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DIGITAL LITERACY IN AN AGE OF ARTIFICIAL INTELLIGENCE

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One of the articles in this issue focuses on digital literacy in schools. This is an extremely important issue of our time and especially in the context of the rising influence of AI in education.

Digital literacy does not simply mean computer literacy (Buckingham, 2015). While that is important, digital literacy involves at least three key ingredients. First is the effective, efficient and above all the responsible use of digital platforms, communication tools and networks. Second is the importance of a sound understanding of these platforms tools and networks. It is one thing to develop a technical know-how, rather more like what may be called recipe knowledge, the knowledge about how to use technologies and get the results. This is the very basic level of digital literacy which can be taught by simple following instructions in order to yield desired outcomes. Schools tend to do this quite well and students in this digital world are usually quite adept at using digital technologies. Sometimes, students seem to know more about using technologies than their teachers, some of whom, especially the older ones, could be what some refer to as digital dinosaurs.

The understanding level provides for a deep dive into the working and rationales behind the technologies. The argument can be captured in practice theory or praxis dynamics which elevates technicist knowing to higher levels of understanding in personally meaningful ways.

The third and most advanced level of digital literacy is the ability to evaluate the digital applications, to understand best practices, to develop a good sense of how to make their use more efficient, more effective and ethical.

The use of AI, while inevitable and beneficial in many ways, has to be understood also from the risks it poses to education, our students and even our economies (Selwyn, 2024). For example, it takes three times more energy to use an AI platform on our computers than when we use traditional platforms such as Google. Equally when we use AI tools on our computers, it is said that three times more toxic emissions are given out. In addition, almost every

question we can give students as homework is likely to be answered through AI tools (Selwyn, 2024). How might teachers know if their students are putting in the effort especially when there are also AI tools which can prevent detection if teachers check for plagiarism and similarity indices.

So, while digital literacy is the future, it's use can be fraught with knotty challenges. In a real sense, digital enablers can be applied in all spheres of our lives including in the issues covered in this current volume. I endeavour to demonstrate this using the articles in the current issue.

In the first article, titled **Classroom Management Strategies Employed by Postgraduate Certificate in Education Foundation Phase Trainee Teachers During Teaching Practice,** Lilymore Mudziwapasi at Nelson Mandela University discusses a range of strategies and their impacts. Curiously, some of the latest developments in classroom management are technologically based. For example, class charts can be used to help students monitor their own behaviour and identify when their behaviour is positive. Other technologies for classroom management include class dojo used to encourage students' goal setting; 'Additio' is both a behaviour and communicative tool; 'Bloomz' is a district wide communicative tool with parents that can help teach management issues at district level amongst others (see https://www.commonsense.org/education/lists/classroom-management-apps-and-websites).

The second article titled **Digital Literacy Practices: Curation and Annotation Associated with E-Textbooks** by Ekaterina Rzyankina and Alfred Mvunyelwa Msomi at Cape Peninsula University of Technology and Mangosuthu University of Technology stimulated this short editorial contribution.

The third article titled **Examining Pre-Service Economics Teachers' Knowledge of Learners in Interpreting the Demand Curve Graphs in the Dynamics of Markets** by Ijeoma C. Ogbonnaya and Beatrice Ngulube at University of the Free State and Tshwane University of Technology draws our attention to the growing technology and digital tools that can be deployed to more effectively teach the difficult concepts of demand curve economics. A good article by Joshi

and Koirala (2023) provides a systematic review of the latest digitally based pedagogies in teaching economics in schools.

In the fourth article titled **Higher Education Reform in Zimbabwe: An Examination of Science Teacher Educators' Work Demands** by Mutseekwa Christopher and Mpofu Vongai at Bindura University of Science Education, Zimbabwe, we learn about the affordances and constraints faced by science educators in Zimbabwe in their transformative ambitions. One key issue in the transformative imperatives of the work of science teachers is the question of digital divides, issues of access, affordability and reliability. Communities in poor settings such as in rural and new farming settlements are often the hardest hit and fare badly in relation to all the criteria of digital transformation in science education in Zimbabwe.

The fifth article titled **The Perceptions of School Managers, Teachers and District Officials on the Implementation of the Integrated Quality Management System in School** by Nyelisani Justice Mungadi and Khashane Stephen Malatji **at** UNISA explore the workings of quality management systems in schools through an examination of perceptions of a range of district and school level personnel. New digital technologies for quality management such as Track Wise Digital, Learning Management systems (LMS), Virtual reality and Augmented Reality, and Online assessment and feedback systems are slowly getting into schools and promise to enhance both the processes of quality monitoring and report writing (see for example Cots, 2018).

The sixth article titled **Exploring the Role of Principals' Leadership Practices on Female Teachers' Self-Learning in the 21st Century** by Potokri, O.C. and Adewale. S at University of Johannesburg tackles the important idea of self-learning as an alternative leadership development strategy for female leaders. Self-learning is both about understanding oneself deeply as it is about self-directed learning. Self-regulated learning is a field with a plethora of new digital tools which facilitate understanding of self and provide useful tools for self-pacing, target setting, self-evaluation and self-improvement.

The seventh article titled **Expectations of Teachers Living With HIV/AIDS: A Call for Support from School Principals by** Zvisinei Moyo **at** University of Johannesburg deals with the rather sensitive issue of HIV/AIDS and how teachers cope with the stigma, and assumptions about their status and condition. In some places, digitalised and online tools have been developed

which limit face to face interactions even though their effectiveness and impact is yet to be fully determined.

In the eighth article, titled **Pedagogical Content Knowledge Development within Pre-Service Mathematics Teacher Education: A Bibliometric Analysis by** Zaheera Jina Asvat **at** University of the Witwatersrand, we are treated to a rich presentation and discussion on PCK development within preservice teachers. New digital tools for bibliometric analysis and for developing teacher pedagogical content knowledge are constantly in development.

In the ninth article, titled **The Association of Anxiety, Depression and Self-Esteem with Students' Nomophobic Behaviour by** Moroesi G Pitikoe-Chiloane and Hilda B Dondolo **at** Tshwane University of Technology, the important question of anxiety and its relationship with mental health issues amongst teachers and learners is explored. Again, new digital tools to measure anxiety are increasingly becoming available on the market.

In conclusion, I must reiterate that digital literacy if fast becoming a key developmental requirement at all levels of the education systems. A three-pronged approach to its development should at the barest minimum deal with three issues of technical/operational literacy, developing some understanding of the science behind the technologies and their utilisation and the capacity for evaluating the efficacy of these new technologies, with a view to enhancing quality, efficiency, effectiveness and more importantly, their ethical efficacy.

I hope that readers will find these articles valuable and stimulating.

Editor in Chief JES.

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CLASSROOM MANAGEMENT
STRATEGIES EMPLOYED BY POSTGRADUATE CERTIFICATE IN EDUCATION FOUNDATION PHASE TRAINEE TEACHERS DURING TEACHING PRACTICE

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Abstract

It is well documented that novice teachers have a problem with classroom management (CM). This study explored CM strategies that Postgraduate Certificate in Education (PGCE) Foundation Phase trainee teachers employed while doing their teaching practice (TP) at one University in the Eastern Cape Province of South Africa. This study used a qualitative research methodology. Semi-structured interviews and document analysis were used as methods for data collection. Participants consisted of eight PGCE Foundation Phase trainee teachers. Content analysis was used to analyse data. The study revealed that these trainee teachers used different strategies for different classroom scenarios. They were not always confident regarding the CM strategy that they were using. The CM strategies of these trainee teachers seemed to be biased towards three broad groups of CM strategies. Firstly, preventative strategies, which included preventing misbehaviour before such misbehaviour occurred. Secondly, there were two proactive strategies used. These were understanding the problem before acting and punishing first, then understanding the problem. Findings were that preventative strategies were more effective but were least used. This study recommends that in the preparation of trainee teachers, more emphasis should be placed on preventative measures in CM.

Keywords: Classroom management strategies, trainee teachers, teaching practice, foundation phase, preventative strategies

Introduction and Background

Novice teachers have been reported to have problems with classroom management (CM) (Reynolds-Keefer, 2013; Peters, 2012; Rosas & West, 2009; Marais & Meier, 2010). This study explored CM strategies that Postgraduate Certificate in Education (PGCE) Foundation Phase trainee teachers employed whilst undertaking their teaching practice (TP) at one University in the Eastern Cape Province of South Africa. The investigation was pertinent to newly qualified teachers as it explored CM strategies used by trainee teachers.

Education is touted as significant in human emancipation, addressing poverty and inequality challenges by enabling meaningful economic participation and growth of the economy (McNally, 2009). Despite the significant effect of education, research on understanding teacher training is still very scant, particularly research looking at CM strategies employed by trainee teachers. Literature reveals much evidence of teachers' challenges in CM and the benefits of proper CM (Miller & Pedro, 2006; Kiggundu & Nayimuli, 2009; Reynolds-Keefer, 2013).

CM refers to teachers' strategies for regulating student behaviour, interaction, and learning (Martin & Sass, 2010). It can be recognised as how teachers create a safe and effective learning environment. It also includes establishing personal relationships with students and working within these relationships (Brophy, 2006). According to Miller and Pedro (2006), CM involves many aspects: the management of space, time, activities, materials, labour, social relations, and student behaviour. It is imperative to note that CM is related to all the teachers' actions in class, to ensure a good learning environment and effective teaching. CM is an important concern of all teachers, experienced professionals and trainees (Gibbs & Powell, 2012; Hammond, 2007).

Kounin's Classroom Management Theory

The Kounin (1970) CM theory was found to be the most relevant in the context of this study. Behaviourist theory explains how individuals act the way they do and why they act that way (Good & Brophy, 2008). Accordingly, Kounin (1970) developed a theory

applicable to CM, which is aligned with this study as it sought to understand what trainee teachers use as CM strategies during TP and why they use such strategies. Four behaviours explained by Kounin's theory are With-it-ness, timing errors, smoothness, and momentum.

With-it-ness behaviour suggests teachers have instinctive feelings for situations taking place in the classroom. They have 'eyes in the back of their head'. Teachers are supposed to stop problems within their classrooms before they start. Timing errors suggest that teachers are supposed to deal with disruptive behaviour while a lesson is going on, that is, managing behaviour and focusing on the lesson. Smoothness indicates that teachers must be able to move from one lesson to another, from one activity to another by providing sufficient clarity at appropriate times: brisk pace- logical order- short directions. Momentum teachers are supposed to be able to conduct lessons, to keep students involved and from being bored in the classroom (Good & Brophy, 2008).

Statement of the Problem

Literature cites that for effective teaching and learning to take place, teachers need to employ diverse and effective CM strategies (Reynolds-Keefer, 2013). CM has been challenging for trainee and in-service teachers (Reynolds- Keefer 2013; Peters, 2012; Rosas & West, 2009). Trainee teachers first encounter the reality of CM during their TP. However, few studies have explored trainee teachers' CM strategies (Reynolds-Keefer, 2013). Identification of CM strategies that trainee teachers employ thus remains a topical research area (Aliakbari & Bozorgmanesh, 2015). It is against this background that this study poses the following objectives, which are to:

i) Investigate PGCE trainee teachers' understanding of CM.

ii) Examine CM strategies that PGCE trainee teachers employ during TP.

iii) Understand CM strategies that trainee teachers believe are more effective during TP.

iv) Unearth and describe challenges experienced by PGCE trainee teachers with CM.

Results

PGCE Trainee Teachers' Understanding of Classroom Management

From the findings, it is apparent that generally, all trainee teachers have some comprehension of what CM is. However, the majority, six trainee teachers, understand CM from the control perspective (P1, P2, P4, P5, P7, and P8). For example, the explanations obtained were as follows:

> *Classroom management is the way the teachers are in full control of the learners so that there will be no disturbances when the teacher is teaching. To make sure that the learners they listen to what the teacher will be saying.* [Interview, P7]

In addition, P1 noted that CM "…is the way a teacher use to control the class..." This is echoed by P2, who also stated that CM is "... the way ...". As expressed by P4, CM is the "… way used by the teacher to control...". The emphasis by P4 on the control aspect of the classroom is also found in the following comment "… these are actions that are being used by the teachers to control the kids in a classroom". Control was also mentioned by P5 and P8: "... classroom management strategies that we were using during school experience to make sure the class is in our full control" [Interview, P5].

In line with this, Wong and Wong (2005) explained that CM is related to all things which teachers do to organise students, time, and materials so that student learning can be meaningful.

> *It is a way in which teachers teach, control learners, putting order in class, arranging the desk in rows so that teacher will be able to move around the classroom and see what is taking place in all classroom corners.* [Interview, P8]

The way the participants explained CM is the same as the international and national perspective, namely, that it is the actions carried out by the teacher. In a study done by Emmer and Stough (2001), CM is mostly defined as actions taken by the teacher to establish instruction, occupy learners, or make pupils cooperate in class. From a national perspective, Pistoe (2014) considered that CM should be learner-centred and approached from a situational perspective. Furthermore, in the past, CM has often

been seen as an issue of dealing with individual behaviour; however, this has changed to account for advanced planning (Pistoe, 2014).

The other two participants (P3 and P6) have a broader and more representative understanding of CM. A comprehensive understanding of CM was revealed in P3's response: "These are the strategies that are being used by the teacher in the class for example how to plan a lesson, delivering the lesson as well as arranging the classroom to make sure everything is in order."

In the interviews with P3 and P6, their explanation was much the same as Tal (2010) who described CM as a cyclical process. It is a process which includes advanced planning, implementation, assessment during implementation, and final evaluation that accounts for factors related to children and their environment and is intended to bring about progress in the activities carried out for the learning and emotional well-being of learners. In addition, from an international perspective, Aliakbari and Bozorgmanesh (2015) considered CM as all things that the teacher does to organise students, space, and materials so that learning can take place.

The same conceptualisation of CM can be observed from the trainee teachers' reflective reports. All the respondents considered CM from the disciplining perspective. It is interesting to note the understanding of CM in reflective report 1:

> *The strategies the teacher uses in a classroom to ensure that learning and teaching are taking place. This will include; discipline, planning, the way you teach and use the resources in the classroom. E.g. for discipline I used a whistle to stop whatever they were doing, stand still and listen to instructions.* [Reflective report 1]

Although this understanding is all-encompassing, there seems to be limited comprehension in terms of what discipline entails. The reporter is referring to the use of a whistle to draw attention as a form of discipline, which in itself is not discipline. This is a CM strategy to draw the attention of learners and thus not a disciplining form. In the reflective reports, some trainee teachers related CM to the disciplining of learners (see RR1 above). They reported: "… it is the different ways in which discipline

can be made to the learners so that they behave well in class and listen to what the teacher is saying" [Reflective report 4].

From all responses given, through both interviews and reflective reports, an all-encompassing definition of CM is found in RR7, which states:

> *Classroom management is the actions that are taken by the teacher to show that everything that is happening in class is well taken care of the way the class is arranged the decorations in class, the way the teacher teach, as well as the sitting arrangement of the learners all this encompasses what is classroom management.* [Reflective report 7]

This definition reveals that CM includes the physical set-up of the classroom (sitting arrangement, decorations, etc.), teacher-learner engagement, and by implication teacher preparedness. The latter is fundamental as trainee teachers understand that they have a responsibility towards CM by going to class prepared. From a national perspective, Coetzer (2010) explained CM as a complex set of behaviours that the educator uses to establish and maintain classroom conditions that are conducive to learning.

However, Burden (2003) indicated that CM is more about the relationship between the teacher and the learners for helpful social learning and self-motivation. To this end, Martin and Sass (2010) indicated that CM includes teachers' strategies to oversee learner behaviour, learner relations and learning. It is worth noting that some trainee teachers are fully acquainted with what CM is, in line with the definition provided by Osakwe and Osakwe (2014).

The trainee teachers interviewed therefore have some understanding, albeit to different extents, of what CM is. This is crucial as understanding what CM is, will assist in identifying and evaluating different but relevant CM strategies. The next section presents CM strategies employed by the trainee teachers during their TP. It is of interest to see how their slightly different opinions of what CM is, can influence their choice of CM strategies employed.

Classroom Management Strategies Employed during Teaching Practice

Strategies used to respond to Latecomers

Three groups of strategies can be identified from the interview responses. First, there are trainee teachers who emphasise preventative measures, such as making sure learners know that it is unacceptable to be late for class, and in the event of being late, written proof of the reasons for such should be produced. For example, P1 notes:

> *I just tell them to walk in and they were knowing that if they are late to school they should produce a note which comes from their parents stating the reason why they are late. From the start the rules of the class indicated that when a learner is late for class should bring a signed letter from parents or guardians indicating the reason for being late.* [Interview, P1]

These preventative CM strategies are also echoed in reflective reports (RR5, RR6, and RR7):

> *If a learner is late for class, the person who is responsible for taking that child to school is supposed to walk with the learner into the classroom and explain the reason to the teacher why that child is late for school. For those learners who come to school alone were supposed to bring in a note to explain the reason why they are late. So learners new that if they are late they have to give a good reason failed to do so they will be punished.* [Reflective report 5]

In this case, the trainee teacher did not give the blame for being late to the learner but blamed the parents who are supposed to make sure the learner is at school on time.

> *Learners in my class they were knowing that if they are late they have to talk to the teacher, therefore most of them came to school early. If they arrived to class when the lessons have already started they were supposed to wait outside and I will call them in when I am done with a lesson to avoid them disturbing those who are already learning.* [Reflective report 6]

Besides emphasising directly to learners that they should be on time and if not, there are consequences – as in the two reflective reports cited above (RR5 and RR6), other trainee teachers made use of indirect strategies. Examples are from RR7 and P6 where the teacher gives learners work to do in class before assembly time, to ensure that learners are at school on time.

These trainee teachers employed preventative measures to avoid disruptions and punishing learners. This is in line with Oliver et al., (2011) who argued that effective CM strategies are the ones that are preventative rather than reactive. Such strategies are premised on the belief that prevention will reduce disruption of learning and bring order to class (Calderon, 2013).

Furthermore, this corroborates Kounin's (1970) classroom management theory, which asserts that CM is characterised by proactive teacher behaviour. This research found that the preventative strategies employed by trainee teachers resemble proactive behaviour. As emphasised by Kounin (1970), preventative strategies are more effective than reactive ones. The trainee teachers' behaviour was in line with the literature as they indeed emphasised preventative strategies. Additionally, some of the trainee teachers had reactive strategies as a backup plan, as suggested by Ducharme and Shecter (2011).

Second, there were those trainee teachers who first privately tried to understand the reason for the learner being late before taking any action (P2 and P3).

> *I try to find out the reason why that learner comes to school late by calling the parents or the person who is taking care of that child at home. Then if it becomes a problem, I write a note to the parents to check what's wrong with the learner coming to school late.* [Interview, P3]

It is important to also note the recognition of the role of a parent/guardian on Foundation Phase learners by trainee teachers in the context of CM strategies. In trying to understand the reason for late coming, parents/guardians are also regarded as key informants. Furthermore, due to the young age of the learners, late coming was either considered not a problem or if it was, then generally it was beyond their control (P2 and RR1). "Normally there were no late comers since the Foundation Phase learners were being accompanied by their parents" [Interview, P2] … "And if there is someone who is late, I would ask why he/she is late and tell them next time they are supposed to come to school early" [Interview, P2].

Trainee teachers indicated that asking learners the reason for being late for school helped them to come early because the learners then knew that the teacher needed a good reason for late coming. Asking a learner why they are late shows that the teacher is very concerned about their learners.

> *I try to find out why the learner is late, the learner in the Foundation Phase are dropped or walked to school, so the learner is usually not at fault. I would see if it is becoming a trend or if the reason was valid or not, if it became problematic, I would write a note in the message book to the parents.* [Reflective report 1]

Engaging parents or guardians is therefore beneficial to getting to the bottom of the problem.

Thirdly, representing the majority, there were trainee teachers who punished the latecomers first and later found out the reason for their late coming. Examples of punishment included making the learner stand in front of the whole class for some minutes or making the learner wait outside until the lesson was done (see for example, P4, P5, P7, P8).

> *I tell the late comers to stand in front for ten minutes, and then they will explain to me why they are late*. [Interview, P4]. *I will call the learner to the front and tell me the reason why she/he is late and tell the learner not to repeat this same mistake again. [*Interview, P5] *I call the late comers to the front and they were supposed to explain to the whole class why they were late and ask for apologies because they will be disturbing others who will be already doing their work.* [Interview, P7]

With regards to making a learner stand outside of the classroom, P8 is clear:

> *If I am busy with teaching, they were supposed to stay outside the classroom and I will tell them to get in when I am done with what I will be doing, because if I just say they are supposed to get in they will be disturbing others who are already busy with work.* [Interview, P8]

This third group of CM strategies to respond to latecomers may be problematic. For example, if a learner is asked why they are late in front of everyone it is embarrassing; however, trainee teachers are banking on this as a deterrent factor in the future. As a result, the learner can end up being stigmatised based on the explanation for their

late coming. Take for instance a learner who is late because unfortunately their parents were fighting or because the learner had soiled him/herself. These two simple scenarios can lead to the learner withdrawing and becoming more passive and shyer, therefore hindering the learning and development of the child. There are even discipline-related comebacks to this, for example, the learner may end up misbehaving to punish the teacher or they can just become stubborn.

The following three broad groups of CM strategies emerged here:

- Emphasising preventative strategies.
- Understanding the problem first before acting (proactive strategy);
- Punishing first then understanding the problem later (proactive strategy).

On the other hand, even though Ducharme and Shecter (2011) proposed reactive strategies as a backup plan when proactive strategies fail, some trainee teachers relied solely on reactive CM strategies. The same sentiments are found in Lane and Kuiper (2012). This involved either punishing the learners who were late for class after understanding the reasons for being late or punishing them before getting the reason why the learner was late for class. It is worth noting that some of these trainee teachers, after implementing reactive strategies, employed preventative strategies later. This approach has been reported as common among Canadian trainee teachers (Reupert & Woodcock, 2010). This approach is used, despite Stoughton (2007) warning against reliance on over-corrective strategies. Overall, trainee teachers who utilise proactive strategies represent the model teachers (Ducharme & Shecter, 2011) while those who rely on reactive strategies show the need for more teacher training (Aliakbari & Bozorgmanesh, 2015). Based on the later curriculum, renewal and lifelong learning are crucial.

Strategies Used to Stop Disruptive Behaviour

The trainee teachers showed that they were aware of reactive strategies to stop disruptive behaviour. It is interesting to note that the trainee teachers made use of set classroom rules to remind learners of the kind of behaviour expected of them, for

example P4 and P7. This then helps the learner to stop disruptive behaviour by realising that such behaviour is against the agreed classroom rules. "I tell them to behave well and no one is allowed to move around the classroom without permission from the teacher". [Interview, P4].

On the other hand, P7 is more explicit in terms of how the learners are reminded of the rules, that is, by making them read out the rules:

> *From the start I tell my learners that those who show good behaviour will be given sweets at the end of the day, therefore the learners knew if I didn't behave well no sweets will be given to me, therefore most of the students behaved well since they were knowing that at the end of the day they will get something to eat.* [Interview, P7]

This kind of CM strategy will work very well when the rules are set and agreed upon in consultation with the learners and every morning the learners are reminded of them (Tillery et al., 2010). It is convenient to have such rules visually displayed, such as on a chart in front of the classroom (Marzano et al, 2003).

Other trainee teachers used isolation of the disruptive learner by asking other learners to ignore the learner:

> *I tell all the other learners to ignore such kind of a learner who will be moving around to disturb others. If that learner continues to misbehave in a way, I couldn't handle that child will be taken to the principal of the school*. [Interview, P6]

Although this may work it could have unintended consequences like perpetual isolation, which is in line with what Marzano (2003) found where learners respond to any strategy depending on whether they feel the teacher cares for them or not. Isolation may make the learner uncomfortable among peers, feeling neglected and rejected to the extent that some learners will end up avoiding school. Such CM strategies should be applied in conjunction with a proper understanding of why the learner is being disruptive.

Some trainee teachers used an indirect strategy to stop disruptive behaviour, by making disruptive learners envious of the reward for good behaviour. "I award good behaviour and praise those who behave well so that the disruptive learners will learn and change in order for them to behave well too". [Reflective report 3].

