digital Transformation of Education: What Are We Learning on 4IR in South Africa? Education Sciences, 10(180).

Mailizar, Almanthari, A., Maulina, S. & Bruce, S., 2020. Secondary School Mathematics Teachers' Views on E-learning Implementation Barriers during the COVID-19 Pandemic: The Case of Indonesia. EURASIA Journal of Mathematics, Science and Technology Education, 16(7).

Merriam, S. B., 1985. The Case Study in Educational Research: A Review of Selected Literature. The Journal of Educational Thought, Volume 3, pp. 204-217.

Morais, A. M. 2002. Basil Bernstein at the micro level of the classroom. In Arnot, M., Apple, M., Beck, J., Davies, B., Edwards, T., Moore, R., Morais, A., Muller, J., Power, S. & Whitty, G. (Eds), British Journal of Sociology of Education, 23 (4) – Special Issue: Basil Bernstein's Theory of social class, educational codes, and social control. London: Carfax Publishing.

Nkula, K. & Krauss, K. E., 2015. The integration of ICTs in marginalized schools in South Africa: Considerations for understanding the perceptions of in-service teachers and the role of training. Port Elizabeth, South Africa, 8th International Development Informatics Association.

Padayachee, K., 2017. A Snapshot Survey of ICT Integration in South African Schools. South African Computer Journal, 29(2), pp. 36-65.

Prensky, M., 2010. Partnering. Teaching digital natives: Partnering for real learning. CA: Corwin

Richardson, V., 2003. Preservice teachers' beliefs. In: J. McAninch & A. C. Rath, eds. Advances in Teacher Education Series 6. Greenwich, CT: Information Age, pp. 1-22.

Rogers, P., 2000. Barriers to adopting emerging technologies in education. Journal of Educational Computing Research, pp. 455-472.

Schrum, L., 1999. Technology Professional Development for Teachers. Educational Technology Research and Development, 47(4), pp. 83-90.

Sherman, K. & Howard, S. K., 2012. Teachers' beliefs about first-and second-order barriers to ICT integration: preliminary findings from a South African study. Charlottesville, VA, Association for the Advancement of Computing in Education., pp. 2908-2105.

Singh, P., 2002. Pedagogising knowledge: Bernstein's theory of the pedagogic device. British Journal of the Sociology of Education, 23(4), pp. 571-582.

Somekh, B., 2008. Factors affecting teachers' pedagogical adoption of ICT. In: J. Voogt & G. Knezek, eds. International Handbook of Information Technology in Primary and Secondary Education. New York: Springer, pp. 449-460.

Taylor, S. & Todd, P. A., 1995. Understanding information technology usage: A test of competing models. Information Systems Research, 6(2), pp. 144-176.

Teo, T., Cha, C. S., Hung, D. & Lee, C. B., 2008. Beliefs about teaching and uses of technology among pre‐service teachers. Asia‐Pacific Journal of Teacher Education, 36(2), pp. 163-174.

Tondeur, J., Van Keer, H., van Braak, J. & Valcke, M., 2008. ICT Integration in the Classroom: Challenging the potential of a school policy. Computers & Education, Volume 51, pp. 212-223.

Tondeur, J., van Braak, J., Ertmer, P. A. & Ottenbreit-Leftwich, A., 2017. Understanding the relationship between teachers' pedagogical beliefs and technology use in education: A systematic review of qualitative evidence. Educational Technology Research and Development, 65(3).

Vandeyar, T., 2014. 'Windows' on Teachers' Beliefs and Attitudes about School ICT Policy Statements. Mediterranean Journal of Social Sciences, 5(14), pp. 339-351.

Van Der Ross, D. & Tsibolane, P., 2017. The Influence of Teacher Attitudes and Beliefs on Information and Communications Technology Integration Behavior in South African High Schools, CONFIRM 2017.

Vannatta, R. A. & Fordham, N., 2004. Teacher Dispositions as Predictors of Technology Use. Journal of Research on Technology in Education, pp. 253-271.

Watson, G., 2006. Technology professional development: Long-term effects on teacher self-efficacy. Journal of Technology and Teacher Education, 14(1), pp. 151-165.

Windschitl, M. & Sahl, K., 2002. Tracing teachers' use of technology in a laptop computer school: The interplay of teacher beliefs, social dynamics, and institutional culture. American Educational Research Journal, Volume 39, pp. 165-205.

Yin, R. K., 2014. Case Study Research Design and Methods. 5th ed. Thousand Oaks, CA: SAGE.

Zhao, Y., Pugh, K., Sheldon, S. & Byers, J., 2002. Conditions for classroom technology innovations. Teachers College Record, Volume 104, pp. 482-515.