The majority of the trainee teachers were using the strategies of calling out the learners' names or asking them to come and stand in front of the class as a way of getting their attention, among other strategies. This is a strategy that P1 mentioned in the interview when she said "I call the learner to sit in front next to the teacher and tell her not to disturb others who want to learn" [Interview, P1]. This was echoed by P5, "I call out the name of that learner who is showing disruptive behaviour" [Interview, P5]. Reflective reports revealed the same sentiments:

> *I call out the name of the learner who is showing a disruptive behaviour, the moment I call a name they give attention to what I will be telling them.* [Reflective report 2] *Learners who show disruptive behaviour were called to seat in front close to the teacher, were the teacher is able to control them without disturbing other learners.* [Reflective report 5]

Just talking to the learners and asking them why they are behaving in a certain way was used by some trainee teachers as a CM strategy to stop disruptive behaviour. This is showing interest in the learner, which can have a positive impact (Marzano, 2003). "I tell them to be watchful and not to behave in a disruptive way" [Interview, P2]. "I talk to them and ask why they are behaving in such kind of way and ask what could be the problem; I also warn them if they continue I will punish them" … "I will tell the learner to come to the front and stand facing to the chalkboard for about an hour" [Interview, P3]

Different strategies are used sequentially by these trainee teachers. Effort is made to make the learner aware that the behaviour they are displaying is not tolerated before any other actions are taken. The actions that are later taken if misbehaviour persists include restraint from entertaining activities, or making the learner write an apology. This approach can also help the learner to know how to write and to learn that an apology is necessary:

> *I tell them to behave in an appropriate way and threaten them that if they continue I will take you to the principal. Learners were so afraid of being taken to the Principal's office so whenever you tell them that if don't behave I will*

> *take you up there, they would cry and ask for forgiveness and tell the teacher I am not going to make noise again.* [Interview, P8]

It is imperative to note that threatening as a CM strategy should be coupled with the ability to execute the threat, shown by executing on one or two cases. If the trainee teacher cannot do that, then managing the class becomes unbearable. In one instance or another the trainee teachers will be expected to react to some behaviour and thus employ reactive strategies. This study posed a specific scenario to elicit the strategies the teachers would use when it becomes necessary (Ducharme & Shecter, 2011). As in Sueb (2013) in the case of Malaysia, there are trainee teachers in this study who mastered the names of their learners and called them out as a way to stop them from disruptive behaviour where applicable. Calling out learners' names is a form of verbal reprimand which Tillery et al. (2010) argued is effective in response to inappropriate student behaviour.

Evaluation of Classroom Management Strategies that were Employed

Having identified the different CM strategies that the trainee teachers used during TP, the researcher now turns to present the evaluation of these strategies by the trainee teachers themselves. The trainee teachers answered questions on which strategies were most and least effective, in both cases giving the reasons why.

In the interviews, all participants indicated that at least one of their strategies was effective. However, in reflective reports, some trainee teachers noted that some of their strategies did not work well (RR4):

> *None of them was effective, in fact they [the learners] behaved when the teacher moved around the class with a stick. The reason I say it was not effective is that, the students were so afraid they wouldn't even be able to express themselves.* [Reflective report 4]

In this instance, the learners were afraid of the teacher and not respectful which resulted in them being passive out of fear. Such environments hinder learning and proper child development as children need to be free to explore and learn. This could be the reason why corporal punishment was banned as it introduces fear rather than discipline. This teacher was using corporal punishment to instil discipline among the learners, which is not a good way for CM morally and legally (see the strategies this

trainer teacher reported in dealing with noisy learners and stopping disruptive behaviour). The encouraging thing is that the trainee teacher identified that their strategy was not effective because of the fear element. Such reflections and self-evaluations are important in making a good teacher. This research provided the trainee teachers with an opportunity to reflect and self-examine their CM strategies.

The trainee teachers who were interviewed were equally divided between preventative and reactive strategies in terms of which they found to be most effective. From these findings it can be noted that both strategies worked; however, in each case, it depended on the situation. Even though the questions posed checked for both preventative and reactive strategies, it is unfortunate that the other four respondents did not find any of the preventative strategies effective. For example, trainee teachers (P2, P3 and P4) identified good CM strategies to prevent disruptive behaviour in Section 4.4 above but did not experience them as effective. The identified strategies were:

> *I make sure from one lesson we go straight to another one without giving them some time to make noise and disrupt others. I make it a rule in the class that a learner is not allowed to move from one side to another, if a learner want to come to the front to talk to the teacher or to ask for a pencil from another learner she/he has to raise a hand first and get permission from the teacher that she can move from her chair.* [Interview, P2]
>
> *I keep them busy with lots of activities. I make sure that all what I want to do for that day is well planned and there are other activities extra to do if we finish early. Learners like to be kept busy and they won't disturb others if they are busy.* [Interview, P3]
>
> *I read the class rules, every morning so that they will know that disruptive behaviour is not tolerated in the class. I also remind them about the rules of the class that disruptive behaviour is no tolerated during the course of the lessons.* [Interview, P4]

Instead, these preventative CM strategies were identified by the respective trainee teachers as least effective. "Giving learners too much work was the least effective to

control misbehaviour" [Interview, P2]. "Giving learners lots of activities was the least effective" [Interview, P3]. "Reading class rules to the learner every morning was the least effective strategy of avoiding disruptive behaviour" [Interview, P4].

To understand why these preventative CM strategies did not work, the trainee teachers were asked to give reasons why they were least effective:

> *Although giving learners too much work to keep them busy helped, but to some extent it did not work very well because some learners start to complain that we are tired we need a break, some if you give them work to write they will complain saying we are tired can we do it tomorrow*. [Interview, P2]
>
> *Even though I read the class rules to the learner, some learners will be still showing bad behaviour. It seems as if some were just used to get their teacher reading these rules and they do not put much concentration that they are required to show good behaviour.* [Interview, P4]

It can be noted that keeping learners engaged is not a straightforward solution as it requires activities to be diverse and interesting, especially for young Foundation Phase learners. However, if learners are kept busy with activities that are planned well in advance, the CM strategy could be effective. For example, P6 reported that proper lesson planning in advance was effective: "When I am having lots of lessons plans the whole day, we were busy and learners liked it and they did not have the time to make noise or moving around the class" [Interview, P6].

Furthermore, reading and reminding of the classroom rules may sometimes become just a routine to the extent that learners fail to pay attention to them and hence continue conducting themselves in a manner contrary to the classroom rules.

RR1 reflected that several strategies employed during TP were effective:

> *Learners know what was expected from them and when I told them to stop, they would know why. The whistle was also a great way of maintaining control in the class. The lessons I designed were interesting and grade appropriate. The learners understood that there was a reward system and they were encouraged to behave, they also knew there were punishments to avoid and behaved.* [Reflective report 1]

Other CM strategies that worked, as evident from the reflective report, over and above those that were identified from interviews, include making the learners sit in groups, rotating the seating arrangement, and isolation. As reported by RR5, RR6 and RR7:

> *The strategy of making my learners seated in groups worked and was effective, and having my learners have work to do all the time whether it was fun work or serious one, this helped because once they know they have nothing to do they become uncontrollable.* [Reflective report 5]
>
> *The idea of the learners sitting in groups worked very well, and changing them more often worked because learners knew that if they misbehave they were going to be changed where they are sited.* [Reflective report 6]

Based on the strategies employed by the trainee teachers, as discussed above, the trainee teachers were asked to evaluate each of the CM strategies in terms of their effectiveness. The most and least effective CM strategies were identified. From the results, it was found that the most and least effective strategies were not common among these trainee teachers. The main differences related to the different environments that they were working in, which among other things, included class size and different school setups. This has been indicated as a common factor and therefore the study could not expect to find much common ground among the trainee teachers (Baker, 2005).

The home environment of the learners is key in terms of how effective certain CM strategies can be in one class compared to the next. As argued by Ducharme and Shecter (2011) children who come from disruptive home environments often exhibit disruptive behaviours and punitive strategy fails to address the underlying problem. Some reactive strategies often even perpetuate the misbehaviour (Ducharme & Shecter, 2011).

For CM to be effective, Osakwe (2011) also argued that the teacher must be competent. In this study, one trainee teacher reported that none of the CM strategies she had employed were effective in either preventing or correcting misbehaviour. Although neither the interviews nor the reflective reports gathered information on

the competence level of each trainee teacher, the competencies of this trainee teacher can be questioned. This is so because it is the same teacher who employed corporal punishment, even though it has been banned in South African schools. In that regard, the study can deduce that the trainee teacher was incompetent in observing the regulations of the teaching profession.

Even though Ducharme and Harris (2005) concluded that proactive strategies are most effective in CM, this study shows that reactive strategies are equally important. What matters is the situation, and reactive strategies are not just another option of strategies but are suitable for specific situations where proactive strategies are no longer applicable or where they have failed.

Benefits and Challenges of the Classroom Management Strategies Employed

It is revealed that effective CM strategies improved teacher efficacy. There are trainee teachers who reported improvements in results after implementing some effective CM strategies (P2 and P5). "Learners do their work very well and they were producing good results" [Interview, P2]. In addition:

> *These strategies that I used helped a lot in the sense that the students were now behaving very well and they were doing their work and most of them produce good results.* [Interview, P5]

The good results reported are a result of a conducive teaching environment created by implementing correct CM strategies. For example, the strategies helped with the smooth flow of lessons:

> *The strategies that I used helped the flow of my lessons to go on very well without the learners' disruption. In my class the learners were behaving very well because of these strategies*. [Interview, P4]
>
> *... the students start to behave well if they notice that the teacher is always looking at them and is aware of everything they are doing.* [Reflective report 7]

The purpose of CM strategies is to realise such benefits, and this means the employed strategies were effective and the trainee teachers thus knew the suitable strategies to

employ in most instances. The employment of these strategies was, however, not without challenges.

Finally, there are trainee teachers who make use of emphasising classroom rules to allow smooth transitions between activities. “I read the rules to them every day after assembly and remind them to behave well in all that we will be doing that day” [Interview, P4]. “I gave rules in the class for example that noise is not allowed. Put order in the class so that the students did not disturb me when I am teaching” [Interview, P8].

Rules are important for CM overall; however, there is a need for buy-in from the learners for the rules to be effective. The rules should therefore not be imposed on the learners but there should be a feeling that some form of consultation has taken place. Overall, the trainee teachers in this study found challenges when implementing either proactive or reactive CM strategies, albeit more challenges were linked to the former. Findings were supported by Ducharme and Harris (2005) as they concluded that reactive or punitive CM strategies are easy to administer. This then justifies why the trainee teachers in this study faced fewer challenges with reactive strategies.

This section set out to present the results based on data from the interviews and reflective reports. A total of eight interviews were conducted with trainee teachers from different previous degree programmes and seven reflective reports by trainee teachers were received. It was found that there is a general level of understanding of CM strategies among the trainee teachers, albeit with a few misconceptions, such as how CM is all about control and discipline. Diverse CM strategies were employed by trainee teachers during their teaching practice. In most instances, given the scenarios presented, the strategies were appropriate and showed some creativity. The trainee teachers also had an opportunity to reflect on the strategies and identify which ones worked and which ones did not, and they provided their reasons for such evaluation.

Furthermore, the benefits and challenges of employing the chosen CM strategies were ascertained. The biggest challenges were the large class sizes and the tender age of

the learners. This section has discussed the results of the study linking to the literature and how the findings meet the objectives of the study. The discussion was divided into sections representing each research question. Conclusions and recommendations based on these findings are provided in the following section.

Conclusions

It can be concluded that trainee teachers are aware of what CM is as well as CM strategies to use under different situations, except for a few who still act outside the education law by applying corporal punishment. Furthermore, the trainee teachers in this study found a host of strategies to be effective, which will boost their confidence as they get into professional teaching. On the other hand, it can be noted that the South African education system has challenges that hinder effective CM, like overcrowded classrooms, lack of furniture, and adequate or timely delivery of learner material.

Recommendations

Although the trainee teachers had some understanding of CM, there were some gaps and misconceptions that can be corrected by including more sections of CM in relevant modules of their course. Higher education institutions must revise their curriculum for training teachers, especially in areas of teaching practice and the theory of CM. School experience needs to be expanded in terms of the period covered. Before the school experience, trainee teachers need to go through more hands-on learning with their lecturers by using case studies. The use of scenarios or case studies in teaching CM to trainee teachers will increase their understanding, awareness, and creativity. The rules should be emphasised to the trainee teachers to understand the so-called “dos and don’ts”, for example, that corporal punishment is an illegal CM method and should not be used. Corporal punishment is against the South African Council of Educators (SACE) code of conduct and therefore teachers should refrain from using it.

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DIGITAL LITERACY PRACTICES: CURATION AND ANNOTATION ASSOCIATED WITH E-TEXTBOOKS

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Abstract

E-textbooks have gained prominence in recent years due to their advanced digital features and accessibility. This evolution has led to innovative digital literacy practices, notably curation and annotation, aimed at enhancing student comprehension of engineering concepts. These practices offer three-fold benefits: they mitigate information overload and provide a systematic learning framework for students. This is crucial in fields like engineering where contextual understanding enhances the practical application of theoretical concepts. By integrating supplementary resources and multimedia elements, e-textbooks provide a richer, more immersive learning experience. This study, focusing on these affordances in e-textbooks, utilised qualitative data from interviews with 12 first-year engineering students at a university of technology. Findings indicate that these new literacy practices hold significant potential for improving student understanding of engineering concepts. The study underscores the need for further exploration into the use of digital tools in education, highlighting their transformative potential in shaping future learning of students.

Keywords: e-textbooks, curation, annotation, digital literacy practices, reading

Introduction

Digital literacy, the competency to use technology effectively and confidently, is fundamental in today's technological landscape. As we delve deeper into the digital age, proficiency in harnessing digital tools – computers, tablets, software and the Internet – is paramount. With the progression of modern education, e-textbooks have

emerged as pivotal tools for students, offering an interactive dimension beyond traditional books. They allow students not only to highlight and make notes but also to personalise their learning through curation and annotation. Despite the prevalence of e-textbooks, there remains a gap in research concerning their digital literacy affordances.

South African universities of technology (UoTs) have acknowledged the importance of equipping engineering students with both knowledge and technological access to digital learning tools. Yet there is a paucity of data on student interactions with e-textbooks. Engineering curricula demand students to not just consume but critically evaluate digital content, using it to construct persuasive arguments. The intricate nature of engineering tasks necessitates additional guidance and in-class support for these students. E-textbooks, in this context, should offer adaptive assistance as students grapple with intricate concepts.

E-textbook capabilities extend to features like curation and digital annotation (Chen & Tsay, 2017). Curation aids students in sifting through and organising digital content, enabling them to prioritise essential information. Annotation allows for reflective note-making, assisting students in understanding and connecting diverse ideas. Such practices enhance comprehension and retention, equipping students with skills that transcend the classroom and prove invaluable in their future endeavours.

The aim of this study is to explore in depth the affordances of e-textbooks, specifically annotation and curation; to contribute this new knowledge to the existent scientific body of knowledge; and to offer e-textbook as a tool for use by future students to better comprehend digital learning material and to make connections between various ideas.

Literature Review

"A multimodal text has created the combination of image, sound (including speech and music) gesture and movement, and writing or print, communicated through paper, the screen, face to face meetings, performative spaces" (Bearne, 2009 p.158)

It can be argued that all texts are multimodal (Andrews, 2001). When we read a novel, for example, we may imagine events and actions in our mind's eye, even experience voice, taste or smell as we read (Bearne, 2009). When reading a picture book, we may equally engage other senses, particularly touch (Mackey, 2002), as part of the reading experience. Multimodal texts (communication), representing diverse forms of communication such as the media landscape, are considered the norm with which we engage daily in private and professional life. Our routine interactions with websites, blogs and YouTube videos, as well as printed texts and journals, involve the frequent use of smartphones, tablets and computers by both lecturers and students. This engagement often extends beyond traditional pen-and-paper methods, encompassing the creation of digital texts, photos, videos and audio messages (Kretzschmar et al., 2013; Rzyankina et al., 2024).

The reading transformation from a paper book to an e-textbook is mentioned variously by many researchers from the 1900s when the Internet and PDF were invented. Reading from a paper is print-centric communication and implies a relationship existing mainly between reader and text. It typically happens in isolation or over a distance for the purpose of gaining information and mastering content (McLean, 2020; Sackstein, Spark, & Jenkins, 2015).

Research on situated literacies, as expounded by scholars such as Barton, Hamilton and Ivanič (2000), Millard and Marsh (2000) and Bearne (2009), underscores the principle that no text exists independently of the social, cultural, economic and political milieus in which it is created. This viewpoint asserts that literacy is not merely a skill but a constellation of culturally evolved practices deeply embedded in specific cultural spaces. In an era where young people are constantly immersed in and interacting with multifaceted texts, it is crucial for them to develop the ability to engage with these texts in a critical and analytical manner, particularly for understanding complex concepts.

However, while acknowledging the diverse literacy backgrounds and experiences of students, as highlighted by Guillory (2023), there is a concurrent necessity to acquaint students with the types of texts that are traditionally valued and prioritised in academic settings. It is essential to strike a balance: giving due importance to students' own situated literacy experiences while also exposing them to conventional forms of texts that dominate classroom learning. This approach to literacy education, which values students' unique backgrounds as much as it does conventional academic texts, demands a thoughtful and analytically constructive attitude from educators. It requires a comprehensive re-evaluation of the content and methodologies employed in literacy teaching, emphasising the importance of critical thinking and the transformative power that such critical engagement with texts can bring. Guillory (2023) aptly points out that the essence of teaching lies in the delicate balance between respecting what students already know and challenging them to expand their horizons.

However, as the realms of representation and communication continually evolve, so too must the boundaries of literacy education. The dynamic interplay between readers, texts and educational institutions necessitates a continuous reassessment of how we facilitate student acquisition of the forms of literacy that are esteemed in academic and professional spheres. In this rapidly changing landscape, educators must remain adaptable, updating their teaching strategies to ensure that students are equipped with the literacies that are not only prestigious but also relevant in the contemporary world (Rzyankina & Simpson, 2022).

With greater availability and accessibility of digital technology, literacy has taken a digital turn. The digital screen now takes a central place in public communications and increasingly in educational settings, changing the ways in which reading and writing are understood. Reading on the screen means using varied, and different, reading pathways and processes to reading continuous print (Holsanova, Rahm & Holmqvist, 2006; Kress, 2003; Tinmaz et al., 2022).

As lecturers, we expect students to transition seamlessly between different modes. For this, it is essential to establish a comprehensive vocabulary that captures the various dimensions of texts; this encompasses elements such as movement, sound, dynamics and the implicit aspects inherent in both visual and verbal print texts. This necessitates a deep understanding of representational modes, which include means of meaning-making like speech, writing, images, gestures, music, sound and simulations. Additionally, it is imperative to be familiar with both traditional and emerging media for disseminating these meanings, such as books, magazines, computer screens, social media posts and vlogs (like those on Instagram and Twitter), videos (with the use of filters and masks), films, stories (found on platforms like Instagram and TikTok) and radio. To achieve this, we must examine the unique affordances of each mode and medium – understanding what each facilitates or restricts – and grasp the inherent logic of texts. This refers to text cohesion that ensures coherence, as elaborated by Bearne and Kress (2001).

Digital annotation is a crucial instrument for our digital times. It empowers users to instantly attach remarks, feedback and additional digital insight to electronic documents. This functionality aids in processing the immense digital data we encounter daily. Annotations enhance the structure, legibility and comprehension of documents, assisting users in monitoring their activities and swiftly identifying pertinent details. Moreover, digital annotation fosters teamwork, simplifying the exchange of thoughts and the collective effort on tasks. The utility of digital annotation in today's world is undeniable and warrants universal adoption. When juxtaposed with traditional paper-based annotations, the digital method stands out. Digital annotations are more streamlined, permitting immediate additions without the need for printouts. They also promise greater security by archiving notes on protected servers instead of physical paper. Collaborative tasks benefit from the ease of sharing and joint access. Plus, the convenience of accessing annotations from any web-connected device surpasses traditional methods.

Given the dilatory nature of the publishing process and limitations of storage, traditional paper books in the modern world do not allow for sufficiently fast access

to information and constitute only one of many possible resources for studying. In the contemporary world, the information we receive and the process of searching is much faster than experienced before. Moreover, fake news, untrustworthy websites and the circulation of extremist propaganda suggest the need for a new kind of critical reading (Luke, 2018). Any learning requires the acquisition of knowledge, and today, knowledge is accessible through a variety of resources and platforms, not only books that are prescribed. Students can choose to learn from a variety of platforms and resources, then use those tools to evaluate their comprehension and meaning and confirm what they have learned. On one hand, by choosing and navigating the text, students have control over their learning. On the other hand, not all students are adept at evaluating and curating materials to identify those that are most reliable and connect with the reader in terms of comprehension and authorial style. In order to assimilate the information and comprehend the concepts, the reader must also develop new literacy skills of critical reading to recognise fake news, untrustworthy websites and the circulation of extremist propaganda (Luke, 2018; Tinmaz et al., 2022).

Research comparing print and digital mediums often centres on memory retention (Matraf, Hashim & Hussain, 2021). Generally, findings suggest that students recall more from paper-based readings. However, this might stem from a lack of efficient reading techniques in digital environments. Digital annotations in e-textbooks present a transformative approach to learning. They enable students to highlight, comment, bookmark and even share insights, streamlining their learning process. Moreover, students can access multimedia resources like videos, audio and quizzes, enhancing comprehension. The crux of digital annotation is its customisation, enabling students to emphasise relevant content, fostering deeper engagement. Sharing notes also promotes collaborative learning, making digital annotation an essential tool for maximising educational experiences.

Digital curation in e-textbooks is a significant boon for learners. It empowers them to tailor content to their preferences, ensuring a more personalised educational journey. Such curation enables swift topic searches, helps with content organisation, and

ensures students remain abreast of current academic advancements. The highlight of digital curation is its adaptability, allowing students to access and focus on pertinent content while maintaining organisation. This tailored learning approach grants students autonomy, enhancing engagement with materials.

However, research based on interviews and observations reveals a discrepancy: students are not fully utilising the capabilities of e-textbooks. This highlights the prevailing challenge: understanding the reluctance of students toward e-textbooks and their rationale minimal use of e-textbooks.

Theoretical Framework

The foundational philosophy for this study's application of mediated discourse analysis (MDA) (Scollon, 1998; 2001; 2014) is rooted in the cultural-historical activity theory (CHAT). Developed by theorists such as Vygotsky (1980) and Leont'ev (1974), CHAT argues that cultural artifacts and historical backdrops profoundly shape human activities. Leveraging this perspective, MDA stands out as an effective methodology for qualitative investigations. Its advantage is its ability to unpack the subtleties present in intricate learning situations.

In research domains, it is typical to be inundated with vast amounts of observational data, especially when examining the complexities of real-life contexts. Navigating this sheer volume requires a strategic method like MDA. By centring on discourse as an intermediary, MDA aids in drawing significant conclusions from abundant data, ensuring comprehensive interpretation of the observed phenomena.

MDA's incorporation in this study was not merely coincidental. It was chosen for its expertise in tackling queries surrounding societal actions. Within this present research scope, societal engagements are predominantly mediated via e-textbook content. Reading, therefore, is more than an individual act; it connects the individual with the larger community. As participants traverse this digital landscape, they utilise specific digital literacy techniques. Deciphering these methods and their associated discourse is essential to understanding modern learning settings.

Methodology

This research adopted a qualitative strategy, taking cues from the seminal work of Lincoln and Guba (1985). This method was preferred to delve deep into participant experiences, yielding insights that are likely more detailed than those from quantitative approaches (Flick, 2018).

Case Study Design

In line with Yin's guidelines (2003; 2009), this investigation was organised as a singular case study, comprising two interconnected analytical units. Each unit, while unique, related to the other, facilitating a comparative study of the central theme. The primary sample involved chemical engineering students from the Faculty of Chemical Engineering and the secondary sample encompassed nautical science students from the Department of Maritime Studies. Both samples collected from the same university of technology.

Participant Selection and Data Collection

From the two aforementioned departments, 12 first-year engineering students were purposively selected for participation, ensuring a balanced representation with six students from each department. The criteria for selection were student willingness to participate and their provision of informed consent, ensuring the ethical integrity of the research. Upon securing student agreements and signed consent forms, a series of interactions were initiated. The researcher conducted individual interviews with the participants, aiming to understand their experiences, perceptions and challenges related to reading digital physics e-textbooks. Additionally, observations were made as they engaged with these e-textbooks, providing a holistic view of their reading habits, strategies and potential areas of struggle. In combining both interviews and observations (Flick, 2018), this study was designed to capture a comprehensive picture of participant experiences, shedding light on the nuances of digital textbook usage among budding engineers in two distinct academic disciplines.

Data Analysis

Before moving data transcripts into ATLAS.ti, the researchers did automatic transcription via Otter.ai software and corrected manually where meaning and spelling were incorrect due to accent and pronunciation of the diverse participants (Smit, 2002; Friese, 2019). Then, data analysis occurred in ATLAS.ti software in two cycles: first, researchers coded inductively and after that, I coded the same data deductively using theoretical concepts from MDA. Interviews comprised the qualitative data analysed through MDA (Scollon, 1998; 2001; 2014) procedures.

The MDA procedures include three steps of data analysis. *The first step* is engaging with nexus of practices. The analysis of data does not constitute discrete processes: the researchers analyses (parts of) the data during the process of gathering data, which in turn allows the researcher to assess what other kinds of data might be useful. Following Scollon (1998), the researchers kept in mind that this step constitutes *how* the students engage in digital and social literacy practices. *In the second step*, researchers navigated the nexus of practice. In this study, MDA applied as the researchers engaged with data from the audio and visual recordings. This allowed a more detailed analysis of not just phonological and grammatical aspects of language but also the non-verbal and contextualised language use of the participants. *The third step* comprises changing the nexus of practice. By engaging with data, the researchers may produce a positive social change in practices. In other words, researchers explored how the nexus of practice has already changed over the course of the research and how the relationship between the researchers and participants has changed. In this study, this approach was applied by the findings of the study and for writing recommendations for future investigation.

Ethics

A letter of invitation was given to all registered students explaining the requirements for student participation and the research purpose. Those students who volunteered to be part of this study signed an informed consent form and returned it to the researcher for record-keeping purposes. As this study involved human participants,

the research design was deliberately crafted to ensure that the research did not pose any risks to any participants, the researcher, the departments or the institution. The researcher indicated to participants that there were no correct answers to interview questions. Participants were allowed to withdraw consent freely and discontinue participation in the study at any time without prejudice to the participant. Finally, participants were given pseudonyms to ensure no bias in the data and full confidentiality (Mertens, 2018; Dewey & Tufts, 2022).

Data Analysis and Discussion

This section delves into two pivotal facets of digital literacy in the realm of e-textbooks: curation and annotation. Both elements play a significant role in how students interact with digital content, so understanding their nuances can provide educators with insights on how best to guide their students in the digital age.

Curating

This section discusses digital curation as a reading strategy and explores why it is important to train students on how to read a digital text and curate the information. The plethora of available information and resources can confuse or even misguide a student, but digital curation can guide student choices, as seen in this admission from student 13*: I don't just watch videos that are random. I watch videos which are in the e-textbook then I note down.* This student expresses a desire access all the idea presentation options in an e-textbook from a single location where students may read text, view videos and annotate.

It was evident that students do not know how to check the information; for example, student 13 has full trust that Google provides accurate answers: *Because it's well known that Google gives accurate answers*. However, other students experienced problems with many of the available resources; selecting the correct one was a challenge.

I get confused. Because sometimes they will explain things. And then I would get it. And then when I watch another video, though, explain. They don't explain it in the same way they do the difference. Let's say that when I watch this topic, they're more

dynamic. So let's say when I go to YouTube and search for it, there will be different platforms on which I can watch this video. So they show different views. I choose when I want to listen first. When I don't understand the first one, I prefer to go to the next one. I will always want the information that I've learned to try to interpret the way they tend to interpret it, but not that I will always listen to the videos and be like, "Okay, what they're saying is correct," because I always ask questions like, "Why?" They're saying this. Why are they doing so? Usually, that's how I understand. (Student 11)

A similar view of uncertainty about curating information was expressed by student 9:

I don't think you can know for sure if it's right. But if you read a sentence from the e-textbook, you will start to get a sense of the meaning. And if you see another description, you can see that there is some correlation if they do mean similar things, just that one you understand more. So I wouldn't just simply go straight to the Internet, but if I do go to the Internet, I go to a well-known website, or a name I've seen before, not just anything.

Some students find that the most trusted resources come from lecturer recommendations. For example, student 3, during the interview discussion, mentioned, *Our lecturer always recommends the e-textbook because he always says that it's better than a paper textbook when it's trusted. So that's why I prefer to read e-textbooks. I was using Google. I just searched for the concepts only.* This learning of this student 3 is based on learning by authority (trust) from the subject lecturer.

With e-textbooks, students were able to view the same topics in a variety of different channels of communication, such as text and media. It is advantageous for students who have lower confidence in reading and who value more visual explanations to find trusted and relevant information in one place, one location. There is a myriad of information and tools available online, but it is still vital to shield students from harmful content. So, locating, evaluating and synthesising information from various Internet resources may be more complex than reading print text (Coiro, 2011). There

are also a number of other factors to take into consideration. In light of the proliferation of radical propaganda, fake news and untrustworthy websites, a fresh approach to critical reading is essential.

Annotation Affordance

Annotation refers to a set of literacy practices, sometimes referred to as 'labelling'. According to Kalir and Garcia (2021a), annotation is an everyday activity because many different types of people add different types of notes to different types of texts. In considering an e-textbook, digital annotation offers many affordances for learning, one of which is that it enables readers and writers to describe the texts in their own words to reflect their personal interpretation. Annotation can also enable access to new meanings and knowledge when students engage with the text. Annotation, however, is one of the emergent affordances of an e-textbook that has not been adequately explored in previous research pertaining to e-textbooks. In this section, researchers discuss annotation affordance as a learning aid when students use an e-textbook.

Annotation facilitates reading and, later, writing about important concepts. The reader of an e-textbook can also collaborate with other readers and texts. One of the chemical engineering students indicated, *Yes… sharing the notes*. A similar view was mentioned by student 11: *I start by reading the text and then note it down by writing on paper*. As such, annotation makes knowledge more accessible for this student. Annotation, therefore, is a process to ensure robust student participation in learning.

E-textbooks enable students to involve particular forms of active engagement with the text through annotation, including commenting, highlighting and even the use of emojis. E-textbooks allow students to annotate digital text, images, videos and audio for the purpose of studying by identifying and categorising concepts. These new ways of annotation open new opportunities for learning. For example, student 10 described the learning process: *I go to diagrams and then read the tips in the text. So, in order for me to read and know what they [the authors of the book] try to put in my mind... I read from tips, and also make notes.* Notes mediate the relationship between reading

and writing. Notes consist of different types of media that communicate through various modes, such as a transcript of the video, symbols of practical examples and images. Student 10 explained the process of study through the following interaction order: diagrams – tips (short summaries) – annotation. In this interaction order, the process of annotation moves from passive to active while engaging with digital text affordances (in the form here of graphical presentations).

Additionally, the e-textbook allowed participants to use comments, including emojis, on the text. The relationship between annotation and comments, both of which are common forms of communication, can provide useful and contextual information about the text and personal expression regarding the text. The usage of emojis in the learning process occurred, for example, by student 1: *Okay, using emojis while reading the book.* This participant used emojis for comments when reading the text and labelling sentences and paragraphs, such as if a paragraph is clear or needs more clarification. In this way, the participant can come back at any time and change the emoji from surprised or sad to happy. Using emoji icons is a fast method for personal expression on the part of the reader about a certain aspect of the text. Emoji use here is about bookmarking places to return to for further study.

Annotation Constructs Meaning

Employing an object like an e-textbook is influenced by context and culture, and the affordances of annotation as a collection of literacy activities have evolved over time to fulfil the demands of students who are simultaneously writers and readers. Reading for meaning, thinking, writing and communicating are all activities that fall under the umbrella of (digital) literacy. Different kinds of text communication are used in e-textbooks. Student 8 employed the video mode in the example below to annotate ideas and comprehend meaning: *I think I watched the video many times to make a note by writing it down. So it will be better for me to understand and write it down.* The same process was mentioned by student 2: *When I'm watching videos on YouTube, I pause the video and take notes. So that's how I do*. Students develop a connection to context and culture through annotation. Students can communicate

with texts, about them and beyond them by annotating them. For the specific purpose of annotating the concept of a video, student 8 watched the video repeatedly.

It was noticed that many students prefer learning by taking notes on paper to construct meaning from their reading. The example of student 3 demonstrates how using an e-textbook for study purposes allows students to assess their comprehension and mastery of new terms and topics: *There might be other words that I don't understand. So I tried to think if I put it in a way that I can understand, I'm trying, by all means, to understand what is written and annotate the text.* The annotation links readers' thoughts to new knowledge and comprehension. Additionally, where students learn vocabulary in a second language, annotation allows access to new meaning and knowledge.

I'm looking at videos. As the video goes on, I'll pause at some point where it gets important information. Then I write it down. Honestly, I believe in just putting things down so that I can clearly understand it. (Student 8)
I prefer writing it down. Then to highlight the text in the copybook. (Student 11)
I prefer to write in a normal copybook. I want to write. (Student 5)

These students comprehend the information by writing; this may be an effective learning strategy, or, as student 5 admitted, simply a learning habit: *My hand needs to be busy*. As observed by the researcher, if policymakers and educators continue to disregard the growing evidence that new skills and strategies may be necessary to read, learn and solve problems with the Internet, our students will not be prepared for the future. In addition, the absence of measures to evaluate online reading comprehension deprives the reading community of the ability to evaluate progress or assist in diagnosing difficulties encountered by some students when reading online.

Annotation Complements Learning

Annotation includes an evolving collection of practices that are sensitive to context and culture. None of the participants employed digital annotation; instead, they all

used annotation in conjunction with reading or viewing videos to study the subject of physics.

Just take my laptop and my notebook. I study to note what I don't understand. And then, after learning, just go back to videos. (Student 1)

In this quote, student 1 notes that annotating a text by hand can clarify conceptual understanding and develop active reading skills. Another example of actively engaging with a text was expressed by student 14*: I usually use my notes, and then I discuss with my friends what I studied*. Student 14 is using annotation as an educational tool in two-way interactions, where learning entails annotation, self-questioning and peer-questioning to ensure knowledge. Individual reading comprehension as well as knowledge recall and retention are supported by annotation.

Even though no participants employed digital annotation, it was interesting to discover that student 14 noticed a difference between hand and digital annotation: *Well, I say I prefer both of digital annotation and writing notes on paper but it's digital, it's faster. But if you write something, it's easy to remember and then choose what to type*.

One student expressed that reading digital text and making notes confused her as she could not select and decide what important information to note. For example, student 11 claimed,

I just like to watch many videos, but that does not help at all. Because some of the videos they make explain it in a different way. And they explain it in the way when you find an American and sometimes look since we don't have the same level, so they speak it in a tricky way. So sometimes I end up having information that I shouldn't even have which is not even important. While I'm studying, it takes a lot of time. So yeah, it's just that I haven't tried any other studying techniques. And so yeah, it's making that difficult... since I just can't take a lot of information, and when you check, most of the information is not all that important.

The decision of what is important in a text and what is not is quite difficult for student 11. The observation from student 11 clarified that reading depends on the purpose, which determines the information to be chosen based on the task at hand. As student 11's anxiety increased, she found it nearly impossible to decide what to select out of

fear of leaving something important out. It takes courage on the part of the reader to decide to take notes rather than copy out large swaths of the reading. It can be challenging to choose the most important information from a chapter because the issue is rarely clear-cut. Student 11's quote above confirmed this as a common difficulty for first-year students. Many first-year students, in fact, found the reading and selection of content to be extremely ambiguous, contradictory and even confusing. Students frequently take notes out of fear of forgetting something vital. According to student 7, *I write all the, all the formulas that are based on this chapter that I need to remember*, because students believe the information will be of use to them. Even this comment from a student has not demonstrated full sets of annotation affordances in e-textbook.

In addition to annotation confusion, some students argued that using annotation with a paper book is better, as indicated by student 9.

I just think it's much easier to study when it's in front of you as if you have two separate things on two separate papers you can order next to each other. In online, you can't, and you have to go to one-by-one tab. When you open this tab, the other tab disappears.

As indicated by students 7, 11 and 14, annotation adds to a range of literacy techniques such as memorisation, writing and conversation. Lecturers should teach students digital annotation techniques as literacy best practices to help them learn more effectively.

All students used annotation or made notes after reading digital text. Annotation is informative and involves learning literacy practices. To annotate means developing a better sense of what readers actually read. However, annotation and learning have a complex, contextual and occasionally unpredictable relationship. Annotation does not always result in more effective, engaging or meaningful learning, and even the presence of annotation does not indicate learning. However, it is important to highlight the benefits and affordances of annotation and discuss how taking notes in a copybook can help students learn. Unfortunately, the social interaction features of e-textbooks, which let students contribute multimodal notes to digital and online

resources for the purposes of information sharing, peer-to-peer contact, collaboration and knowledge generation, were not engaged by participants in this study.

Conclusion

The findings show that annotation constructs and complements the learning process. While the phenomenon of annotation is not new as a literacy practice, digital annotation (Kalir & Garcia, 2021a; 2021b) is relatively new as a learning aid in the educational space. The new literacy studies (NLS) framework has established a process of investigating informal and everyday literacy practices (Goodfellow & Lea, 2013). This framework highlights the importance of studying language and literacy within their natural social context, considering the meanings of different cultural groups. Additionally, NLS emphasises the need for educators, curriculum designers and evaluators to recognise how students bring meaning and practices from their home communities to formal learning settings such as university classrooms.

Curation and annotation are important components in the use of e-textbooks as educational material. By providing students with a structured and organised learning experience, educators can encourage students to focus on the most important information and retain vital material more effectively. Another important finding from this discussion on curation is that students in digital learning environments rely entirely on Google and YouTube, implying that they do not curate the most relevant and trustworthy resources. However, it is hoped this it will be included in first-year student induction and that librarians will reinforce the reasons for carefully identifying resources.

This extensive exploration of the affordances of e-textbooks made evident that understanding and utilising digital literacy practices such as curation and digital annotation are pivotal for optimal student engagement and comprehension. However, a gap remains: many students are unfamiliar with or under-equipped to harness these tools, especially in the South African context. To bridge this gap, a proactive solution would be the introduction of library training for all incoming first-year students, training on the use of e-textbooks but also guidance for navigating

news, databases and other diverse sources of information effectively. Moreover, training on how to engage in digital annotation for learning may potentially improve student understanding of complex engineering concepts.

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EXAMINING PRE-SERVICE ECONOMICS TEACHERS' KNOWLEDGE OF LEARNERS IN INTERPRETING THE DEMAND CURVE GRAPHS IN THE DYNAMICS OF MARKETS

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Abstract

National Senior Certificate (NSC) diagnostic reports for the matriculation examinations show that learners have not performed well on questions related to the topic 'Dynamics of Markets' (DM). While DM remains a crucial topic in economics education due to its implication for economic analysis, the demand curve (DD) aspect of the topic poses a challenge to learners. Thus, there is a need to examine pre-service economics teachers' knowledge of learners in interpreting the DD graphs. Using a purposeful sample of a case of three pre-service teachers from three secondary schools in the Gauteng Province of South Africa, the pre-service Economics Teachers' Topic-Specific Pedagogical Content Knowledge (ET-TSPCK) Model was used as the theoretical framework. Data was collected through classroom observations and analysed thematically. One of the findings shows that although the teachers showed knowledge of learners' misconceptions in interpreting the DD graphs, learners' difficulties in interpreting the DD graph were affected by pre-service teachers' presentation of the graphs. The study proposed a framework for pre-service teachers in teaching the DD graphs and concluded that pre-service teachers' knowledge of learners in interpreting the DD graphs needs some improvements. Although the findings of this study might not be generalised due to being context-specific, they could serve as a lens in teaching the DD graphs in DM in another context.

Keywords: Economics Teachers, Demand Curves, Dynamics of Market Graphs, Topic Specific knowledge

Introduction

Over the past decade, the teaching and learning of the dynamics of the market have been of interest to various stakeholders (Burdina & Sauer, 2015; Khoo & Fitzgerald, 2017; Manzi et al., 2021; Kurniawati, 2020; Ogbonnaya, 2022) across the globe including South Africa. DM graphs are used in economics to help learners analyse and apply critical thinking skills; thus, learners ought to explain complex ideas logically based on their understanding of graphs. Although there have been numerous studies on learners' challenges in interpreting graphs (Amin et al., 2020; Radulović et al., 2022; Skrabankova, 2020; Klein et al., 2019), such studies are rarely found in economics education, especially for topics that are overly mathematical and graphical such as DM.

In South Africa, DM is a topic taught in the further education and training (FET) band, which starts from the 10th grade to the 12th grade. It is important to note that DM as a topic occupies the Term 2 economics curriculum in all the FET phases in a greater volume. Each concept in the topic is taught separately and extensively in the 10th grade. The demand curve (DD) is one of the concepts in DM that pre-service teachers predominantly teach during their teaching practicum in the second term, hence our focus on the concept of the 'demand curve'. One of the learning objectives of DM in Grade 10 economics curriculum is that *"learners are expected to understand the concept of the demand curve and the graphical representation"* (Department of Basic Education [DBE], 2011, p. 68). This is because learners' understanding of the DD aspect of DM improves the general understanding of the topic 'DM'.

Understanding the basic concepts of DM requires understanding concepts such as the DD graphs in the 10th grade, which is the base year. This is because the base year has some implications for learners in the 12th grade, where learners are expected to write the final matric exams. These exams cover 50% of the questions in Paper 2-Microeconomics, mostly the interpretations and representations of DM that encompass the DD graphs. However, it has been observed that over the years learners struggle in the interpretation of the DD graphs. One likely reason for the learners' challenges with DD graphs could be their inability to relate the various representations

of the graphs. Evidence from the Test of Understanding Economics in South Africa (TUESA) of economics literacy on the test of learners' understanding of basic microeconomic concepts shows that learners struggle to understand economics concepts such as graphs and are unskilled with the basic economics concepts contained in the TUESA microeconomics test (Fourie & Krugell, 2015). The TUESA results showed that an overall economic literacy score of the basic microeconomics concepts such as graphs, demand and supply, scarcity and pricing was 50.9 per cent, with 46.38 per cent in microeconomics and 55.61 per cent in macroeconomics (Fourie & Krugell, 2015).

Further evidence from the National Senior Certificate Diagnostic Reports for the matriculation examination from 2019 to 2021 showed that learners have not performed well on questions related to DD graphs in Microeconomics Paper-2 over the years (DBE, 2020). Excerpts from the 2019-2021 Senior Certificate Diagnostic Reports in South Africa also prove that learners struggle to understand the aspect of DD graphs. For example, the National Senior Certificate Diagnostic Reports of 2020 and 2021 reported the aspect of DD that proved challenging. According to the report, a lack of application and interpretation of a graph in a certain context was evident in Q2.3.5 (DBE, 2021, p. 96). Another report states that graphs should already have been discussed in the necessary detail in Grades 3 and 11 to ensure a complete understanding in Grade 10 (DBE, 2020, p. 82). This evidence proves clearly that teachers need to do more work concerning learners' graphical skills and competence in the South African context.

Notably, research on graphical interpretation has focused mostly on learners, and little is known about pre-service teachers' knowledge of their learners in interpreting graphs. In fact, little is said about pre-service teachers' ability to observe learners' interpretation of graphs closely. In light of this, this study aims to investigate economics pre-service teachers' knowledge of learners in interpreting the DD graphs in DM. The research question addressed in this study is: *'How does pre-service teachers' knowledge of learners in demand curve graphs support learners' graphical interpretation'?*

Theoretical Framework

The research question was investigated under the theoretical lens of Economics Teachers' Topic-Specific Pedagogical Content Knowledge (ET-TSPCK) model developed by Ogbonnaya et al. (2020). The ET-TSPCK model is integrative and tends to understand how economics teachers integrate their transformed content knowledge in understanding the challenges faced by learners in learning specific topics in economics. Their ET-TSPCK model consists of five components: teachers' content knowledge (Graphical Knowledge), teachers' prior knowledge of learners' knowledge, teachers' knowledge of representation, teachers' knowledge of the curriculum, and teachers' knowledge of teaching strategies. However, in this study, we concentrate on the first two components. Ogbonnaya et al. (2020) defined these components as teachers' content knowledge as teachers' understanding of not only the subject matter of the topic but why the topic seems difficult to learn, i.e., teachers' understanding of what makes a particular topic difficult. Teachers' knowledge of learners' prior knowledge was defined as teachers' knowledge about learners' preconceptions and misconceptions about the topic.

Teachers' Content Knowledge

Teachers' content knowledge of graphs play a fundamental role in interpreting meaningful and purposeful graphs for learners (Ainley et al., 2001). Teachers' knowledge is essential for quality teaching in any subject, including economics, and is the major key to improving learners' understanding of graphs. Teachers must be knowledgeable enough to identify why learners struggle to grasp important concepts in teaching and learning graphs. In their paper on teacher candidates or pre-service teachers' economic pedagogical knowledge to integrate economics content into the teaching, Kieninger and Kopish (2023) found that teacher candidates have nascent economic pedagogical content knowledge and therefore needed support to foster its development. This simply implies that pre-service teachers' content knowledge on most topics is still in the developing stage.

In one study on pre-service teachers' knowledge of graphs, Patahuddin and Lowrie (2019) revealed that most of the teachers had difficulty answering questions that

required 'reading beyond the data'. Rather than interpreting the graph as an abstract representation of data, the teachers interpreted the graph as an iconic representation of an actual event. Teachers need robust knowledge of graphs because if they experience difficulties understanding and interpreting graphs, they may be unable to help their learners overcome similar difficulties. Another study by Hidayat et al. (2019) on pre-service teachers' knowledge of graphs found that teachers were operating at literal or rational levels where they could only read values and trends from the graphs and provide contextual explanations limited to the meaning presented. Glazer's (2011) findings concur with the finding that pre-service teachers' expertise in graphical interpretation might be a barrier to the execution of meaningful practice in graphing.

Other findings from a study by Çil and Kar (2015) on pre-service teachers' knowledge of graphs revealed that teachers can read values and trends in graphs, but they are not successful at the higher levels within the interpretations of graphs hierarchy. Yet another finding from Vermeulen and Meyer (2017) on pre-service teachers' knowledge of learners' misconceptions showed that teachers lacked the knowledge and skills to identify, prevent, reduce or correct learners' misconceptions on specific topics, which is contrary to the findings from Burdina and Sauer (2015) who analysed learners' misconceptions and found that teachers had adequate knowledge of learners' misconceptions on graphs. Bahtaji (2020) identified the area where teachers engage learners in the active construction and interpretation of graphs to improve their conceptual understanding as an aspect where pre-service teachers' content knowledge is made evident. Pre-service teachers' knowledge of graphs could be understood clearly by their knowledge of learners' prior knowledge.

Teachers' Knowledge of Learners' Prior Knowledge

Prior knowledge could be described as existing knowledge before a given task. For effective teaching and learning, teachers should be able to understand and identify pre-existing knowledge that learners come into the class with. Teachers should be able to predict how to handle any situation and problem that may showcase itself during the learning process. Understanding learners' prior knowledge is one way of knowing

such situations. Prior knowledge is some life experience, either real or vicarious (Knuth & Jones, 1991). Prior knowledge is rooted in the constructivist theory of learning that proposes that learners construct and reconstruct meanings and ideas from what they already know as they learn from their past and integrate their present experiences and perceptions of reality (Gee, 2012). A study by Mihalca et al. (2011) found that learners with a higher level of prior knowledge would have better existing working memory to identify their current learning state and academic needs and be able to choose their own learning strategies. Dong et al. (2022) also found a similar result: prior knowledge was positively associated with learning engagement, and this relationship was mediated by cognitive load and instrumental help-seeking.

Although there may be a tendency to believe that always having prior knowledge will positively affect new learning, in some cases, it may not be so. For example, Hailikari et al.'s (2007) study on how different forms of prior knowledge affect learning found that declarative knowledge did not contribute to student achievement. Glazer (2011) also found that other forms of prior knowledge did not improve learners' achievement. This finding may, therefore, imply that incorrect prior knowledge may hinder learning. David (2017) concurs that prior knowledge could either help or hinder learning, especially when the prior knowledge is inaccurate. David stressed that inaccurate knowledge could lead to misconceptions. In fact, a misconception is erroneous, illogical, or misinformed Knowledge that learners already have about a topic/concept before it is being taught, which impedes learning.

Difficulties in Interpreting Graphs

Glazer (2011) identified a range of difficulties graph readers face when interpreting graphs. These include confusing the slope and the height (slope-height confusion), reading a graph as a picture, and confusing an interval and a point. A study by Klein et al. (2019) aligns with Glazers' observations where physics learners outperformed their economics counterparts in graphical interpretations. Their result shows that economics learners tend to compare the graph height rather than the area under the curve. Other difficulties associated with graphical interpretation are teaching approaches teachers adopt and the graph's presentation. Most times, teachers are

seen providing incomplete information for the graph or using the wrong graph instead of the right one. The result of the study conducted by Radulović et al. (2022) for physics teachers to determine the differences between Serbian and North Macedonian learners' graph understanding shows that a higher instructional efficiency of teaching approaches was used for the Serbian learners while fewer mental efforts were applied for the North Macedonian learners.

Research has shown that graph characteristics are another factor that affects how graphs are interpreted. The use of colours, for example, may simplify the interpretation process because users use them to track changes and recognise patterns or trends. For example, using different colours for each line in a multiple-line graph might help to differentiate a specific graph one refers to instead of identifying different lines with different shapes, such as a line with triangles or a line with circles (Brockmann, 1991). Another essential characteristic of graphs that affects graph interpretation is that theories govern graphs. Good theories should work in the real world; otherwise, they are not good theories. One of the challenges learners encounter with theories is to provide interpretations and explanations for the data that contradict the theories (Glazer, 2011). According to Chinn and Brewer (2001), the interpretation of graphs is influenced by prior theory (commitment to a theory) and learners' prior expectations. Prior expectations may not be in line with the theory, thus leading to biases and errors. Teachers, therefore, require robust knowledge of the theories governing graphs to resolve learners' misconceptions relating theories to graphical interpretation. In the context of economics, for example, teachers use graphs to illustrate their theories because theories are based on facts (data). In other words, economists gather data and find theories to explain the data.

Method

Research Approach, Design and Paradigm

This qualitative case study involving three Grade 10 pre-service economics teachers is undergirded by the interpretivist paradigm (Creswell, 2017). The paradigm helps us gain a deep understanding of the pre-service teachers' teaching of the DD graphs in DM in a natural setting.

Participants and Sampling

This study used the case of three pre-service economics teachers of the 10th graders. These pre-service teachers' names were represented with pseudonyms (Teacher A, Teacher B and Teacher C), and there were two female teachers and one male teacher in the group. These teachers were purposefully sampled from three secondary schools in Tshwane North District of South Africa. Purposeful sampling serves the idea that the researcher desires to discover, understand, and gain insight into the phenomenon at hand (Etikan et al., 2016). Following an inductive approach to analyse the data, the researchers immerse themselves in the data to identify themes that are in turn explained by the study's theoretical framework.

Data Collection Techniques

Data was collected through lesson observation. All data collected was video recorded and transcribed. Three lesson observations were video recorded for each pre-service teacher of the 10th graders. These lessons were transcribed and analysed. The analysis followed the process of open coding, axial coding and selective coding. Patterns formed were grouped into categories and codes from which themes emerged to make sense of our data. The most important aspect of the analysis was the coding process. Specifically, open coding was used to identify the pre-service teachers' knowledge of learners when analysing their gestures and teaching. The observation checklist guided us to categorise our findings under pre-service teachers' content knowledge (graphical knowledge) and pre-service teachers' knowledge of learners' prior knowledge of the DD graphs.

Ethical Considerations

The researchers obtained ethical clearance from the universities. They ensured confidentiality and anonymity while risks to participants were minimised. All participants received consent forms that told them they had the right to withdraw at any given time. The aims and objectives of the project were also explained.

Results and Discussions

This section presents the results and discusses the findings. The findings are presented according to the emerging themes after considering questions and answers, teachers' knowledge of learners' misconceptions, familiarity with the content and active construction of knowledge.

Findings

Questions and Answers

Our findings showed that all the pre-service teachers started the lessons with an introduction on which questions and answers on the concept of demand were based. For example, pre-service Teacher A started the lesson with questions and answers to test learners' prior knowledge of the 'graph' and the 'demand curve' concepts. Pre-service Teacher A asked learners to mention any subject where they encountered graphs. He also asked them to define the term 'demand' as it relates to economics and as it is used in everyday life. Teacher A had pre-knowledge of learners' possible difficulties with understanding the concept of 'graph' and the term 'demand' as learners most times assume the literal meaning of the concept of demand.

Pre-service Teacher B began the lesson by understanding learners' knowledge of the bar graph and relating the DD to the bar chart. She explained that the bars are plotted on a graph, as is the line that makes the DD drawn on the graphs to create the curves. Pre-service Teacher C, on the other hand, continued in his introductory lesson by stating the law of demand with an example illustrated in a simple graph. Teacher C stated, *"as the price of the product decreases, more of the good is demanded and vice visa."* The learners could not relate the law of demand to the real-life scenario. One of the learners challenged this theory of demand with a familiar and personal scenario and said, "As *the prices of cars drop, the quantity demanded will not rise because my father just bought a new car*". Teacher C knew of the learners' misunderstanding in relating theory to practice; thus, he carefully explained to the learner that he failed to factor in the general market demand rather than only considering the household demand and family consumption behaviour. Teacher C used another real-life example to explain further and to prevent the misconception. Our findings at the introductory

stage of the lessons from all the teachers showed that pre-service teachers' knowledge of learning difficulties (KoLD) in MD graphs was adequate at this level to support learners' understanding of the concept of 'graph'; this they have done to prevent learners' possible difficulties in understanding what a graph is.

Teachers' Knowledge of Learners' Misconceptions

All the teachers noticed that learners expressed the meaning of one concept to mean another. For example, Teacher A observed that learners tend to see firms as price setters. The learners presume firms will earn more revenue as more goods are demanded and earn more revenue as more goods are sold in the event of a price fall. We found that pre-service Teacher A used his content knowledge to support the learner by explaining the market forces that set the price step by step. This misconception is based on the prior knowledge that the learner had on how she thought the economy worked before the understanding of the theory.

Another finding that shows teachers' knowledge of learners' misconceptions was when pre-service Teacher B warned of the mistake learners made when plotting a simple DD. Pre-service Teacher B reminded the learners that plotting a DD begins from the '0 origin' as constant and gave the learners a class activity to plot the DD with a given data. The teacher understood learners' misconceptions in placing the 'zero' origin from the data supplied, as in Figure 1.

Table 1
Demand Schedule for the Number of Books Demanded at Different Prices

Price	0	5	3	15	20	25	30	35
Quantity	70	60	50	40	30	20	3	0

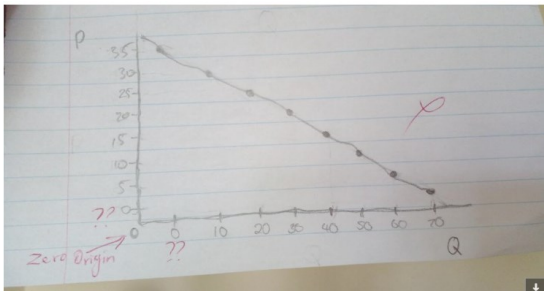

Figure 1. Learners' difficulty in plotting the DD.

Figure 1 shows learners' difficulty plotting the DD graph after marking the class activity. A learner asked, "*Ma'am, I am confused there. You told us that the zero origin (0) is constant right? What if at price 35, Peter bought no loaf of bread, how would you place it on the graph? Is it not supposed to be the zero origin 0,0, 3, 20, 30, 40, 50, 60, and 70 on the X-axis?"*

The learners' confusion was how to represent the price at 0 when the quantity demanded is 70 and how to represent the quantity demanded at 0 when the price is 35 considering the 'zero origin 0'. Our findings showed that the question somehow threw the teachers off as they could not properly explain the 'zero origin 0'. Teachers show a little bit of knowledge of the graph. The study also found that learners want to see a *curve*, not a line representing the DD. A learner asked, "*where is the demand curve as I only see a line and not a curve*". Learners find it difficult to assume how a straight line can be called a curve. Although the teachers tried to answer the question by giving the learner a clue, our observation shows a lack of confidence in the teachers.

Learners had misconceptions in their understanding of terminologies. During class observation of Teacher B, learners found it difficult to understand the terminology that "*the demand curve slopes downwards from left to right*". Learners confused the statement with the *shift of the demand curve from left to right*. The two sentences mean two different things. They also find it difficult to relate the negative slope of the DD to the inverse relationship that exists between the price and quantity demanded. The teacher used her knowledge of learners' prior knowledge of the terminology 'shifts' of the curves and content knowledge to support the learners by explaining these confusing concepts**.**

We also found that learners confused the concepts of '*movement*' with the concept of '*shift'*. For example, in Teacher C's class, a learner asked, "*What is the difference between a movement and a shift? If I move a cup from 'Point A' to 'Point B', haven't I shifted the cup?"* This is a layperson's interpretation of the concept of movement and

shift the teachers explained. He used his KoLD to support this learner by illustrating further with a graph. Another finding from Teacher C shows that learners tend to confuse *'a shift in demand'* with '*a movement along a demand curve'*. For example, learners were asked to explain what happens to the price of a banana (normal good) if the income of their parents decreases. One learner explained that "*if the income of my parents decreases, their demand for [a] banana will decrease, then the price of bananas will go down*. *When the price of [a] banana falls, demand increases*". The pre-service teachers explained that the learner confused a shift in demand with a movement along the DD. Learners explained that although the decrease in income will reduce the demand for bananas and the decrease in the demand for bananas will reduce the price, the reduction in price does not increase demand; instead, it increases the quantity demanded, which is the movement along the curve.

In another lesson, our findings indicated that the pre-service teachers' demonstrated inadequate knowledge of learners' prior knowledge of the concept of '*change in demand*' and '*changes in quantity demanded*'. This lack of knowledge was evident in all the teachers' presentations of the concepts. The teachers did not consider assessing learners' prior knowledge of the determinants of demand. One clear piece of evidence was from Teacher A's class activity: "*assume that bread is a normal good. Demonstrate with a graph what will happen to the demand or quantity demanded of bread if the income decreases"*. It was surprising that after much explanation, most of the learners answered this question incorrectly, perhaps because they were familiar with the item "bread" or did not have knowledge of the determinants of demand that would have informed the answer to the question. Learners assumed that the DD for bread would shift to the right (increase) instead of shifting to the left (decrease), which should indicate a change in demand. The teacher further used an analogy to explain this concept.

However, in another observed lesson on plotting the graphs, the pre-service teachers assessed learners' prior knowledge by explaining first how 'Price P' and 'Quantity Q' should be placed and plotted on the 'X' and 'Y' axis. Teacher C reminded learners not to interchange data from the x-axis for the y-axis but failed to remind them that the

dependent variable in economics is on the horizontal axis while the independent variables are on the vertical axis as opposed to mathematics classes. Learners' difficulty in this regard was evident when some placed the variable price (P) on the horizontal axis and the quantity (Q) on the vertical axis. Learners were drawing curves from left to right instead of right to left. This finding showed that the teachers had adequate knowledge of learners' prior knowledge or the common mistakes learners make when plotting the DD.

In another lesson, we found that the pre-service teachers presented the movements along the DD and shift of the DDs on the same graph with different colours and then explained the differences. Although there is nothing wrong with representing the two graphs in one graph, our finding shows the pre-service teachers' presentation of the two graphs with the different colours was confusing to learners. This was evident when a learner asked Teacher A for the curve representing the movement along the DD, as he only sees the two curves representing the shifts from one curve to the other. On the same graph, a learner asked why the new DD does not have any price and quantity.

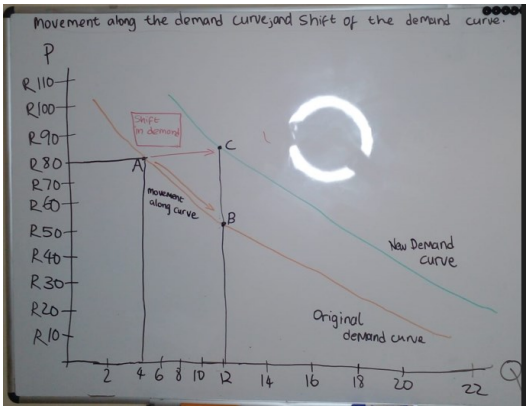

Figure 2: The movement along the DD and the shift of the DD

Familiarity with the content: Due to familiarity with the dynamics of market content, learners tend to take the meaning of some concepts for granted. We found this to have impacted adversely on learners' understanding of the graph. For example, in all

the classes observed, we found that learners seem to be too familiar with concepts such as 'Demand,' 'Supply,' 'Price', 'Quantity,' etc., so they tend to use the general and common meanings of these concepts rather than their economic meanings. The teachers noted that although those concepts are common knowledge in our everyday use, the general or literal knowledge of such concepts could lead to misconceptions among learners if not well taught.

Active Construction of Knowledge

Our findings showed that all the teachers engage learners in constructing and interpreting graphs as they relate to real economic problems. They do this to improve learners' conceptual understanding of DD graphs. They also tested learners' economic analysis with the use of graphs. The findings showed that learners could not interpret and relate the graphs to the economic situations and thus could not answer questions on different graphs beyond the data. However, the pre-service teachers showed adequate content of KoLD by answering learners' questions, explaining and interpreting the graphs beyond the data. The study's findings in this regard showed that the teachers could answer the questions beyond the graph.

Discussion

One novel finding in this study is that, to a greater extent, the teachers showed knowledge of learners' prior knowledge of DD graphs. The teachers were knowledgeable in identifying learners' prior knowledge, which could lead to confusion and misconceptions. This finding was in line with that of David (2017), who stressed that inaccurate knowledge could lead to misconception. In particular, the finding of the study disagrees with the findings of previous studies (Çil & Kar, 2015; Patahuddin & Lowrie, 2019) that most of the teachers had difficulty answering questions that required 'reading beyond the data' Our findings showed that the teachers were able to answer the questions beyond the graph. Our finding contradicts those of Hidayat et al. (2019) and Glazer (2011) on pre-service teachers' knowledge of graphs, who found that teachers were operating at literal or rational levels.

Another finding from the study showed learners' familiarity with the content, which was a challenge for the teachers to pick precisely where learners had challenges with the DD graph, which adversely impacted learners' understanding of the graph. This finding shows that teachers should not just know the topic but should also know every aspect of the content. Although learners were familiar with the dynamics of market content, they were not familiar with most concepts on the graphical component of the content. This finding is contrary to that of Glazer (2011), who found that learners' familiarity with the content affects learners' graphical interpretation positively. Learners should be familiar with the content, as familiarity with the content could limit misconceptions.

One of the findings was that learners' difficulty in interpreting the MD graph was affected by pre-service teachers' presentation of the graph. Beside graphical presentation, the different colours used to represent the different curves confused learners. These findings concur with the findings of Glazer (2011) and et Radulović et al. (2020), who emphasised that the presentation and teaching approaches affect learners' understanding of graphs. The study found that the teachers effectively used their content knowledge of DD graphs to engage their learners in the active construction and interpretation of MD graphs. The finding resonates with Bahtaji (2020) findings that learners' active construction and interpretation of graphs improve learners' conceptual understanding. The findings also showed that the teachers demonstrated adequate content KoLD in relating theory to practice. The finding is in line with Chinn and Brewer (2001) and Glazer (2011), who found that learners often provide interpretations and explanations for the data that contradict the theories. Furthermore, our finding that the teachers had pre-knowledge of learners' misconceptions in the topic of the dynamics of the market is contrary to Vermeulen and Meyer (2017), who found that teachers lacked the knowledge and skills to identify, prevent, reduce, or correct learners' misconceptions on specific topics. However, our finding aligns with that of Burdina and Sauer (2015), who analysed learners' misconceptions and found that teachers had adequate knowledge of learners' misconceptions on graphs.

To improve learners' understanding of the DD graphs in DM, we propose an alternative method of teaching using 'Worked Examples' to reduce learners' difficulties in understanding the DD graphs. Learners are expected to construct their own knowledge through worked examples on the DD graphs. This study proposes a step-by-step approach with worked examples (planning, executing the worked example graphs, explanation and reflection), where new knowledge is integrated with prior knowledge to understand how graphs are constructed and interpreted. Studying worked examples is encouraged as it reduces the extraneous load normally present in traditional problems. Sweller (2012) referred to the use of worked examples as cognitive load theory. The developed framework is what we refer to as 'Pre-service Teachers' Framework in the Teaching of the Demand Curve graphs". The framework is self-explanatory and could be applied to the teaching of other concepts in different contexts other than the DD graphs. The framework is attached in Appendix 1.

Conclusions

This case study explored economics pre-service teachers' KoLD in interpreting MD graphs of the DD. Our findings showed that pre-service teachers' knowledge of their learners in interpreting the DD graphs is limited. The study concludes that pre-service teachers' knowledge of the learners in interpreting the DD of DM graphs needs some improvement. The study contributed to the literature by proposing a framework presenting a case of pre-service economics teachers' knowledge of the learners in DD-MD curve graphs. This study will help economics teachers know where to focus when presenting this topic to learners. We encourage that future studies could use more than three teachers and other grade levels to analyse their KoLD. The findings from this study are valuable to the Department of Basic Education in South Africa and all other stakeholders in economics education globally to improve pre-service teachers' knowledge of their learners' learning not only about DD graphs but also in other topics in economics education that are challenging to learners.

To improve learners' understanding of DD graphs, we recommend that the Department of Basic Education consider including more worked examples and practice for learners to work with graphs in the school curriculum. Teachers are also

encouraged to prescribe textbooks with good graphs and real-life examples that learners can relate to easily.

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HIGHER EDUCATION REFORM IN ZIMBABWE: AN EXAMINATION OF SCIENCE TEACHER EDUCATORS' WORK DEMANDS

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Abstract

There has been a global movement towards a demand for high-quality Science teaching anchored on 21st-century skills. The new demands on Science teacher educators require them to acquire a wide range of competences to innovate and industrialise. To date, empirical evidence on how Science teacher educators in Zimbabwe are grappling with the multiple and complex demands of heritage-based education 5.0 (HbE 5.0) and balancing their work activities is missing. This multi-case study examines Science teacher educators' work demands in the context of higher education in Zimbabwe. Qualitative data was generated with five Science teacher educators purposively sampled from the respective Science departments of two universities. The semi-structured interviews and document data were deductive-inductive content analysed. The study's findings revealed that although the Science teacher educators were familiar with some competences needed for effective work engagement within the HbE 5.0, they remained glued to the traditional practices. Additional findings showed that several constraints, such as inadequate funding for projects, and disproportionate teaching loads hindered their work. The study recommended increased support for research, innovation, and student learning, and enhanced opportunities for educators' skills utilization.

Keywords: Heritage-based education, Work-demands, Innovate, Industrialise, Professional development

Background

There has been a global movement towards a demand for high-quality Science teaching anchored on 21st-century skills. Many countries have sought to strengthen their curriculum in Science through initiatives that set standards for Science, technology, engineering, and mathematics (STEM) education. "Recent school reforms expect students to learn about the practices of Science and the nature of scientific knowledge and develop more complex analytic skills in preparation for education and work in the twenty-first century" (Mork et al., 2021 p. 3018). In the United States, assessment approaches, novel pedagogy, revision of textbooks, and design of materials have to be aligned with the Next Generation Science Standards (NGSS) (Fulmer et al., 2018). This movement for better Science teaching in schools has implications for Science teacher education and educators. Many studies have called for Science teacher educators to be at the centre of preparing competent Science teacher candidates who rise to this need for quality Science teaching (Craven & Penick, 2001; Berry & Van Driel, 2023). Craven and Penick (2001) contend that Science teacher educators are catalysts for conceptual and cultural change that inspire Science teacher candidates to acquire new mental models for teaching school Science. That places a heavy demand on the Science teacher educator's work. In most universities or teacher education colleges, Science teacher educators are thus expected to possess unique sets of skills that will assist them in imparting specialized competences for teaching school Science. In addition to these skills, Science teacher educators operating in universities need to adapt to other demands for higher education. Science teacher educators at a university are recruited from diverse backgrounds (Mork et al., 2021). Some are recruited from teacher education colleges while others come straight from high schools. However, both of them need to adapt to the new environment for teaching Science and perhaps acquire new sets of skills for university teaching which has been confirmed in some studies as equally demanding (Hanuscin et al., 2021; Irez, 2006; Mork et al., 2021).

Work demands for teacher educators are constantly changing due to diverse factors that impact higher education transformation. This has necessitated a change in the definition of what constitutes work engagement for staff. Mapesela & Hay (2006 p.

711) say; "…trends such as the massification of higher education widened access, response to new demands of technology, globalisation, internationalisation, increased accountability, the use of new modes of delivery and materials, as well as dwindling higher education resources, are placing enormous pressure on staff". This pressure on the work demands varies depending on institutions and their geo-political location. Knowledge generation in higher education happens in diverse social processes that involve power relations in nationally or regionally based systems (Arocena et al., 2017). Some universities have well-defined working conditions for academic staff in relatively efficient systems while others have ill-defined roles and unfavourable working conditions. There is a generally held perception that higher education institutions in the global north have better-organised working conditions than those of the global south (Robertson & Komljenovic, 2016). International higher education trends show a decline in the prestige of the academic profession, "…and diminishing funding for Higher Education Institutions (HEIs) in most parts of the world translates into adverse working conditions and low morale" (Portnoi, 2015 p. 258). These trends are most noticeable in higher education institutions in the global south where work engagements happen in constrained work environments (Muriisa, 2014).

Another phenomenon gaining currency, and borne out of the process of commercializing research and knowledge capitalization, is the extension of universities' mandates from the usual teaching and research to other areas such as community engagement, innovation and industrialisation. This process of commercializing research and innovation that facilitates cooperation between universities and industry has been taken on board as integral part of knowledge based institutions. Accordingly, universities are granted intellectual property (IP) rights for new technologies and they set up incubators, innovation hubs, science and industrial parks, which lay the foundation for the development of industry. The Ministry of Higher and Tertiary Education, Innovation, Science and Technology Development (MHTEISTD) (2018), in Zimbabwe aver that economic development is animated through technology transfer at the innovation hubs and industrial parks that are based at or linked to the country's state universities. Despite the commonly held view that such expansion spurs positive growth on economic and industrial development, little

is known about how the expansion and additional workload impact on the academic staff work-demands, resources, task autonomy, complexity and adaptation to novel work circumstances. More research is, therefore, needed to investigate how science teacher educators balance their professional work in the context of this expansion of the universities' missions.

Statement of the Problem

Science teacher educators' work implores unique sets of skills that can assist them in adapting to peculiar requirements for Science teaching and Science teacher education in diverse university environments. The demands keep evolving due to many factors that impact the transformation of higher education. The need to bolster industrial growth through patents from higher education, the teaching and learning technology boom, the development of ICTs-related pedagogy, and the requirements for 21st-century Science curriculum reforms all influence universities and academic staff operations. Accordingly, higher education institutions thus require faculty academic staff to teach, research, community engage, innovate and produce. While that is the case, general observations reveal that the majority of this staff struggle to meet the demands owing to several factors. This becomes evident when universities fail to deliver on some of their mandates, particularly in Africa. Despite these mandates of teaching, research, community service, and others appearing on the institutions' strategic documents, the roles are mucky and somewhat poorly performed (Muriisa, 2014). Additional research that illuminates case realities and proffers solutions to the challenges met when Science teacher educators manoeuvre around their work demands is thus called for. This study, therefore, seeks to examine the Science teacher educators' "balancing act" on their work in the context of higher education in Zimbabwe.

Research Questions

Specifically, and in the context of higher education in Zimbabwe, the study sought answers to the following questions:

1. What motivation and competences for preservice Science teaching do the educators possess?

2. What challenges constrain the Science teacher educators' capacity for professional growth?
3. How do the Science teacher educators grapple with the novel work demands of the HbE 5.0 framework?

Context of the Study

In the context of Zimbabwe, there are two operating environments for Science teacher educators. Some Science teacher educators teach at teacher education colleges and others are university lecturers. On occasion, both groups can find themselves appraising and supervising the student teachers on internships that are done in schools.

Although the teacher education colleges and the universities are governed under the same Ministry of Higher and Tertiary Education, Innovation, Science and Technology Development (MHTEISTD), schools operate under the jurisdiction of the Ministry of Primary and Secondary Education (MoPSE). Paradoxically, both MHTEISTD and MoPSE use different frameworks for Science teaching and learning. School Science is guided through Science, Technology, Engineering and Mathematics/Science, Technology, Engineering, Arts and Mathematics (STEM/STEAM) frameworks whilst Science teacher education under MHTEISTD is informed by the heritage-based education 5.0 (HbE 5.0). Rosdin et al. (2019) frame STEM education as a learning approach that integrates Science, technology, engineering, and mathematics whilst Tan (2020) views it as a combination of disciplines whose existence is sustained by overlaps among them.

Thus the STEM/STEAM designation in the MoPSE curriculum framework recognizes the importance of STEM as a vehicle for socio-economic development but acknowledges the existence of and importance of the "Arts" disciplines as tools for integrated learning (Liao, 2016). Conversely, while the HbE 5.0 curriculum framework for higher education recognizes the centrality of STEM to national development, it portrays higher education operations as being guided through five pillars- teaching, research, community service, innovation, and industrialisation. According to this view, heritage-based education is structured through the interconnectedness of the five

pillars. Teaching is, therefore, meant to be research-based to bring about new ideas that are processed into certified prototypes in innovation hubs (MHTEISTD, 2018). However, the differences in the focus of MHTEISTD and MoPSE curriculum frameworks present a dilemma to the Science teacher educator. Despite operating in an environment guided through HbE 5.0, Science teacher educators need to produce teacher graduates who fit and effectively operate in the STEM/STEAM framework. Thibaut et al. (2018) observe that effective implementation of integrated STEM requires teachers with specialized pedagogical content knowledge and deep knowledge of the Science, technology, engineering, and mathematics content which is largely and unfortunately lacking.

The promotion of academic staff in a HbE 5.0 framework is operationalized through an act of the Zimbabwe Council of Higher Education (ZIMCHE). ZIMCHE is the guarantor of quality for all higher education institutions.

The appointment, grading, tenure, and promotion of the university staff are informed by the ZIMCHE Act Chapter 25:27. In appraising "…academic staff for appointment, grading, and promotion, the University Council shall consider the following five missions under the Education 5.0 as the broad criteria: teaching; research; innovation; industrialisation; and community service" (ZIMCHE, 2022 p. 3). Following the point-based model, relative points are assigned to a range of activities that staff engage with (Kenny, 2018).

The table below shows the target points that each member needs to achieve to be promoted to the next grade.

Table 1. Target Points for Promotion, Tenure, and Grading of University Academic Staff (Adapted from ZIMCHE, 2022)

	Teaching	**Research**	**Community Service**	**Innovation**	**Industrialisation**
Professor	25	40	15	30	25
Associate Professor	25	30	12	20	20
Senior Lecturer	20	18	15	15	12
Lecturer	Entry level				

According to this tabulated requirement, the Science teacher educator, like any other academic staff, has to strive to meet the requirements of the five missions (ZIMCHE, 2022). Thus, for the Science teacher educator, teaching involves achieving target pass rates for the modules they teach, supervising student research projects, assessing student learning, developing new modules and regulations, preparing short courses, and receiving satisfactory student and peer evaluation results. Research requires the same educator to author and publish textbooks, book chapters, and research articles in peer-reviewed journals, review peers' scholarly work, and make presentations at research conferences. The community service mission will demand that the Science teacher educator holds administrative posts in the department or faculty, conduct public lectures, engage in outreach programmes, sit as a member in some of the university committees, and sometimes source equipment or funds for and on behalf of the institution. In the last two related missions- innovation and industrialisation, creating prototypes and designs, registering patents and copyrights, commercializing Intellectual Property (IP), developing models and novel artefacts, and holding patents that are used in industry are some of the expectations.

Literature Review

Theoretical Framework

Science teacher educators' work demands can be framed within the Job Demands-Resources (JD-R) model. The JD-R is an influential theory developed by Demerouti, Bakker, Nachreiner, and Schaufeli (2001) to integrate stress and motivation research traditions. In the setup of many organisations, demands made on the employees and the corresponding availability of resources or lack thereof can be antecedents for stress or motivation. Workplace stress can reduce employees' optimal functioning (Dhanpat et al. 2019). Stress occurs when individuals fail to access resources or when there are limited resources to aid job effectiveness. Naidoo-Chetty and Du Plessis (2021) say persons who lose resources experience actual stress, or when resources are threatened, they will experience anticipatory stress before any actual resource loss occurs. The JD-R model thus postulates that when employees have adequate job resources that assist them in successfully coping with their job demands, it spurs an extrinsic and intrinsic motivational process that leads to higher levels of engagement (Naidoo-Chetty & Du Plessis, 2021).

Science teacher educators' work demands are difficult to place. Van de Broeck et al. (2010 p. 737) say though necessary for accountability of institutional performance "…academic work is notoriously difficult to quantify". This is the case because the academic staff in higher education are faced with complex work conditions. Bakker and Demerouti (2017) identify two broad categories of working conditions- job demands and job resources. On one hand, "…job demands are defined as those physical, psychological, social, or organisational aspects of the job that require sustained physical and/or psychological effort and are therefore associated with certain physiological and/or psychological costs" (Bakker & Demerouti, 2017 p. 2). Aspects such as task interruption, workload, role ambiguity, and work-family role interference also relate to job demands (Van de Broeck et al., 2010). On the other hand, job resources are the disposable resources (psychological, physical, social) that either hamper achievement of job demands or function as stimulants for success, personal and organisational growth, and development. The educator's skills and opportunities for skills utilisation, competences variety, autonomy, performance

feedback and supervisor support, financial rewards, and growth opportunities that an organisation avails to its staff are examples of job resources (Van de Broeck et al., 2010). Several studies (Baka, 2015; Tims et al., 2013; Zhang et al., 2022) have confirmed the negative impact of high job demands on workers' physical, emotional, and mental well-being. Physical strain, fatigue, stress symptoms, turnover intentions, maladaptive coping, and anxiety are some of the documented effects (Zhang et al., 2022).

Qualitative Job Demands for Science Teacher Educators

Qualitative job demands refer to the difficulty or complexity level needed to carry out the job (Bowling & Kirkendall, 2012). Such qualitative demands focus on the type of skills such as cognitive, emotional, or physical skills, and the effort required to complete work tasks. Studies in Science teacher education frame it as a complex phenomenon that requires unique sets of skills. A Science teacher educator is the first educator who initiates pre-service and in-service teachers on the nuances of Science teaching. The Science teacher educator develops pre-service teachers' skills for teaching Science in schools through deliberate programmes designed to impart conceptual, epistemic, technical, and pedagogic competences of Science education. Laderman et al. (1997) argue that the Science teacher educator requires diverse knowledge, skills, attitudes, and dispositions addressed in four critical areas: knowledge of the discipline, Science pedagogy, and assessment; knowledge of learning and cognition; knowledge about Science inquiry and scholarly research; and knowledge acquired through continuous professional development. In Laderman's et al. (1997) framing, the Science teacher educator needs to keep abreast with developments in Science and Science education through distinguished scholarly research activities both inside and outside the classroom and engagement in continuous professional development that can be pursued individually or with peers. Building on this framing, Mork et al. (2021) propose an expanded four-domain notion inclusive of Natural Science, Science education in schools, Science teacher education, and Science education research. The domain of natural Science relates to the teacher's subject matter knowledge, procedural knowledge, and epistemic knowledge that deals with research practices in Science and the nature of Science (NOS)

respectively. In the second domain, the Science teacher educator must possess knowledge about learning theories, school Science curriculum, pedagogy, inquiry-based approaches, assessment of learning, 21st-century skills, and STEM integration approaches. The third domain implores skills in developing pre-service and in-service teachers' mastery of the natural Sciences domain and the practice of teaching. In the fourth knowledge domain, the educator engages in diverse research activities inclusive of action research, collaborative research, action Science, and presentation of research findings.

The Science teacher educator domains of knowledge in the description above imply a multi-layered venture where the Science teacher educator owns subject matter knowledge (SMK), professional knowledge (PrK), pedagogical and pedagogical content knowledge (PCK) for both school Science and Science teacher education. SMK relates to a domain of teacher knowledge (its facts, concepts, organisation, and structure) that is deemed legitimate, declarative, procedural, and conditional (Nixon et al., 2019). This is the Science teacher educators' knowledge that defines the different academic study areas of the Science discipline. PrK, on the other hand, is the disposition for the actions of teachers in the execution of their daily teaching tasks. In some literature, the actions are described as intricate and intuitive covering a wide diversity of elements inclusive of communicative knowledge, knowledge of learning theories, research knowledge, content knowledge, pedagogical knowledge, and pedagogical content knowledge of the teacher's work (Jegstad et al., 2022; Kulgemeyer et al., 2021; Ngan et al., 2021). Pedagogical and pedagogical content knowledge relate to each other. While definitions may vary and be subject-specific, PCK can be viewed as the observable teaching behaviours and decisions Science teacher educators make in the process of organising, adapting, and representing content through specific pedagogies to learners of diverse interests and abilities (Kim, 2021). Thus, the Science teacher educator requires expert PrK and other domains of knowledge that represent 21st-century learning to make decisions about their teaching actions.

The knowledge about 21st-century skills is a wide area that cannot be adequately covered in the scope of this paper. Pitaloka et al. (2021) postulate that 21st-century skills as competences that emphasise process skills in the discovery of knowledge utilising: investigations, argumentation, analysis, inference, organisation of information, communication, decision-making, problem-solving, and drawing up conclusions. Creativity, critical thinking, problem-solving, collaboration, language skills, digital literacies, inquiry mind-set, and productivity as examples of 21st-century competences. For instance, Foulger et al. (2020) advance the Teacher Educator Technology Competences (TETCs) as representing digital literacy domain knowledge of teacher educators who are preparing pre-service teachers to use and deploy ICTs in their teaching. Among other things, the teacher candidates are supported to: develop technology competences for online teaching and online communication tools; design instruction and collaborate using online tools; and create hybrid learning environments. Engagement with this diverse knowledge and skills requires an intricate balance of the Science teacher educator's job demands. This is because each single knowledge requirement places sufficiently heavy demands on the educator's intellectual capabilities, time, and resources.

Science teacher educators' work demands are difficulty to place. Van de Broeck et al. (2010 p. 737) say though necessary for accountability of institutional performance "…academic work is notoriously difficult to quantify". This is the case because the academic staff in higher education are faced with complex work conditions. Bakker and Demerouti (2017) identify two broad categories of working conditions- job demands and job resources. On one hand, "…job demands are defined as those physical, psychological, social, or organisational aspects of the job that require sustained physical and/or psychological effort and are therefore associated with certain physiological and/or psychological costs" (Bakker & Demerouti, 2017 p. 2). Aspects such as task interruption, work load, role ambiguity and work-family roles interference also relate to job demands (Van de Broeck et al., 2010). On the other hand, job resources are the disposable resources (psychological, physical, social) that either hamper achievement of job demands or function as stimulants for success, personal and organisational growth and development. The educator's skills and

opportunities for skills utilisation, competences variety, autonomy, performance feedback and supervisor support, financial rewards, and growth opportunities that an organisation avails to its staff are examples of job resources (Van de Broeck et al., 2010). Several studies (Baka, 2015; Tims et al., 2013; Zhang et al., 2022) have confirmed the negative impact of high job demands on worker's physical, emotional and mental wellbeing. Physical strain, fatigue, stress symptoms, turnover intentions, maladaptive coping and anxiety are some of the documented effects (Zhang et al., 2022).

Methods

To examine Science teacher educators' balancing act of their work demands, the researchers applied the exploratory qualitative approach. Exploratory qualitative approaches aim to generate new knowledge by exploring novel topics where little or no data exists (Rendle et al., 2019). Specifically, the researchers used a multi-case design in which two units, Bindura University of Science Education (BUSE) and Great Zimbabwe University (GZU), were used to provide a situational analysis of the work engagement of Science teacher educators in their respective departments. The multi-case study was considered appropriate because it allowed the researchers to explore phenomena using the replication strategy. According to Zach (2005), replication is carried out in two stages-literal replication and theoretical replication. In the literal replication stage, the researchers selected the two cases based on teacher educators' shared subject expertise to get relatively similar results that were then used to "explore and confirm or disprove the patterns identified in the initial cases" in the second, theoretical replication stage (Zach, 2005 p. 9). Access to the purposively sampled group of five participants was gained through personal contacts. These are participants who constituted the academic staff of the Science departments of the respective universities as shown below in Table 2.

Table 2. Some Characteristics of the Participating Science Teacher Educators (GZU, N=2; BUSE, N=3)

Participant Name*	Discipline Taught	Highest Professional Qualification	Work Experience (in years)
Danny	Chemistry	PhD Science Education	12, in high school, 10, in university
Leo	Biology	PhD Science Education	9, in high school, 3, in teacher education, 7, in university
Grey	Physics	MSc- Science Education	7, in high school, 3, in university
Carlos	Chemistry	MSc- Science Education	13, in high school, 13, in university
Kudzie	Biology	MSc- Science Education	4, in high school, 9, in teacher education, 11, in university

*NB. Pseudonyms were used.

A pre-tested interview protocol with seven questions was used to generate semi-structured interview and document analysis data. The same questions on the interview guide were converted to corresponding questions seeking answers from the Science educators' documents. The documents analysed were educator generated inclusive of course outlines, lecture notes, staff appraisal forms (where these were made available) regulations for the various disciplinary areas, time-tables, published articles, strategic plans, and artefacts in laboratories. By using a variety of approaches to collect data from various sources, the researchers hoped to achieve confirmability of the research findings. Zach (2005) says confirmability of results is achieved when steps are taken to gather data from several sources and, where possible, by researchers with diverse perspectives. Data gathered were content analysed using a combination of deductive and inductive approaches. Pre-determined themes assisted

the researchers in organising the raw data and focusing on the findings. Once the data were classified under themes from the review of literature, inductive analysis ensued to yield patterns, codes, and new themes. At this stage, follow-up member-check communications were also done, through e-mail or WhatsApp, with all participants to verify initial perspectives and confirm the accuracy of resultant themes and conclusions.

Findings and Discussion

The major findings of this study that emerged from the researchers' analysis of the participants' responses to interview questions and a study of their professional documents are presented using five themes: self-actualised and "motivated"; competences variety; constraints as in "we want but we are limited"; capacity for professional growth; and adapting to novel work demands.

Theme 1: Self-Actualised and "motivated"

The first theme of the findings came from an assessment of the interviewees' work environments, the participants' body language, and an analysis of their responses. Evidence from this analysis showed that despite having limitations in some areas, they presented themselves as self-actualised and somewhat motivated. They showed confidence in different areas such as mastery of their subject matter knowledge [Carlos], teaching skills [Kudzie], professional qualifications that were all aligned to their specialisation area [Leo], and an apparent awareness of their job requirements [Danny]. However, despite this show of confidence, some of the participants indicated a lack of inertia, that is, the ability to self-start themselves in performing task requirements. For instance, Carlos kept indicating that he would not engage in any initiatives on his work unless superiors tasked him to do so. The excerpt below exemplifies this phenomenon:

Yes, our administrators, the chairperson, do not know; they are also being asked to do things that I said they don't understand. Those things normally put us off because some of us don't like working in the dark. I'm sure you know that from our past interaction. You tell me what you want me to do and I will do it to the latter. But

if you cannot explain yourself what you want me to do then I stop and I don't even bother to understand those things [Carlos].

In terms of motivation, the data gathered were not conclusive. On one hand, some participants like Danny were somewhat motivated. He reported on the financial benefits they were getting from engaged projects. In addition, he indicated that he was motivated by the trust given to them by the community, and local high school chemistry teachers, who engaged them as consultants on practical chemistry sessions. However, on the other hand, although the other participants staged a motivated mood during the interviews, their lack of interest in some activities important to their job description, like research, perhaps signalled a depleted zeal for the work.

The findings in Theme 1 were not conclusive about job satisfaction and the levels of confidence displayed by participants. On one hand, there were those participants (e.g. Danny and Leo) who felt that they had self-actualised and were senior degree holders. Their disposition for work engagement was, therefore, positive and this aligned with existing evidence from literature suggesting that demographic variables such as age, gender, and level of education had positive influences on job satisfaction (Chimanikire et al., 2007). On the other hand, some of the participants (e.g. Carlos and Grey) lacked motivation to perform tasks on their initiative. Jegstad's et al. (2022) contend that when teacher educators are not adequately inducted into the work demands of their job, frustration sets in. This is due to the demanding nature of the induction phase (early years of joining university) which "…is experienced as demanding by teacher educators, especially since the character of the profession is multifaceted and complex" (Jegstad et al., 2022 p. 1006).

Theme 2: Competences Variety

Based on a question that asked for the competences required for Science teacher education in the 21st century, the participants reported having a variety of these but lacking in some, such as the knowledge of the NOS. Carlos demonstrated familiarity with Pedagogical Content Knowledge (PCK) when he explained situations that required a variation of approaches. He said:

The other components they don't know how I prepared this and that, right? They are just there to mix those chemicals. That is what we call the integrated approach. The integrated approach is for the student who is going to write the examination. The stand alone approach is for the student who is going to teach other students how to go about it.

Although Grey's PCK was fragmentary, he displayed some digital literacy skills and knowledge of the application of culturally relevant pedagogy in Science teacher education. He intimated that he was carrying out an innovative project on the creation of a virtual laboratory using a smartphone. Danny claimed to be using STEM education approaches. He professed:

So, we make use of mathematics, mathematics is needed when dealing with titrations. Although we do not have a specific STEM integration approach at the moment we incorporate technology, some videos, online discussions, and engineering design approaches to teach.

Kudzie had this to say:

For our students to adequately deal with continuous assessment and learning activities (CALAS) that were introduced in the schools, they need to possess critical thinking, innovation, problem-solving, and other 21st-century skills.

However, an analysis of the participants' documents, publication profiles, and laboratory environments revealed some limited capacities in research, creativity, and innovation. In the laboratories visited by the researchers, no tangible artefacts emerged from the professed competences application.

Largely, this theme showed that participants were somewhat familiar with some competences for 21st-century Science teacher education but also lacking in some areas. In some of their views, possession of SMK, PCK, knowledge of STEM integration approaches, knowledge on the use of culturally relevant pedagogy, collaboration skills, and engaging students through virtual spaces was important for a Science teacher educator's work engagement. Their views resonated with studies that have put forward the knowledge requirements for Science teacher educators. Such studies (Jegstad et al., 2022; Kulgemeyer et al., 2021; Ngan et al., 2021) postulate that for Science teacher educators to operate effectively they need PrK which is diverse and

covering elements inclusive of communicative knowledge, knowledge of learning theories, research knowledge, content knowledge, pedagogical knowledge and pedagogical content knowledge.

Theme 3: Constraints as in "we want but we are limited"

Concerning constraints that interrupted them from carrying out their job demands effectively several were highlighted.

Despite advocating for some changes in the way we do our job, the university systems and set up do not allow diversion from teaching to do other things such as innovation [Grey].

This excerpt set the tone for most of the challenges that were reported by the participants. The universities introduced new ways of work engagements but some vestiges of traditional approaches remained. Carlos commented:

As much as I would want to innovate in my academic work, as a chemistry teacher, I am very much limited by the measures of our examination system.

This participant further intimated that the assessment system in the university had remained fixed on a 30%: 70% weighted ratio for coursework and examination respectively, thus compelling them to teach for examinations intensively. Despite working in the same department, Danny and Leo did not agree on the issue of workload as an obstacle to effective work engagement. Whilst Danny said they shared teaching loads equitably and sometimes engaged part-time lecturers to ease the high workloads, Leo said something different. He contended:

I think you saw it when I gave you my teaching load that here at our university we teach four modules but because of the high workload at times, you end up teaching five or even six. So, you find out that they will say you have four modules to teach but then we have one student from Namibia you have got to attend to but in fact, you will be teaching the full load. So, to have additional time to attend to other issues like research? You know in our area you might need to travel to go out and collect data from the field and then you face challenges because of that.

Other constraints that were reportedly impeding effective work engagements included limited or sometimes lack of laboratory equipment, inadequate time to deal with block release students who only had two weeks for in-person sessions, delays in

financing project proposals, restricted funding for publishing, poor student ICT skills coupled with erratic network connectivity and some students' off-task behaviours.

In each of the excerpts above, it is evident that the participants encountered many constraints that affected how they did their work. Many of the constraints raised in the study are echoed elsewhere in the literature. Chimanikire et. al. (2007) investigated the factors that affected job satisfaction among university staff in Zimbabwe. The authors observed that 61% of the respondents identified high volumes of work that included teaching many cohorts of students, marking large numbers of assignments, and supervising a large number of student research projects as a major contributor to employee dissatisfaction. This theme, therefore, laid bare the need for support so that educators to perform tasks effectively (Van de Broeck et al., 2010). Support includes positive feedback on activities carried out, supervisor support, student learning support, funding for research and publications, improved connectivity, and other job resources that make it maximally possible to carry out their duties.

Theme 4: Capacity for Professional Growth

In the excerpt below Leo sounded what they had intended to do with colleagues, students, and corporate partners to enhance professional growth and contribute to general community welfare.

We had partnered with other colleagues in the Natural Sciences and gone out of our way to buy some of the materials needed for a project that we had proposed.

The project was about making pavers from recycled plastic. We partnered with the Environmental Management Authority (EMA). Students were also involved in the collection of plastics.

Though he reported that the project failed to take off because of failure to secure sponsorship that had been promised, he outlined the benefits that would accrue to them had the project materialised. Collaboration across departments, student learning in the laboratory processes, extension of knowledge frontiers, and engagement with other stakeholders from the community were the benefits he

highlighted. All the participants thought that opportunities that resulted in additional skills to their already existing repertoire were needed to enhance work performance. They spoke about public lectures [Danny], research workshops with invited colleagues from other universities [Kudzie], short courses for locals [Grey], and mentorship support and co-teaching with colleagues [Carlos]. In his words, Danny said:

We have some research fares, research week, and also they are other fora like public lectures. We usually make efforts to be included in the calendar of public lectures at the university. Also, as the Science department we visit schools, and local secondary schools, after getting some consent from MoPSE, where we hold some workshops with the Science teachers so that they can develop these skills, those innovative skills in the learners.

Thus, despite some limitations encountered, the participants made efforts to grow their professional skills through engagement with other colleagues, students, and community stakeholders.

Some teacher educators, like Carlos in the current study, found it extremely difficult to manoeuvre through job requirements without support from the institution and peers. The participants' observation that opportunities that resulted in additional skills to their already existing repertoire were needed to enhance their work performance is confirmed in other studies. Chinamasa (2012) explored factors influencing research output in Zimbabwe universities and suggested research mentors, practitioner collaboration, and professional development workshops as recommendations that would assist budding researchers.

Theme 5: Adapting to Novel Work Demands

This theme related to how the participants managed their work schedules in settings where additional work demands, such as innovation and industrialisation were introduced to the already existing activities of teaching, research, and community service. The findings indicated that the novel work demands resulted in many scenarios. While a few gave the impression that they were adapting, for some the additional demands created role ambiguity, and yet for others, the demands were

complex such that they could not cope. Thus, perceptions about what constituted the HbE 5.0, the framework that has introduced novel work demands, and how it could be operationalised differed. Some, like Grey and Carlos, thought that HbE 5.0 was a far-fetched concept that was difficult to implement in the context of education. Grey argued that the job of a Science teacher educator should end with teaching about teaching and that some aspects of the HbE 5.0 framework did not apply in Physics. In his words, he said:

That heritage part! To me, honestly, it is far-fetched as a system because in Physics we don't have such things as heritage. It's not proper to talk about heritage in Physics.

The other participants confused innovation with improvisation. For instance, Kudzie thought that repairing broken laboratory equipment represented innovation in Biology. However, a few of the participants narrated success stories with the new demands in their work engagement. One of them had this to say:

So, now need to patent our idea on the mauyu (baobab fruit) project. In the project, we are producing a wide range of products with mauyu, such as yogurt, juice, and coffee, and some of the products we intend to sell in town [Danny].

The participants confirmed findings from theme 5 above by shading the approximate man-hours they spent on each activity of the five missions of the HbE 5.0 framework as represented in a twenty-segment pie chart. The results were summarised as follows in Figure 1 below.

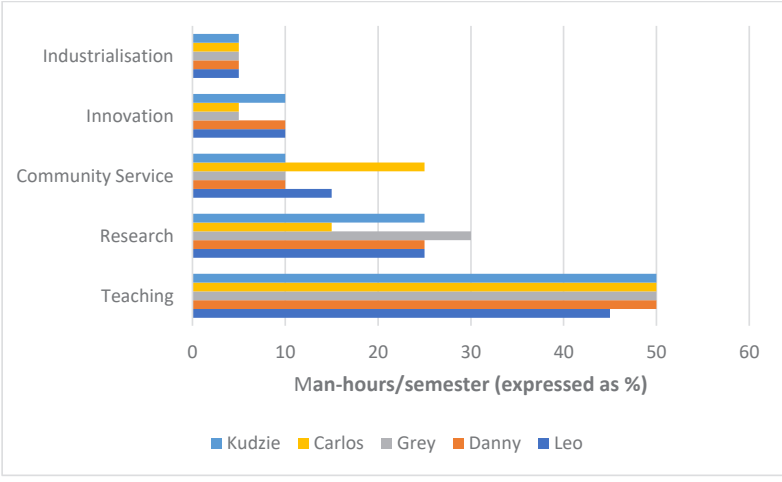

Figure 1. Approximate Educator man-hours/semester (expressed as %)

Figure 1 shows that all the participants spent close to half their time at work engaging in teaching activities. Innovation and industrialisation, which constituted the additional work demands barely got attention from the Science teacher educators. From an analysis of their documents, especially the teaching plans, research profiles, and performance appraisal forms, innovation and industrialisation were activities that only remained on paper or as plans in their minds without concrete products such as patents, IP rights, and prototypes evidenced on the ground. Although all participants did very little on industrialisation, Grey and Carlos, extended the paltry 5% man-hours to innovation. These are the participants who, earlier in the interviews, doubted the applicability of the HbE 5.0 framework in the context of education and expressed the view that the concept was far-fetched and complex to fathom. Carlos and Grey's perceptions of HbE 5.0 ran contrary to what other studies have found. Muzira and Bondai (2022) explored educators' perceptions of adopting Education 5.0 at a state university in Zimbabwe. The study showed that educators perceived the HbE 5.0 framework as helpful and more beneficial to the education system than the previously adopted Education 3.0.

However, the other findings of the current study in Theme 5 indicated that the novel work demands resulted in many scenarios is also confirmed in a survey by Munikwa and Mapara (2022). The study explored the crafting of HbE 5.0 as a philosophy guiding the activities in higher education in Zimbabwe. They concluded that: the "Education 5.0 curriculum was characterised by lack of expertise in curriculum revision activities, superficial understanding of the Education 5.0 doctrine, limited stakeholder consultation, inadequate capacitation of lecturers and the limited time given to the exercise" (Munikwa & Mapara, 2022 p. 182). The overall summary results presented in Table 3, however, contradict the terms of reference for the appointment, grading, tenure, and promotion of the university staff as informed by the ZIMCHE Act Chapter 25:27. Regarding Table 1, the Science teacher educators in the current study spent disproportionate time engaged in teaching instead of aligning and balancing their activities as required in ZIMCHE regulations. According to Table 1, the workload for senior lecturers is distributed on weighted scores of 0.25, 0.23, 0.19, 0.18, and 0.15

for teaching, research, community service, innovation, and industrialisation respectively as shown in Table 3 below.

Table 3. Weighted scores showing (i) ZIMCHE requirements for promotion into senior lecturer grade, and (ii) Danny's approximate man-hours on HbE 5.0 missions.

	Teaching	**Research**	**Community service**	**Innovation**	**Industrialisation**
(i) *Senior lecturer*	0.25	0.23	0.19	0.18	0.15
(ii) *Danny (Participant)*	0.5	0.25	0.1	0.1	0.05

In comparison, Danny's weighted scores (as calculated from Figure 1) on the same respective activities are 0.5, 0.25, 0.1, 0.1, and 0.05. According to the information in Table 3, Danny is trailing behind and not fulfilling the requirements on community service, innovation, and industrialisation to merit a promotion. The implication is that although this participant is an experienced lecturer and holder of a PhD he struggled to maintain the stipulated balance for work engagement. The educators should engage more in innovative research and community service- holding public lectures, engaging in outreach programmes, designing prototypes, and creating and developing models for patenting in innovation hubs (ZIMCHE, 2022).

Conclusion

The Science teacher educators in this study had an appreciation of what was expected of them in terms of job demands. The majority of them perceived their job as requiring an extensive base of professional knowledge. Professional knowledge for them implied knowledge on teaching students about teaching, a process that required them to have skills in "…. content knowledge, communicative knowledge, knowledge about adult learning, feedback and motivation, research knowledge, and how to develop reflective competence within others" (Jegstad et al., 2022 p. 1007). The evidence in the findings reveals that attaining and using these competences in practical teaching

was not easy for some of the Science teacher educators. Several constraints, such as limited or sometimes lack of laboratory equipment, inadequate time to deal with block release students who only had two weeks for in-person sessions, delays in financing project proposals, restricted funding for publishing, poor student ICT skills coupled with erratic network connectivity and some students' off-task behaviours came in their way. This and the need to balance work demands in university environments operating under an HbE 5.0 framework made their job somewhat difficult. While a few seemed to be adapting to the demands for innovation and industrialisation, others found the concept difficult to implement thus causing them to revert to more teaching than anything else. The study had its limitations worth mentioning, that is, the reliance on interview information and some documents without observation of the actual actions of the practitioners. Therefore, Future research should focus on observing and investigating what occurs with the educators' practical teaching. Based on the findings, the study recommends increased support in funding for research, innovation, and student learning, and enhanced opportunities for educators' skills utilization through collaborative research, co-teaching, workshops, and the establishment of Science communities of practice.

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THE PERCEPTIONS OF SCHOOL MANAGERS, TEACHERS AND DISTRICT OFFICIALS ON THE IMPLEMENTATION OF THE INTEGRATED QUALITY MANAGEMENT SYSTEM IN SCHOOL

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Abstract

The purpose of this study was to investigate perceptions of school managers, teachers, and district officials on the implementation of Integrated Quality Management System (IQMS). A qualitative approach with Case study design were adopted. A purposive sampling technique was used to sample teachers, principals, heads of departments and district officials to explore their perceptions towards IQMS implementation. Data was collected using interviews, document analysis and reflective notes. The study used an interpretive paradigm to assess a day-to-day practices and processes of the IQMS implementation in schools. Social Realist theory was used to explore the practices of IQMS through Structure, Culture and Agency as theoretical lenses. Data collected was analysed using thematic data analysis. The study found that the IQMS was not effectively implemented because of dysfunctional structures and lack of thorough training and workshops. The study concluded that there is a need for all structures involved in the IQMS implementation to be trained thoroughly to equip them with knowledge and skills to manage and monitor the implementation processes. This study recommended that for IQMS to be effectively implemented there must be a change in structure, culture, and agency to eliminate challenges facing the IQMS implementation in schools.

Key terms: Performance appraisal, integrated quality management system, perceptions, attitudes, quality teaching, knowledge.

Introduction and Background to the Study

The Department of Education (2004, p.1) states that the Integrated Quality Management System was established to identify specific needs of education, school and district offices for support and development; provide accountability; monitor the overall effectiveness of the institution and to evaluate the teachers' performance. The aim of the IQMS is to achieve school improvement goals. Many schools are now using the IQMS as a tool to improve school effectiveness and the quality of results. Most teachers participate in IQMS activities for incentives and developmental purposes. Schools are judged through the delivery of quality education to all those who attend school. Odhiambo (2008, p.418) maintains that the IQMS is a means of getting better results from the organisation, its teams, and individuals, through understanding and managing performance within an agreed framework of planned goals, objectives, and standards.

According to Mahlangu (cited in Mhangani, 2012, p.71), the "implementation of IQMS policy in our schools is still a challenge" since it was introduced some years ago. Reports from the National Department of Education (NDoE), IQMS external moderators and provincial IQMS officials also indicated that schools are at different levels regarding the implementation of IQMS. Some schools are indeed at full implementation whereas others are struggling to implement the program. The report further indicates a high positive correlation between schools that perform excellently in grade 12 examinations year after year and schools that implement the IQMS policy fully (Mhangani, 2012, p.71).

The report also indicated that most schools implement IQMS policy partially, and yet others are implementing the policy poorly after all these years of training and conducting workshops. According to the Department of Basic Education Action Plan to 2014 (2011, p39), national officials found that in the 2009 to 2010 period, only 7% of schools visited could be considered as having fully implemented the IQMS and it was not well implemented in a consistent and uniform manner in schools. The Education Labour Relation Council (2003, p.8) stipulates that IQMS should be

implemented in a uniform and consistent manner for all schools. Mji (2011, p.47) revealed the Department of Education trainings did not prepare people for the effective implementation of IQMS policy.

The purpose study purpose was to explore the perceptions and experiences of principals, heads of departments, teachers, and district officials regarding the IQMS implementation in schools.

Problem Statement

The Integrated Quality Management System was established by the Education Labour Relations Council in 2003. This policy is mandatory for all schools in South Africa and all supervisors, i.e. circuit managers, principals, deputy principals and heads of departments, and educators must comply with its rules and regulations. It comprises three programmes; namely, Development Appraisal (DA), Performance Measurement (PM), and Whole School Evaluation (WSE) that are aimed at enhancing and monitoring the performance of educators. The purpose of the IQMS is to evaluate educators' performance, to monitor an institution's overall performance, to promote accountability, to provide support for continued growth, and to determine the kinds of needs that educators, schools and district offices have regarding support and development. When the IQMS is implemented well, it enhances quality and accountability for teachers. According to Mamabolo, Malatji and Mphahlele (2022) supervisors have the responsibility to monitor and ensure good implementation. However, in this principal, head of departments, teachers, and district officials, did not instill positive culture as articulated in the Social Realist theory (Archer, 1995). Therefore, lack of agency when it come to the implementation of IQMS has compromised its practice.

Literature Review

Perspectives on how the IQMS should be Implemented in Schools

Domingues, Sampaio and Arezes (2015) staff members should be trained to address issues relating to IQMS implementation in all schools. District officials and teachers must all have thorough understanding of the principles, process and procedures of

IQMS. District officials and teachers must be acquainted with knowledge and skills to plan and administer IQMS in a uniform and consistent manner. Education Labour Relation Council (2003, p.8) and the National Training Team (NTT) have to conduct training sessions for the provincial delegates; the Provincial Training Team has to train officials from the regional or district level, while clusters and schools have to be trained by officials from the district level. According to Basaran (2018) principals are assigned responsibilities to training teachers in their schools. She argues that principals are often not well prepared for tasks they must undertake and given insufficient training to perform their tasks. According to Daharat, Sued and Gheisari (2022) without the involvement and commitment of the senior managers the "process is likely to collapse. It was revealed that 70% of the deputy principals do not meet with their Development Support Groups, hence an indication of a lack of direction as far as the implementation of IQMS is concerned. Principals as the immediate supervisors of the deputy principals should ensure that there is a meeting between the deputy principals and their Development Support Groups (Meng, Fu & Butler, 2017).

According to Plimley and Bowen, as quoted by Mhangani (2012, p.69), "if principals are not well informed and there is no support rendered to teachers, therefore, the implementation of IQMS will be hampered". Principals put the blame on the Department of Education for all challenges faced by all stakeholders during the implementation process of IQMS for not trained them thorough to acquaint them knowledge and skills on IQMS. Minkman (2016) found that principals maintained that the Department of Education failed to make IQMS a workable entity. The Staff Development Team confirmed lack of proper training and hence, they were unable to offer support that is due to their subordinates. Principals and teachers indicated that the support from the Department of Education was not enough and made it difficult for teachers to take IQMS seriously (Mji, 2011, p.53). According to Mamabolo, Malatji and Mphahlele (2022) the most fundamental tool for implementing IQMS policy is support from SMT and district. Mhangani (2012, p.71) found that the IQMS was partially implemented due to a lack of support from the Department of Education to schools. Mhangani added that "the IQMS is a system that does not measure what is

supposed to measure", hence, it does not help teachers to become productive. Many schools are still experiencing challenges regarding IQMS implementation and teachers are not satisfied with the pay progression. It was revealed that communication between the department and schools is not effective (Maphutha, 2006, p.60).

According to the Department of Education (2004, p.15), the teacher should be evaluated on every performance standard that is applicable to his/her post level. Domingues, Sampaio and Arezes (2015) revealed that teachers were not evaluated on all performance standards. This raises some questions on the validity of scores teachers received. This was supported by Basaran (2018) when saying that other school's resort to a "round table exercise" because there are no lesson observations. The effective implementation of IQMS relies on the commitment of teachers and their ability to refrain from regarding it as a formality (Minkman, 2016). Meng, Fu and Butler (2017) assert that principals "often not well prepared for tasks they must undertake and are not given sufficient training to perform their tasks." According to Mamabolo, Malatji and Mphahlele (2022) without the commitment and involvement of the senior managers the process of implementing IQMS is likely to collapse.

Mhangani (2012, p.69) cited that "if principals are not informed and there is no support rendered to teachers, the implementation of the IQMS will be hampered," as Plimley and Bowen (2006, p.221) maintained. In the light of all challenges faced by all stakeholders during the implementation process, principals put the blame on the Department of Education. Pillay (2005, p.57) in her findings she cited those teachers had not received feedback, support and some teachers slowly developed a "don't care" attitude towards the IQMS. According to Mhangani (2012, p.71), support is the most fundamental aspect or tool in implementing any policy or program. Hence, her study found that the IQMS is partially implemented. Many schools are still do not implement IQMS effectively and teachers are not satisfied with pay progression. It was also found that communication between the department and schools is not effective (Minkman, 2016). Systems theory will help to bring the department and schools together to make IQMS policy a success and this will resolve the blame game between them (Daharat, Sued & Gheisari, 2022).

Mhangani (2012, p.57) cited that the management plan for IQMS implementation is important but it must be communicated to all those involved in the implementation. She explained that effective implementation of IQMS relies on the support from school management team and commitment of teachers. Mhangani's (2012, p.57) findings revealed that teachers did indeed receive the management plan; however, they "claim" that they did not receive the plan, and this signals their negative attitudes towards the IQMS implementation. The Department of Education (2004, p.3), stated that the School Development Team should prepare and monitor the management plan for the IQMS.

The Role of the District in the Implementation of Integrated Quality Management System

Advocacy, training, and proper implementation of IQMS is the overall responsibility of the district office. The district office is responsible for the development and arrangement of professional development programs in line with the identified needs of teachers and improvement plan. The district office has the responsibility to monitor, moderate results of schools to ensure consistency and give support to schools to help them improve the implementation. Where the summative evaluation results of a school are not consistent with the school's general level of performance, the district should refer the results back to the school for reconsideration (Department of Education, 2004, p.5).

Principals' Roles in the Implementation of the Integrated Quality Management System

According to Mamabolo, Malatji and Mphahlele (2022) it is the responsibility of the principal to implement IQMS in school because he/she leads the school management team in the process. Principals are required to meet the external demands of the schools and be accountable for developing staff members. Principals should understand that effective management of people in the school results in effective individual and team performance. The principal has the responsibility of training staff members; develop training programs and development. He/ she is assigned

responsibilities to assist teachers, particularly new and inexperienced teachers to achieve educational objectives in accordance with the needs of the school. The principal participates in agreed teacher appraisal processes to regularly review their professional practices with the aim of improving management, teaching, and learning and IQMS implementation (Department of Education 2004, p.5). The principal should ensure that performance review in school be procedurally sound and should be seen to be consistently applied. The principal as the manager of the school should be the first one to be appraised to demonstrating that there is nothing to fear in the system (Basaran, 2018). Principals should ensure that the IQMS is effectively implemented in the schools. They should perform the following duties: ensure that all teachers are provided with copies of the IQMS documents; organize school based workshops on IQMS in order to clarify areas of concern for teachers; facilitate the establishment of the School Development Team in a democratic manner; ensure that all documentation of teachers' evaluations sent to the district office are correct and delivered in time; and is responsible for internal moderation of evaluation results in order to ensure fairness and consistency (Menf, Fu & Butler, 2017).

School Structures Needed for Implementing the Integrated Quality Management System

According to Domingues, Sampaio and Arezes (2015) an effective performance appraisal program requires a great deal of organization, as well as sensitivity in the way in which it is managed. Implementing the appraisal scheme is the responsibility of school senior management and district officials. Structures that are required to implement the IQMS in schools are Senior Management Team (SMT) (the principal, deputy principal and heads of departments); Staff Development Team (SDT) which plans, overseas, coordinates and monitors all quality management processes and the Development Support Group (DSG) which for every teacher consists of his/her immediate superior and one other teacher. The IQMS thus reinforces the existing hierarchies of control and the line management in school (Education Labour Relation Council, 2003:5). The principal has the responsibility to ensure that the IQMS is implemented uniformly and effectively at the school. He/she should organize a workshop where each teacher could clarify areas of concern. The teacher should

undertake self-evaluation for his/her personal growth and development. Teachers should have the Development Support Group (DSG), which will comprise his/her immediate senior and peer of his/her choice (Minkman, 2016, p.21).

Staff Development Team

Mamabolo, Malatji and Mphahlele (2022) states that before the implementation of the IQMS in schools, all schools are required to establish an elected Staff Development Team and the Development Support Group for the IQMS implementation to be successfully. Key structures that need to be established are the Staff Development Team and the Development Support Group. Staff Development Team is assigned the responsibility of planning the appraisal process, facilitating appraisal training and on-going support and the preparation, and monitoring of a management plan for appraisal. Staff Development Teams are also responsible for consulting appraisal panels and the identification of appraises, ensuring a link between appraisal and the Whole School Development, monitoring the effectiveness of the appraisal system, and ensuring the records are maintained. Basaran (2018) explains the purpose of the Staff Development Team as initiating, coordinating, and monitoring the appraisal process in institutions and ensuring that training occurs. It also facilitates ongoing professional support. It helps in training and supporting every teacher to develop professionally, to keep up with the modern challenges in the teaching fraternity (Daharat, Sued & Gheisari, 2022).

Roles of the Development Support Group (DSG)

The Development Support Group identifies teachers' development possibilities within their job positions. Employees are expected to complete personal growth to inform the school management teams of areas that need development. The Development Support Group must provide mentoring and give support to educators towards achieving professional excellence. The Development Support Group should collaborate with teachers to develop a Personal Growth Plan and work with the Staff Development Team to incorporate plans for the development of the teachers into the overall School Improvement Plan (SIP) (Minkman, 2016).

Professional Development and Training

According to Basaran (2018) training and professional development are critical to school's performance improvement. Teachers should show their willingness towards the implementation of IQMS. IQMS policy should be well communicated and understandable to teachers for its implementation to be effective. It must be flexible enough and consider the different circumstances of South African schools. The IQMS should provide constructive support to help schools to improve. The Department of Education should provide appropriate training for all stakeholders for the IQMS to be implemented effectively in schools. The school management team should implement teacher's professional development activities in schools and must encourage teachers to attend development programs that will assist them in improving their knowledge, skills, values, and attitudes for them to become better equipped in the management of their classrooms (Meng, Fu & Butler, 2017).

Advocacy and Training in Integrated Quality Management System

According to Mamabolo, Malatji and Mphahlele (2022) principals should conduct advocacy and training at a full staff meeting. He/she should explain to the staff what IQMS is and its benefits to teachers, learners, the school, and the department. Principals should also explain to the staff why IQMS was adopted. According to the Education Labour Relation Council (2003, p.8), training should specifically address issues relating to how IQMS should be implemented at schools. All teachers should have thorough understanding of the purposes, principles, procedures, and process of IQMS. Training must enable officials and teachers to plan and administer the IQMS in a uniform and consistent manner. The Staff Development Team must plan and incorporate all the processes with the time limit in which they must be completed, and the responsibilities of all individuals involved (Department of Education, 2004, p.6).

The Importance of Self- Evaluation

According to Minkman (2016) advocacy and training should involve the criteria and instrument that will be used for both Development Appraisal System and Performance

Measurement. This should enable teachers to become familiar with the evaluation criteria. Teachers should also familiarize themselves with the performance standards, the criteria as well as the levels of performance to meet at least the minimum requirements for pay progression. According to Education Labour Relation Council (2003, p.21), self-evaluation should form part of both Development Appraisal System and Performance Measurement. The Performance Measurement is used for determining pay /or grade progression and should be used to evaluate the performance of the teachers annually. It is through self-evaluation that a teacher becomes familiar with the instrument and is compelled to reflect critically on his/her own performance. The teacher is expected to set own targets and time-frames for improvement. Self-evaluation becomes an on-going process, it enables a teacher to make inputs when the observation takes place and this process becomes more participatory and he/she can measure progress and successes and build on these without being dependent on cyclical evaluations (Department of Education, 2004, p.7).

The Importance of Classroom Observation

According to Basaran (2018) classroom observation provides the SMT with the information needed to plan for developmental programmes. It is important to be observed the by other teachers and receives specific feedback from that observation**.** Observation helps the SMT to identifying areas that need development to allow the SMT to plan developmental programmes to address areas of need. The SMT has the responsibility to monitor and determine teachers' progress. The teacher will have to complete self-evaluation reflecting strengths as well as areas in need of development before actual classroom observation (Department of Education, 2004, p.8).

Daharat, Sued and Gheisari (2022) states that classroom observation enables discussion between appraiser and appraise regarding strengths and areas in need of development. Discussion on classroom observation helps to reach consensus on the scores for individual teacher performance. It provides opportunities for constructive engagement on what the teacher needs to do for him/ her and what need to be done

by the school in terms of mentoring and support. The district office should conduct training and initiate other programmes to address teachers' need. Classroom observation enables the development support group and the teacher to develop Personal Growth Plan which includes targets and time-frames for improvement. The teacher should primarily develop the personal growth plan assisted by the Development Support Group. The personal growth plan should provide a basis for comparison with the evaluation for Performance Measurement purposes, which is conducted at the end of the year (Minkman 2016, p.28). The teacher should be evaluated on performance standards (PS) other than classroom observations. This is based on general on-going observations, discussions and feedback from the Development Support Group, submission of documentary evidence, proof of participation and evidence of information that should be provided by the educator (Department of Education, 2004, p.8).

The Personal Growth Plan

The teacher should develop a Personal Growth Plan is with the assistance of the Development Support Group. The PGP is used to inform the School Improvement Plan. Personal Growth Plan should address areas where the teacher needs development, areas where the Development Support Group should provide guidance in areas where the district should provide training. It serves as an important record of needs and progress of individual teacher (Department of Education, 2004, p.12).

Team Building as a Strategy for Implementing the Integrated Quality Management System in Schools

Team building is regarded as an effective strategy to manage and implement the IQMS in schools. Daharat, Sued and Gheisari (2022) clarifies that a team is a "group of people who share a common name, mission, history, set of goals or objectives and expectations". Members in a team work together in school and complement each other for better delivery of quality public education. They work jointly as a team to accomplish set tasks to achieve their objectives. The success of the IQMS implementation relies on School Development Team, School Development Team, and Development Support Group. It is clear that the successful implementation of IQMS

is dependent on strong team-work and cooperation among these structures (Malatji, Mavuso & Malatji, 2018).

Importance of Communication in the Implementation of the Integrated Quality Management System

Buasaran (2018) regards communication as a valuable tool to facilitate the smooth implementation of IQMS in school. Communication should be open, transparent, and constant among all role players. There should be easy access to information and consistent reinforcement of the key messages of the IQMS. Communication is crucial to the successful adoption of IQMS implementation and to mobilize the programs effectively within the school (Minkman, 2016).

Monitoring the Implementation of IQMS

Monitoring the implementation of teacher appraisal within the school is of great importance. There should be no judgments based on the impact of appraisal until it is established that the scheme is being conducted as planned. The school should devise effective ways of monitoring the implementation of the agreed activities. It is possible to evaluate the impact of IQMS implementation to the school. Monitoring of IQMS implementation has an added advantage of reminding staff of what they need to do to produce effective activities within the appraisal process to take place (Meng, Fu & Butler, 2017). Basaran (2018) suggests monitoring as a tool to modify and correct any deficiencies at the earliest possible stage. The monitoring process is an ongoing activity, which is conducted by departmental officials, Staff Management Teams, Staff Development Teams and Development Support Groups (Mamabolo, Malatji & Mphahele, 2022).

Moderation of the IQMS Results

According to Mamabolo, Malatji and Mphahele (2022) moderation needs to be done both internally and externally. District officials should conduct external moderation to ensure consistency among schools. Schools are responsible for conducting internal moderation at school level by the principal and School Management Team. The district

manager has the responsibility to moderate evaluation results of schools to ensure consistency. This is done to determine whether the evaluation at schools were either too strict or too lenient. Basaran (2018) regard strictness as a situation where other appraisers display a tendency to appraise appraises at a lower level than their performance warrants allowing for growth. Leniency is the tendency to rate appraises more positively than their performance warrants, and usually more than other appraisers would rate them.

Research Question

- What are the perceptions of school managers, teachers, and district officials on the implementation of the Integrated Quality Management System in school?

Methodology

The qualitative research approach was adopted for this study. Qualitative approach allowed us to garner information on IQMS implementation in schools to improve the quality of teaching. An interpretive paradigm was selected to help us understand the views of principals, heads of departments, teachers, and district officials regarding the implementation of IQMS and meanings they attach. Purposive sampling technique was used to select principals, heads of departments, teachers and district officials who participate in IQMS implementation annually. Face to face interviews, focus group interviews and document analysis were used to gain insight into the participants' views on the implementation of IQMS. A thematic analysis was used to ascertain the similarities and differences in the points of views, perceptions, and experiences of the various participants.

Theoretical Framework.

The study adopted social realist theory of Margaret Archer which was developed in 1995. The theory applicable to the implementation of the IQMS, looking at how the concepts of structure, culture and agency can help eliminate challenges hindering the implementation processes of IQMS in schools. Archer (1995) explains that the term morphogenesis refers to change (genesis) in the shape of things (Morpho). The theory refers to the change in structure, culture, and agency. In analysing how IQMS is

implementated in schools the researchers used the concepts' structure, culture, and agency as theoretical lenses to interpret the implementation of IQMS in schools. The results of the study are further discussed and interpreted through the three theoretical lenses as indicated above.

Application of Realistic Social Theory into the Study

The study focused on the perceptions of school managers, teachers, and district officials on the implementation of IQMS in schools. The study was an attempt to eliminate challenges hindering effective implementation of IQMS in schools. As indicated above, the implementation of IQMS in schools is interpreted within the realist social perspective, using the concepts of structure, culture, and agency as theoretical lenses. Below is the application of all three theoretical lenses on the implementation of IQMS in schools.

Structure

Archer (1995), in her Social Realist Theory, regards issues of structure as a critical element for any successful project. Structure in the context of this study, refers to all committees within the school assigned responsibilities of implementing IQMS effectively. Therefore, using structure as a theoretical lens, researchers investigated the nature of structure in schools under study, to determine its impact on the implementation of IQMS. Sokhulu (2021) discovered a strong positive significant relationship between the IQMS and effective curriculum delivery. Researchers are of the view if the structure of the school is user-friendly for the implementation of IQMS, its end product is likely to be unproductive when it comes to quality enhancement.

Culture

Archer (1995) regards school's culture as the day-to-day practices of staff members. Culture in a school plays a critical role when it comes to the implementation of IQMS for the development of teachers. The combination of characteristics from staff members, learners, practices within the different committees and the school leadership culture encompass the culture of the school. Societal cultural values affect

the school culture; the community where the school is located also has a significant influence. The family background of learners may affect school culture as well. the concept of culture in the context of this study is interrogated within the ambit of IQMS implementation, prior knowledge, and proficiency of staff members in the school under study. The researchers interrogated the culture in the schools to determine if such culture complements and affects IQMS implementation in schools for the development of teachers. Obviously, if there is a culture of negativity towards IQMS implementation in schools, its developmental initiatives to complement the development of teachers for effective curriculum delivery will be minimal. The study by Malatji and Singh (2018) reveals that most of the experienced in schools have negative attitude when it comes to change towards IQMS implementation. Therefore, this theoretical lens becomes relevant to interrogate the implications of culture on IQMS implementation in schools. Culture determines how IQMS should be implemented to develop teachers for the enhancement of school's overall effectiveness.

Sergiovanni (2017) states that schools have different cultures, whether strong or weak, functional, or dysfunctional which determine their way of doing things within their schools. He further alluded to successful schools seeming to have strong and functional cultures aligned with the vision of the school. School leaders should share a clear, articulated vision; a vision that embodies core values and purposes to successfully shape positive school culture. In the context of this study, the implementation of the IQMS in school should be part of the culture all staff members. Good practices, knowledge and skills of staff members and school leaders on the implementation of IQMS contribute to the positive culture among the school community.

Agency

Agents stand for 'people' in the socio-cultural system (in this article, the school) into which they enter, and who operate within a particular structural and/or cultural system. Archer (1995) argues that the agential role of SMT and teachers on IQMS implementation is likely to be affected by the structure as well as the culture of the

school. Therefore, there is a relationship between these three theoretical lenses, as articulated in Social Realist Theory by Archer (1995). In the context of this study, the agency who are SMT's and staff members determine the success of the implementation of IQMS in schools. For instance, the school may have a good structure and culture that supports the implementation of IQMS in school; however, if the staff members do not want to take it upon themselves (agential role) the implementation of IQMS is likely to fail. Therefore, the researchers looked at how the SMT and staff members implement IQMS in schools under study to determine the agential role. The Social Realist Theory gives direction to this article. These three concepts, namely, structure, culture, and agency, give a clear theoretical lens that provides a focused and strong theoretical base. Finally, the results of this study are also discussed within the three components.

Discussion of findings

The results from this study are presented within the Social Realist perspective, using the concepts of structure, culture, and agency. The results are categorised within three theoretical lenses as indicated above.

Structure

Structure, in the context of this study, refers to stakeholders or committees and human resources that include SMT, teachers and district officials who are part of the IQMS implementation. Regarding structure, the following findings emerged: perceptions of SMT's to IQMS improvement, perceptions of teachers on IQMS implementation.

Perceptions of Teachers in the IQMS Implementation

The findings revealed that there is no contribution from School Management Team towards the effective implementation of the IQMS policy; instead, they contribute to its failure. All fifty participants maintained that the success and failure of this policy rest on the shoulders of school managers/ SMT's. They suggest that the managers are

the once who should set the tone. They also suggest that managers must act as role models, encourage, motivate, and provide support during the IQMS implementation process. School managers should initiate school-based workshops regarding IQMS and explain the purposes, expectations, programmes, management plans and benefits for IQMS to teachers and the school. Teachers shared the same sentiments that "*the SMT's are not equal to the task to perform their responsibilities towards the implementation of IQMS in schools*". The findings from teacher's responses are in line with the view of the Department of Education (2004) that managers must create a climate conducive for IQMS implementation which is free from fear, threats, and uncertainty (DoE, 2004). As long as there is still a culture of linking IQMS with monetary rewards, its purpose remains defeated.

When reflecting on the information above, the SMT's have been unable to set a tone for IQMS implementation and seemed not motivating to teachers. This finding is in contrary with the view of Steyn and Van Niekerk (2007, p.253) who maintain that principals have the responsibilities to ensure that each of the structures play their roles and ensure that IQMS is implemented effectively in schools. The School Management Team as a structure is responsible for teacher's professional development in schools and must encourage teachers to attend development programmes that will assist them in improving their knowledge, skills, values and attitudes in order for them to become better equipped in the management of their classrooms.

Perceptions of SMT's to IQMS Improvement

The finding revealed that principals and heads of departments lacked knowledge and skills to train and workshop all those involved in the process of IQMS implementation in schools. It was agreed that it is the responsibility of the SMT's to ensure that everyone within the school is well trained to execute his/ her role, starting from the School Development Team, Development Support Group to teachers. Principals and heads of department acknowledged that they should have programmes for training and development in schools.

Principals and heads of department also acknowledged that it is their responsibility to encourage everyone in the school to take IQMS seriously and consider all its purposes as beneficial to them and school. They maintained that they must inform everyone that IQMS is a departmental policy and as such, it must be implemented as stated in the Education Labour Relation Council policy document. They agreed that they must make everyone aware of what is expected of him/her from the onset of the process. They indicated that all staff members should be aware of all the criteria and purposes of IQMS. One principal said, "*the success and failure of the IQMS at school rest in my shoulder because as the manager I have to set the tone*". They maintained that they must change the perceptions and attitudes of all staff members by explaining and clarifying all the processes and communicate all information to staff members. They indicated the need to create a climate conducive for appraisal by establishing trust and sense of purpose to all staff members.

The principals and heads of departments suggested that they all must be involved and set the tone as leaders. They should make the process fair and transparent by allowing the sharing of information and welcoming inputs from staff members. They felt that discussions before and after evaluation should take centre stage and the results of each member should be confidential. The findings supported the view of Mamabolo, Malatji and Mphahlele (2022) who echoes that an open, transparency and consistent reinforcement of the key messages of the IQMS is crucial to the successful adoption of implementation thereof and to mobilise the IQMS programs effectively within the school.

Culture

Archer (1995), in Social Realist Theory, indicates that teachers and learners background may have an influence on school culture, and the surrounding environment where the school is located also contributes to the culture of the school. Culture in this study is limited to the way teachers are developed through IQMS implementation which will lead to effective teaching and learning in schools.

Working together as a Collective

The study revealed that the district officials, SMT's and teachers should work together as a collective to make the implementation of IQMS effective. It was revealed that structures involved in IQMS implementation should have working relationships for a common goal. One of the heads of departments added that "*there must be effective communication among all the stakeholders, each stakeholder needs to know the expectations by other stakeholders"*. He further explains that "*there must be transparency on the flow of information from the district to the teachers".* The finding is in support of Higgs and Smith (2008, p.35) who maintain that all structures involved in IQMS implementation should work collaboratively to achieve a common goal and information should be cascaded from higher structure to the lowest. The study also revealed that the district, SMT's and teachers are not collaborating cooperatively with each other and the information from the Department of Education is not cascaded to all schools and stakeholders.

It emerged from the findings of the study that training regarding IQMS implementation must be conducted to the district officials so that they can be able to train SMT's and teachers on how to implement IQMS as per policy. It was found that some staff members were not at same level in terms knowledge regarding IQMS implementation in schools. Schools were found to be at different level regarding IQMS implementation. One of the principals highlighted that "*trainings conducted were not through enough to equip all staff members with the needed knowledge for IQMS implementation and indicated that there is lack of cooperative working relationships among all the stakeholders".* The findings opposed to ELRC (2003:8) which explains that training should specifically address issues relating to how IQMS should be implemented in schools. It states that all teachers must have thorough understanding of the purposes, principles, procedures and processes of IQMS. The study suggested that if all stakeholders can work together, challenges facing the implementation of IQMS could be eliminated.

Analysing and reflecting on the feedback information on the working relationships among structures to make IQMS implementation effective, it was clear that there is lack of collaborative working relationships among structures. Steyn and Van Niekerk (2007, p.253) maintain that the success of IQMS implementation relies on well organised structures working together for a common purpose. The Department of Education (2004, p.5) added that structures involved in IQMS implementation should have positive attitude towards achieving its developmental goals. It was clear that IQMS implementation in schools was not taken seriously.

Agency

According to Archer (1995), in *Realist Social Theory*, the agential role refers to powers within the individual to change to the situation. In this study, it was revealed that teachers, SMT's and District officials lack agency for the implementation of IQMS due to some structural challenges as discussed above.

Departmental Strategies to Monitor Implementation

The study finding revealed that district officials acknowledged in their responses during interview sessions that they have a team of district officials which visits schools, monitors if all schools are implementing IQMS in a consistent and uniform way and gives support to schools that are not doing well. They also acknowledged that they lack personnel to visit all the schools; instead, they sample a few schools for this project in a year. Participants agreed that they have a program for submission to the district for assessment and pay progression which all schools should adhere to. They indicated that after all submissions are made, they compile the district improvement plan to draw up programmes of development to address schools' developmental needs. One of the officials hinted that "*our district improvement plans are not cascaded to schools because schools are expected to develop their own school improvement plan"*. It was clear from this finding that the district and schools were working parallel to each other because school improvement plan must inform the district improvement plan; hence schools need to have district improvement plan indicating how their schools' needs will be addressed. The finding opposed to the view

of Higgs and Smith (2008, p.30) that schools should be in constant interaction with the department as a bigger system to make IQMS implementation work. The two should work together as a system and influence each other for the IQMS policy to achieve its purposes.

Reflecting on the finding above, the study revealed that the district, SMT's, SDT's, DSG's and teachers should take responsibility of implementing IQMS effectively. It was clear that structures involved in IQMS implementation do not take IQMS seriously and there is a need for change to make the implementation better. Pillay (2005, p.57) cited that teachers have developed a "do not care attitude towards the IQMS. Rabichund (2011, p.199) argues that without effective involvement of principals and district officials the processes of IQMS implementation are likely to collapse. Mji (2011, p.47) asserts that sufficient training is needed to help all the structures change their attitude towards IQMS implementation for the purpose of the policy to be realised.

Conclusion from the Study

The study concluded that IQMS plays a key role in the development of teachers for overall effectiveness of the school. However, there should a thorough training to acquaint all staff members with knowledge and skills required for IQMS to be implemented effectively. IQMS is a developmental tool used to eliminate teachers' weaknesses and substitute it with strengths for effective curriculum delivery. Schools and district should address structural, culture and agency issues for IQMS to be implemented effectively.

Recommendations

- **Involvement:** Appraisees should be actively involved in the process of evaluation from the beginning of the process. Communication between the appraisee and the appraiser should be valued. The procedures for appraisal should be clear from the outset. Classroom observation should be seen as a positive tool for growth, for both appraisee and appraiser. Mji (2011, p.16) states that classroom observations enable discussion between appraisers and

appraisee around strengths and areas in need of development and helps to reach consensus on the scores for individual teacher performance. It provides the opportunity for constructive engagement around what the teacher needs to do for him/herself, what needs to be done by the school in terms of mentoring and support and what training and other programs need to be provided by, for example, the district office. The success of appraisal process in schools, depends on positive perceptions of teachers and their will for own professional development and individual fulfilment.

- **Understanding the roles**: Making all those involved in the process of appraisal understand the role and the importance of the entire process will ensure the smooth and regular implementation of appraisal in an atmosphere of honesty and trust. Create a climate where collaboration, openness, trust, honesty, and transparency are encouraged.
- **Implementation**: The IQMS implementation in school is the overall responsibility of the principal who leads the School Management Team in the process of implementation. The principal must be one with the responsibility to train staff members and develop training programs for school-based training and development to assist staff members to achieve their developmental and educational objectives in accordance with the needs of the school. The principal should ensure that any system for performance review in school is procedurally sound and should be seen to be consistently applied.

- **Working relationships**: There should be working relationship between the Department of Education and school structures. Communication between the department and schools should be valued by the Department of Education to enable them to collaborate with school structures. The flow of information should be vital to close gaps between the Department of Education and schools.

Conclusion

For IQMS to realise the purpose it was established to achieve, there should be a need for all stakeholders to work together as a system for a common purpose. There should be transparency among stakeholders and the information regarding IQMS implementation should be cascaded from the district to SMT's and teachers. All stakeholders involved should be thoroughly trained to know their roles and responsibilities. Success of IQMS implementation of in schools relies on the knowledge and skills of all stakeholders so that they could be able to change and shape the attitudes of staff members on IQMS implementation.

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EXPLORING THE ROLE OF PRINCIPALS' LEADERSHIP PRACTICES ON FEMALE TEACHERS' SELF-LEARNING IN THE 21ST CENTURY

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Abstract

In the 21st century, educational systems are continuously evolving, emphasising the significance of lifelong learning and professional development for teachers especially females. Within this context, principals play a crucial role in shaping the learning environment and facilitating female teachers' growth. This study explores the leadership practices employed by principals and their roles on female teachers' self-learning in contemporary educational settings. The research adopts a qualitative research design. A semi-structured interviews protocol was used for collecting in-depth data. With the aid of NVivo software, the interview transcriptions were coded and categorised into themes. The findings revealed that while principals' leadership practices like collaboration, empowerment and sharing of the school vision and mission among others promote practices of self-directed learning among female teachers in secondary school, coercion, and lack of access to learning resources negatively affected them. Based on the findings, the study recommends that principals as the leader should be retrained to discharge their instructional role towards the teachers; employ motivation to encourage self-directed learning practices and liaise with the concerned educational stakeholders to provide needed resources for self-directed learning for all teachers irrespective of the level, gender, and race.

Keywords: self-directed learning; female teachers; secondary schools; leadership practices; professional development

Introduction

In the 21st century, education systems are continuously evolving, emphasising the significance of lifelong learning and professional development for teachers. It has ushered in the use of technology (Karakose et al., 2021) and making more demand from teachers professionally in order to remain relevant. In fact, the experience of the Corona Virus pandemic (COVID-19) also contributed to the need for teachers to key into the new normal which is digitalisation of teaching and learning (Saboowala & Manghirmalani Mishra, 2021). However, the extent to which teachers see the need to develop themselves and involve in self-directed learning may be influence by the school leaders. Therefore, the role of school principals will have to increase from traditional administrative duties to encompass a broader spectrum of responsibilities, including instructional leadership. This expansion in principals' leadership roles will have significant implications for teachers, particularly female educators, who make up a substantial portion of the teaching workforce worldwide. Principals are now expected to be instructional leaders, guiding and supporting teachers to ensure their continuous professional development (Honig & Rainey, 2019). This transformation has brought to the forefront the importance of leadership practices in shaping teachers' experiences of personal sense of responsibility of self-directed learning and, subsequently, student achievement.

The teaching profession, despite becoming increasingly diverse, still faces gender disparities (Llorens et al., 2022) in terms of self-directed learning to meet up the contemporary professional needs. Female teachers constitute a majority of the workforce (Dhal, 2016), and their experiences and professional development can be influenced by gender-related factors. Research has indicated that women in education often confront unique challenges, including implicit biases, gender stereotypes, and work-family balance issues (Adewale & Potokri, 2023a). These challenges can impact their self-perception and professional growth. Female teachers need to engage in self-development through self- directed learning in order to manumit themselves from women centered challenges. Similarly, there is need for female teachers to be digital natives to maximize the benefits of technological advancements which have made

technology integration an integral part of education, changing how students learn and teachers instruct. Digital natives, as described by Prensky (2001), expect technology to be seamlessly integrated into their educational experiences. As such the goal of self-directed learning can be realised by taking advantage of online learning and distance education, facilitated by the internet and exemplified by Massive Open Online Courses (MOOCs) which have made quality education accessible to a global audience (Liyanagunawardena et al., 2013) especially females, the engendered species. The COVID-19 pandemic further accelerated the adoption of online learning for self-directed learning, emphasising its flexibility and adaptability (Hodges et al., 2020).

Statement of the Problem

The growing need for teachers to prepare learners to acquire 21st century skillsets (project based learning, collaborative skill) (Martinez, 2022; Sulaiman & Ismail, 2025) implies that teachers possess relevant knowledge to discharge this duty. Teachers' competency was put to test during the spontaneous switch to online teaching and learning during the COVID 19 period. Many teachers could not cope because of lack of required skills (Al Abiky, 2021; Gurung, 2021). Individual teacher is expected to bridge the observed gaps in teachers skills level during COVID 19 pandemic (González-pérez & Ramírez-montoya, 2022). Despite technology-driven opportunities to improve instructional skills through self-directed learning, Etejere et al. (2023) noted that women are still lagging behind. Female teachers face challenges in pursuing professional development due to balancing professional aspirations with caregiving responsibilities (Keng, 2020), worsen by unequal distribution of domestic duties. Gender bias and discrimination hinder their progress, leading to obstacles like unequal pay and limited access to leadership roles (Heilman et al., 2024). These challenges impact personal growth and educational quality, highlighting the need to address disparities for a more inclusive and equitable educational environment. Addressing these disparities and challenges is essential to create a more inclusive and equitable educational environment for all.

Considering the instructional supervisory responsibilities of principals, studies have shown that instructional role of school principals plays important role in the realisation of objectives of schools (Adewale, 2014; Iroegbu & Etudor-eyo, 2019). It is therefore to explore how leadership practices of principals can influence teachers' attitude to self-directed learning. This study therefore explores the role of leadership practices of secondary school principals on self-directed learning among female teachers in secondary schools. The study specifically determines the key leadership practices of principals in secondary schools for female teachers' self-directed learning; and identify the common self-learning practices among female teachers in secondary schools.

Research Questions

The following research questions are raised in this study:

1. What are the key leadership practices of principals in secondary schools for female teachers' Self- directed learning in Nigeria?
2. What are the common self-directed learning practices among female teachers in secondary schools in Nigeria?

Theoretical Foundation

This study is hinged on feminist leadership theory. The feminist theorists are of the belief that women are not subordinate to men in all ramifications. The advocators work towards shattering all forms oppression of (Allen, 2023). The relevance of this theory to this study is that it is believed that there is a wide gap between male and female in all ramifications. In the research conducted to determine the role of gender in the winning of research awards, Meho (2020) found that there is 13% gender gap per award recipient annually and 2% in international collaboration in favour of male. It is therefore believed that self-directed learning of female teachers is capable of manumitting women from the shackle of inequality. Women have always been taking the back seats in leadership especially. It is believed that leveraging on the 21st century educational components to raise status of women. Meanwhile, the leadership practices of school principals can either positively and negatively contributed to self-

directed learning among female teachers. Feminism strives to equalise men and women in career and decision making (Kumar Mohajan, 2022).

Literature Review

Self-Directed Learning in Teaching

Self-directed learning as a means of professional development, has gained prominence in the 21st century educational discourse. It refers to teachers' ability to take charge of their own learning and development, seeking opportunities for growth, innovation, and the enhancement of instructional practices (Garrison, 1997; Loeng & Story, 2020). Self-directed learning is closely tied to teacher efficacy and has the potential to positively impact student outcomes. The need for teachers to adapt themselves to the 21st century classroom needs (Alamer, 2023) and produce self-directed learners (Grow & Grow, 1996) necessitate the need to engage in self-directed learning for adequate preparation. Self-directed learning among teachers is a concept that has gained increasing recognition and importance in the field of education. It refers to the ability of educators to take charge of their own learning processes (Alwadaeen & Piller, 2022), identify their learning needs, set goals, and actively seek out opportunities for growth and development. It can also be defined as the ability to plan, implement and evaluate one's learning goal and progress (Pimdee et al., 2023). This proactive approach to learning goes beyond traditional professional development activities and empowers teachers to tailor their learning experiences to their unique needs and interests. Self-directed learning places teachers in the driver's seat of their professional growth journey, allowing them to stay relevant in a rapidly changing educational landscape. The importance of self-directed learning among teachers cannot be overstated. Teacher has to be aware, keep pace in the ever changing and dynamic world (Alwadaeen & Piller, 2022) and evolving field of education, where new teaching methods, technologies, and pedagogical approaches continuously emerge, teachers must be agile learners. Self-directed learning equips educators with the skills and mindset necessary to adapt to these changes effectively. It encourages reflective practice, critical thinking, and the pursuit of innovation in teaching methods (Loeng & Story, 2020). Furthermore, self-directed learning allows teachers to address their

specific professional needs, whether it is mastering a new subject area, improving classroom management techniques, or enhancing their proficiency in educational technology. Ultimately, it fosters a culture of continuous improvement in education, benefiting both teachers and their students by ensuring that educators remain engaged, motivated, and well-equipped to deliver high-quality instruction.

Self-directed learning helps teachers to respond to societal needs by producing adaptable workforce (Smith, 2017). The sustainable development goals were purposely identified to bring development to all spheres of life and guide against inequality (Economic Commission for Latin America and the Caribbean (ECLAC)., 2020). To achieve all of this, self-directed learning which is a form of long-life education becomes essential. Additionally, personalised learning has gained prominence, with educators using data and analytics to customize instruction to individual student needs, enhancing engagement and achievement (Pane et al., 2015). The focus on 21st-century skills, such as critical thinking, creativity, collaboration, and digital literacy, has become central to education, preparing students for success in a rapidly changing global economy (Partnership for 21st Century Learning, 2009). Traditional lecture-based instruction has given way to project-based and experiential learning, where students apply knowledge to real-world problems, fostering practical skills and problem-solving abilities (Dias & Brantley-Dias, 2017). Furthermore, inclusivity and diversity have become priorities in education, with efforts to accommodate students of various backgrounds, abilities, and learning needs, promoting equity and social justice (UNESCO, 2017). This evolving landscape has also been influenced by globalization, with schools and universities incorporating international perspectives into curricula to foster global competence (Hancock et al., 2009). The assessment landscape has shifted towards formative assessment, competency-based education, and authentic assessment methods to provide a more accurate picture of students' abilities (Wiggins, 1998). Teachers are expected to be lifelong learners, adapting to new teaching methods and technologies through professional development (Inan & Lowther, 2010). Education policies have adapted as

well, with initiatives like the Common Core State Standards emphasizing critical thinking and problem-solving skills in the United States (NGA Center & CCSSO, 2010).

Factors Affecting Self-Directed Learning

There are different factors that can determine whether teachers will embrace self-directed learning. The factors can be grouped into two broad categories, the individual and organizational factors (Kim et al., 2021). The organisational factors are external and as such teachers may not have control over them. Among these numerous factors are the availability of learning resources (Yang et al., 2021), access to professional development opportunities, such as workshops, courses, and educational materials, and leadership. Teachers in advantaged schools explain scientific ideas than those in disadvantaged schools (OECD, 2016). The school leaders are expected to activate a supportive school culture because when teachers feel encouraged to explore new ideas and experiment with innovative teaching methods, they are more likely to take initiative in their professional development. Conversely, a stifling or overly rigid school environment can stifle self-directed learning. Principals and administrators who prioritize and promote continuous learning among their teaching staff can positively influence teachers' motivation to engage in self-directed learning. Clear communication of the value of self-directed learning in the context of the school's mission and goals can also be a motivating factor. Lastly, time management and workload are critical considerations. Teachers who are overburdened with administrative tasks and excessive workloads may struggle to find the time and energy for self-directed learning, making it essential for schools to strike a balance between professional responsibilities and opportunities for growth. On the other hand, individual factors include teachers' personal characteristics (Paiwithayasiritham, 2013). The teachers' gender type, level of experience and individual learning style are important determinants of their engagement in self-directed learning. Teachers who have developed a capacity for independent action and a sense of self-efficacy (Bloom, 2019), will be creative and productive. Intrinsic motivation is a powerful driver, and so teachers who have a genuine passion for teaching and a desire for self-improvement are more likely to actively seek out learning opportunities (Lai et al., 2024). Also, the

teacher's level of experience can influence their approach to self-directed learning. Novice teachers may be more focused on acquiring basic teaching skills, while experienced educators may seek opportunities to deepen their expertise or explore innovative teaching methods. Finally, individual learning styles and preferences are significant factors. Teachers have diverse learning preferences, and self-directed learning activities that align with these preferences can be more effective and engaging. Personal factors intersect with organizational factors, and it is often a dynamic interplay of both that shapes a teacher's ability and willingness to engage in self-directed learning.

Instructional Roles of School Principals on Female Teachers' Self-directed Learning

The outbreak of the COVID-19 pandemic has significantly reshaped the responsibilities of school principals worldwide, necessitating a shift towards systemic approaches (Pollock, 2020). With the implementation of compulsory stay-at-home orders during the pandemic, principals found themselves tasked with ensuring uninterrupted learning and fostering digital skills development for both educators and students. Education experts emphasize the pivotal role of principals in cultivating conducive environments for effective curriculum management (Mestry, 2017), underscoring their influence in shaping the vision, mission, and direction of educational institutions (Alward & Phelps, 2019). Beyond administrative duties like budgeting and staffing, principals are instrumental in guiding curriculum development, promoting effective teaching strategies, and supporting professional growth among teachers (Iskandar et al., 2023). Their supervisory role not only encourages teachers to engage in self-directed learning but also impacts learners and the overall school system. Principals' instructional responsibilities extend beyond the classroom, encompassing the provision of feedback to educators to enhance their performance and improve the school ecosystem (Balyer & Özcan, 2020). By fostering positive school climates, inspiring stakeholders, and optimizing resource allocation for instructional methods, principals contribute to holistic teacher development and student success (Mestry, 2017). As chief executive officers (CEOs) of their schools, principals play a crucial role in shaping teachers' professional growth, influencing their self-efficacy and fostering

a culture of continuous improvement (Liu et al., 2021) . Through the establishment of clear educational goals and expectations, principals provide a framework for aligning teachers' development efforts with the broader mission of the school, while also catalyzing Professional Learning Communities (PLCs) that facilitate collaborative problem-solving and reflective practices among educators (Oakes et al., 2018). This concerted effort not only enhances individual teacher development but also elevates instructional quality, ultimately benefiting students and the wider educational community.

Methodology

Qualitative Research Design

This study is a qualitative design of phenomenological type. The choice of qualitative approach is because it allows the researchers to have access to and explore a complex aspect of human experience (Adewale & Potokri, 2023b; Creswell, 2014). Qualitative studies give preference to the perspectives and lived experiences of the participants in the findings and as a means of proffering solution to research problems. Convenient and purposive sampling techniques were used to select the participants in this study. While convenient sampling allows the researchers to select only the available and accessible ones among the target population (Etikan et al., 2016), purposive sampling technique enables researchers to select only the participants who possess the qualities suitable for the study (Uleanya, 2023). The selected institution shares similar features with other secondary schools in Lagos state, Nigeria. They are government owned co-educational schools where there is presence of male and female teachers. Certain inclusion criteria identified by the researcher determined the selection of ten participants in this study. These inclusion criteria include being a female, have spent more than five years in service, and an academic member of the purposively selected schools in Nigeria. It is the belief of the researcher that the selected participants would be able to proffer answers to the research questions raised to guide the study. Thus, two senior lecturers, four postdoctoral fellows, and two doctoral students served as participants in this study. Semi-structured interviews were conducted to elicit data from each of the participants. The choice of semi-structured interviews is to give room

for follow-up questions where and when necessary, during the interviews and to be able to clear ambiguities in the participants responses. The interviews were recorded in audio gadget ab initio with the consent of the participants. Afterwards, it was transcribed, coded, and categorized into themes and sub-themes with the aid of NVivo 14 pro software.

Ethical Considerations

The issue of ethics in conducting research was strictly adhered to by the researcher in conducting this study. The researchers ensured the informed consents of the participants in writing, detailing the purpose of the study and their roles (Manti & Licari, 2018; Yip et al., 2016). Their participation was made voluntary, which means they were not coerced and have opportunity of withdrawing their participation at any stage. Yip et al. (2016) added that participant right to privacy and confidentiality should be guaranteed by the researcher. In addition, the participants were assured of confidentiality of the information provided, and that their real identities will not be revealed, upholding the principle of anonymity in research. Furthermore, the researcher specifically sought the participants' permission to record the interview in audio gadget. Kural (2020) submitted that "Recording does not only help you retain the information you find relevant at an interview, but also gives you the chance to listen and discover new themes and answers you have not thought of during the interview (par. 7)." The researcher will adopt the Trustworthiness, Auditability, Credibility and Transferability (TACT) framework (Daniel, 2019) to ensure the quality and reliability of this qualitative research. Made the expository presentation in 1985 to demonstrate what should be the validity and reliability measure in qualitative study. According to them, it is not to be determined by scientific measures, but by assessing the research trustworthiness which comprise credibility, transferability, dependability and confirmability (Lincoln & Guba, 1985). Trustworthiness involves the confidence in the sources of data, research outcome and researcher's experience. The most important aspect of trustworthiness in qualitative research is transparency, because it determines the relevancy of any research outcome (Adler, 2022). This was achieved in this study by familiarizing self with the participant and ensuring to be

neutral in reporting the outcome. The researcher did not add or reduce the findings or allow personal view to override the outcome of the study (Daniel, 2019). Daniel (2019) asserts that Auditability "requires the application of systematic procedure for collecting, analysing and interpretation of data (page 120)." In this study, the researcher systematically conducted the interview after fulfilling the ethical requirement, sought the participants' consents to interview and record on audio gadget, transcribe the data, used Nvivo software to code, generated themes and reported the findings.

Results

Table 1: Demographic Profile of Participants

S/N	Highest Academic Qualification	Years of Experience	Current Role	Subject Taught
1	B.A	13 years	Senior Education officer	French
2	M.Ed	25 years	Class Teacher	Business studies
3	B.Ed	11 years	Class Teacher	Chemistry
4	M.Ed	5 years	Class Teacher	Economics
5	B.A	10 years	Class Teacher	English
6	PGDE	5 years	Cass teacher	English
7	B.Ed	5 years	Class Teacher	Mathematics
8	BSc(Ed)	10 years	Class Teacher	Civic Education
9	M.Ed	15 years	Principal Education officer	Accounting
10	B.Ed	12 years	Senior Education officer	Biology

Table 1 provides a clear overview of the demographic profile of the participants, including their qualifications, experience, roles, and subject areas of expertise. In terms of highest academic qualification, three participants are master's degree holder, one person has Postgraduate degree certificate in education while six others have bachelor's degree. Also, the years of experience which denotes the number of years of teaching experience, participants with 25, 15, 13, 12, 11 are one each while participants with 10 and 5 year were two and three persons respectively. In addition, "Current Role" describes the current position or role of each participant, and "Subject Taught" specifies the subject that each participant teaches.

Common Self-Learning Practices Among Female Teachers In Secondary Schools

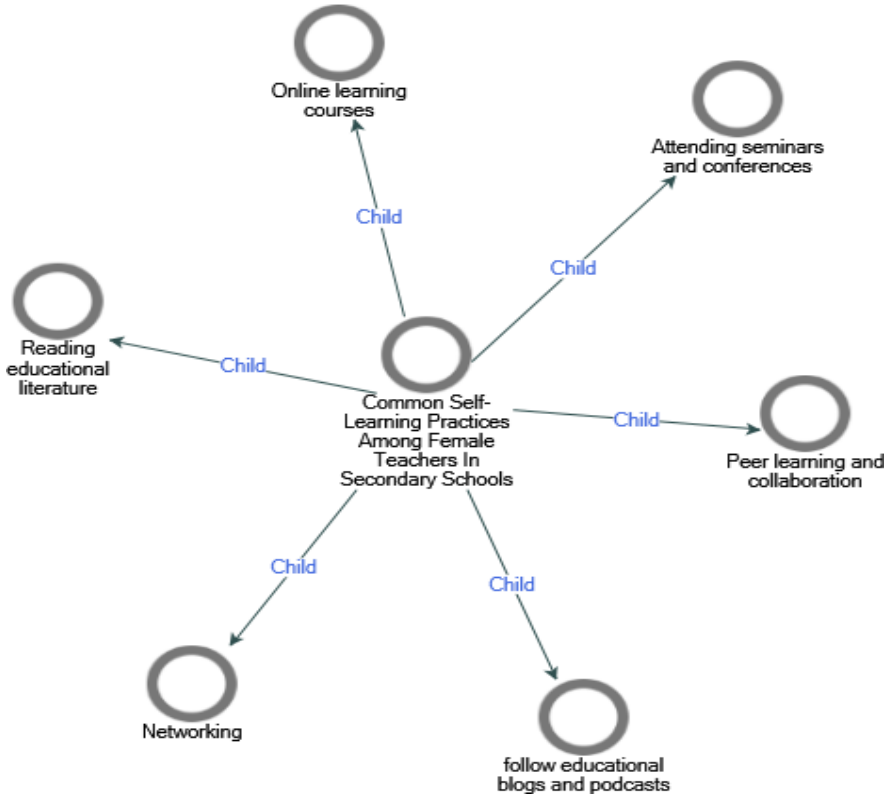

Figure 3:Common Self-learning Practices among Female Teachers in Secondary Schools

The interview result yielded six common practices among female secondary school teachers as shown in figure 1. The practices include networking, following educational blogs and podcast, peer learning and collaboration, online learning courses, reading educational literature, and attending seminars and conferences. One of the participants expressed as follows:

As a French language teacher, the regular use of bilingual dictionary, reading of French textbooks. It came about as a result of challenging topics and the outcome was, increase in knowledge and understanding.

Another participant responded that :
there have been instances when I, as a teacher engage in self-learning and professional development. As a teacher I attend seminars or training where I can develop myself as a teacher. I also joined association of commercial teachers' organization of Nigeria where we discuss about related issues. These have been assisting me in my teaching and learning experience.

This finding is in congruence with Thurlings and den Brok (2018) that peer learning and collaboration is useful to teachers because collaborative activities reduces feeling of isolation, improves both the pedagogical content knowledge and subject matter knowledge. Graham (2019) also found that women faculty across Africa, Asia and Latinx attributed their career development to their mentors who introduced them to network groups for collaboration.

This implies that teachers acknowledge the important contribution of mentoring and networking in professional development, and so they embraced it. In their own study, Govender (2015) found that female teachers in South African schools take up various sources of learning to develop themselves professionally.

Table 2: Key Leadership Practices of Principals In secondary Schools for Teachers' Sel Directed Learning

Theme	Sub-theme	Practices
Key Leadership Practices of Principals In secondary Schools for Teachers' Sel Directed Learning	Positive Practices of Principals that Affect Female-teachers' Self-learning	a. Collaborative decision making b. Enforcement of the state-organised mentoring c. Friendly but firm d. Procedural e. Teacher empowerment f. Understanding and empathetic g. Words of encouragement h. Vision setting i. leading by example
	Negative Practices of Principals that Affect Female-teachers' Self-learning	• Coercion • Hostile work environments • Lack of access to resources • Unequal access to training

In Table 2, we organised the key leadership practices of principals that influence female teachers' self-directed learning into two sub-themes: positive practices and negative practices. The specific practices associated with each sub-theme are listed in the table. This tabular format makes it easy for readers to grasp the different practices related to principals' leadership and their impact on teachers' self-directed learning.

Principals' Positive Leadership Practices

The participants maintained that principals' positive practices that encourage them to engage in self-directed learning includes collaborative decision making, enforcement

of the state-organised mentoring, being friendly but firm with them, being procedural, and teachers' empowerment. Other positive practices are understanding and empathetic, using words of encouragement, vision setting and leading by example.

One of the participants revealed as follows:

My previous school Principal is a is an understanding man. He's very gentle. He talked to us as if we were colleagues, which makes everybody to be closer to him, but the one I am in with now, she is also a good person. She makes sure we deliver all our duties properly. But you know, as human being, you don't force things on teachers – participant A

Another participant expressed that:

Leadership style of my principal is basically empowering, leadership style. What do I mean? What I mean is the fact that she allows us to infuse different teaching methods. In school, as teachers, as long as the aim of teaching learning is achieved. participant

These findings align with Huang (2020) who found that though it was painful initially for both teachers and their students, online teaching and learning as the last resort during the COVID-19 pandemic period has been a propelling force for teacher to self-learn some rudiment of internet -based technologies, adjust their teaching methodology. Female teachers have the opportunity of learning through synchronous and asynchronous modes.

Mentoring of teachers is another positive principals' leadership practices affirmed in this study by female teachers to be instrumental to their self-development. The efficacy of mentoring has been confirmed in the study conducted in three continents, Africa, Asia and Latinx (Graham, 2019). Similarly the outcome of this study that teachers' empowerment contributed to learning through self among female teachers in Nigeria aligns with the finding by Dağlı and Kalkan (2021) that a significant relationship existed among empowering leadership behaviours of school principals and teachers' self-efficacy. In other words, when the principals demonstrate empowering leadership behaviours towards the female teachers especially, their self-efficacy increases on self-learning and job satisfaction. Principals choice of strategies

to lead and the trust teachers have influence on behaviours and thought of teachers in general (Atik & Celik, 2020). Principals who regularly share useful information, create effective communication networks and delegates authority are capable of positively encouraging self-directed learning. It is therefore important for principals to psychologically empower female teachers in order to see the need to practice self-directed learning.

Lastly, the findings of this study align with various intervention programmes implemented in some selected secondary schools to determine their efficacy on teachers profession (Admiraal et al., 2021). These interventions includes shared school vision, learning leadership, collaborative work and learning and change of school organisation.

Principals' Negative Leadership Practices

The participants also maintained that principals are not without some negative practices that demotivate female teachers and practices of principals that affect teachers' self-directed learning. These demotivating practices originating from the school leaders include coercing teachers, hostile work environments, lack of access to teaching and learning resources, and unequal access to training. This aligns with Imhangbe et al. (2019) who found that principals are mostly democratic but sometimes adopt autocratic style in decision making. One of the participants that …. *principal ought to know that respect is reciprocal, and so teachers should not just be command like a student*. This implies that teachers may not enjoy or satisfy with what they do when the organisations atmosphere is toxic. Teachers who are demotivated will not see any need to work with teaching experts or engage in self-directed learning to develop themselves professionally (Zhang et al., 2021). The more emotional pressure teachers face, the less autonomously motivated towards self-directed learning (Zhang et al., 2021). Sudden changes in professional practices can cause anxiety for teachers (Karakose et al., 2022).

Limitations of the Study and Directions for Future Research

This study like any other studies is not without its limitations. The use of qualitative research design is often criticized for its subjectivity for relying solely on individual lived experiences which may be biased. Also, the purposive sampling technique is not a probabilistic, the samples were drawn from a region in Nigeria, as such, the findings of this study cannot be generalized.

Based on the identified limitations, it is recommended that future studies may adopt mixed method which allows for the use of both quantitative and qualitative methods and triangulated. Similar study may be replicated in other regions in Nigeria or through a comparative approach to compare the practices in different regions.

Recommendations

in order to improve female teachers' self-directed learning, and attainment of the objective behind the establishment of secondary schools, the following measures ought to be meticulously looked into and put in place:

1. Principals as the leader should be retrained to discharge their instructional role towards the teachers.
2. Self-directed learning requires both internal motivation and external motivation. As such, principals as instructional leaders should provide necessary support that will propel teachers to engage in activities can improve them.
3. Principals should liaise with the concerned educational stakeholders to provide needed resources for self-directed learning for all teachers irrespective of the level, gender, and race.
4. Principals as leaders in their various schools should inaugurate teachers' development with objectives targeted at improving all the staff professionally.
5. Special interest and attention should be created for female teachers to navigate between home chores and occupational responsibilities.

Conclusion

This study explored the role of principals' leadership practices on female teachers' self-learning in the 21st century in secondary schools in Nigeria. It was found that principal as instructional leadership practices have great influence teachers' willingness to develop self professionally. However, female teachers identified lack of access to adequate learning resources, principals' autocracy, and excessive workload demotivate them from engaging in self-learning. It is therefore important for principals to be democratic, be balanced in the distribution of school assignment, and improvise where there is no resources to encourage female teachers develop professionally in order to achieve the broad education goals.

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EXPECTATIONS OF TEACHERS LIVING WITH HIV/AIDS: A CALL FOR SUPPORT FROM SCHOOL PRINCIPALS

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Abstract

A lot of research has documented and assessed the prevalence of HIV/AIDS, health status and related struggles experienced by teachers in South Africa. It is established that the number of teachers living with HIV/AIDS has increased. This study was designed to examine the expectations of teachers living with HIV/AIDS from their principals in South African public schools. A narrative inquiry with its roots in social constructivism was utilised together with narrative interviews to obtain qualitative data. The transformational leadership and ethics of care theories underpinned this research. The data were analysed according to the qualitative content analysis method. Key findings show that teachers expect principals to support and tolerate their situation by reducing their workload, be role models, be resourceful, care and support, initiate programmes, be tolerant and perform the extra duties. Principals are expected to be more knowledgeable and regarded as possessing answers to problems experienced by teachers living with HIV/AIDS. This journal article is important because it examines the expectations teachers have of their school principals and highlights the difficulties faced by teachers living with HIV/AIDS. It is essential to comprehend these dynamics to promote the well-being of teachers, create inclusive and supportive school environments, and address any potential stigmas related to HIV/AIDS in educational settings. Further research is required with the school principals to determine leadership and management strategies that equip them with necessary skills and knowledge to deal with HIV/AIDS-related issues in a more effective way.

Key words: HIV/AIDS; teachers; school principals; expectations; prevalence; South Africa

Introduction

Significant progress has been achieved in determining the health status, prevalence of HIV/AIDS, and other challenges faced by South African teachers. There is a need to take action to supply antiretroviral medication and undertake preventive measures because it is expected that the number of teachers living with HIV/AIDS has increased (Ndlovu, & Potokri, 2023) This study sought to explore the expectations of teachers living with HIV/AIDS from their principals in South African public schools.

The lives and careers of teachers are adversely affected by this condition. With 7.8 million (12.7% of the total population) living with HIV/AIDS, South Africa has the greatest HIV/AIDS epidemic in the world, according to Human Sciences Research Council (HSRC) (2023). The same report estimates that South Africa has made great strides towards the UNAIDS 95-95-95 targets. It states that by 2025, 95% of all HIV-positive individuals will be aware of their status, 95% of those who are receiving ART will have achieved viral load suppression. 90% of South Africans living with HIV/AIDS who were 15 years of age or older in 2022 knew their status, 91% of those who knew were receiving ART, and 94% of those who were receiving ART had viral suppression (Johnson, & Dorrington, 2023). Teachers are among the infected population. According to Zuma et al. (2016), there are 58,000 (15.3%) teachers in South Africa who are HIV/AIDS positive. This report came out ahead of the 2004 survey, which showed a 12, 7% trend. I utilise the above-mentioned statistics because no other statistics are available following the ones from 2016.

The above statistics show that the rate of transmission amongst teachers has gradually increased with possible negative impact on teachers' discharge of their professional duties. However, HIV/AIDS has become a manageable chronic health condition for most people due to improved access to effective HIV/AIDS prevention, diagnosis, treatment, care as well as ART (Johnson & Dorrington, 2023). ART has helped to save lives and contributes to reducing HIV transmissions. What appears to be needed are care and support programmes successfully implemented by the school leadership. At school level teachers living with HIV/AIDS also need considerable care and support if

they are expected to fulfil their roles as teachers. To this end, school leaders require additional skills, which are most often not taught in educational leadership and management courses. The review of the existing literature shows that not enough research has been done in school leadership in South Africa amid widespread evidence that HIV/AIDS has grown to be a rampant cause of negative effects in all aspects of school life (Moyo & Perumal, 2020). Therefore, there is a need to undertake this study. Most principals work under pressure. They deal with emotional and moral behaviour. Furthermore, school leaders may not wish to borrow ideas from other professional specialists outside the education system simply because they may feel undermined.

Scholarly attention is being paid to the effects of HIV/AIDS and the challenges which it presents in the workplace regarding labour productivity in general and the economic sector (Hawkes, 2023; Muremela et al., 2023). Because of the inherent complexity of HIV/AIDS, policymakers and practitioners must do thorough studies and prepare ahead to ensure a successful roll-out. HIV/AIDS can manifest in a variety of ways, necessitating compassion and understanding. When talking about HIV/AIDS-related topics at work, people often go quiet.

This is a management area that is surrounded by sensitivity and confidentiality. Principals need to get teachers to talk about the disease. The teachers need to be led to be united so that the corporate culture is passed on to new teachers who join the schools. Principals need to work on eradicating prejudices that lead to negative attitudes towards those infected with HIV/AIDS. There are set procedures in The Joint United Nations Programme on HIV/AIDS (UNAIDS) (2017) and the guide books published by the Department of Education for achieving this. Principals may collaborate with important governmental and non-governmental organisations to exchange knowledge and experience about HIV/AIDS and discrimination (Moyo & Perumal, 2020). School leaders lead the school HIV/AIDS committees.

Several policies have been enacted to protect people living with HIV/AIDS at work and elsewhere. The South African Department of Education released a set of recommendations for those in charge of executing HIV/AIDS awareness campaigns inside the educational system. (Walker, 2024). According to the guidelines, schools are required to set up HIV/AIDS committees to offer support to all staff. Furthermore, the South Africa Department of Labour (2003) outline the legal and policy framework and offer advice on how to handle HIV/AIDS-related issues in the workplace. Therefore, principals need to be acquainted with all national policies, human rights, and legal issues related to HIV/AIDS. Such knowledge will equip principals to effectively assist teachers living with HIV/AIDS in the workplace.

The fact that HIV/AIDS has such a profound impact on teachers is noteworthy; further research is required to better understand the prevalence of the disease as well as the expectations of teachers who are living with it. Teachers have emotional breakdown due to emotions of guilt, fear, and denial (Kafwanka, Nalule & Michelo, 2023). The majority of researchers agree that stigmatisation and discrimination have negative effects on people's feelings of worthlessness, status, and reputation (see for example, Bwalya & Mulubale, 2023; Gouda, 2023; Moyo & Perumal, 2020; Quach et al., 2023). Teachers who are HIV/AIDS positive typically experience low self-esteem and morale, and they may even feel unmotivated. This is bad for the educational system, which is already experiencing a serious skills shortage, particularly in critical subjects like science and maths (Moyo & Perumal, 2020). When teachers fall sick, the whole process of teaching and learning is disrupted, and this compromises the quality of education. The study could contribute to knowledge by illuminating the difficulties and resources found within school environments. It might look at the effects of stigma, how leaders can create inclusive settings, and how to support teachers who are dealing with health concerns at work. This study may provide insightful information for academics and educators who want to build more welcoming and compassionate learning environments in schools.

The research question for this study was: What are the expectations of teachers living with HIV/AIDS from their principals in South African public schools? To answer the

research question, a narrative inquiry design located within the qualitative methodology was used. This study was guided by the social constructivist paradigm which believes that knowledge is socially constructed. Data were collected via narrative interviews from eight teachers living with HIV/AIDS who were selected through network sampling. The transformational leadership and ethics of care theories underpinned this research. The following section provides the theoretical framework that underpins the study, followed by the literature review. Thereafter, a presentation of research design and methodology, results and discussion followed by conclusion.

Theoretical Framework

The transformational leadership and ethics of care framed this study. The two theories formed the lens through which the problem was formulated, data were collected, analysed and discussed. The transformational leadership was chosen as argued by Bush (2008) that it provides followers with a compelling vision through a strong role model that followers can trust. How teachers living with HIV/AIDS perceive their situation goes a long way to insightful leadership knowledge and support on HIV/AIDS issues by principals. Since leaders take individual needs into consideration (Bass & Bass, 2008), principals are able to create a supportive environment for teachers living with HIV/AIDS. It makes it ideal within the emerging paradigm in which principals must not only fulfil their traditional roles but also have to immerse themselves in sensitive HIV/AIDS-related issues. Several researchers agree on the inclusiveness of transformational leadership and assert that high productivity is linked to job satisfaction and a work environment that considers staff members as contributors to the success of the whole organisation (see for example, Deng et al., 2023; Greimel et al., 2023). Transformational leadership is predicated on the idea that problems are resolved by agreement and decisions are made by consensus (Bush, 2008). The possible value of the transformational leadership approach in handling HIV/AIDS derives mainly from its involvement of everyone in the organisation. Leaders try to raise their followers' consciousness by appealing to higher ideals and values, such as

liberty, justice, peace and humanitarianism, instead of dysfunctional emotions such as fear, greed, jealousy and hatred (Tomkins & Bristow, 2023).

In light of this, the transformational leadership approach has been deemed appropriate because of its normative style, which capitalises on a series of methods that view subordinates as major contributors to organisational success (Bush and Anania, 2023). Transformational leadership encourages leaders to instil a collective vision based on the assumption that subordinates follow leaders who inspire them and that leaders care about their subordinates, always injecting enthusiasm and energy into their interactions (Bush, 2023). As such, ethics of care emphasises that caring relations are fundamental to human existence and consciousness (Noddings, 2009). As such, caring ought to be a principle on which to base ethical decisions because caring is a fundamental need in the lives of human beings (Ferrario, Gloeckler, and Biller-Andorno, 2023; Noddings, 2009; Ratliff, 2023).

The ethics of care approach, as propounded by Noddings (2003), maintains that caring should be rooted in receptivity, relatedness and responsiveness (Noddings, 2009). Ratliff (2023) refers to ethics of care as a normative ethical theory regarding what makes actions right or wrong. Caring relationships are basic to human existence and consciousness and they consist of two parties; that is, the carer and the person being cared for (Noddings, 2009). It is the principal's responsibility to care for teachers living with HIV/AIDS. The ethics of care speaks to the concerns about oppression and abandonment that happen in everyday life and argues that human beings need care for survival. Basically, all human beings need care and are dependent on one another in order to achieve their various interests. Teachers living with HIV/AIDS are in particular need of such care. Therefore, the two theories assume that the principals as leaders create a supportive environment where teachers living with HIV/AIDS are free to disclose expectations based on trust and caring relationships.

Teachers as Ambassadors of Good Health

Teachers have historically been important information ambassadors, role models, and representatives of a positive school climate (Gouda, 2023). Unfortunately, there has not been much attention given to what teachers go through as individuals and unpacking the problems that this causes for school leadership. As their immune systems weaken, infected teachers' health problems multiply, forcing them to keep working in order to be able to cover their medical and related expenses. It is beyond doubt that the HIV/AIDS pandemic in the education sector is seriously threatening the school leadership.

It has been observed that when teachers are sick, they frequently miss work (Hawkes, 2023). Moyo and Perumal (2020) found that teachers who are HIV positive are more likely than teachers who are HIV negative to be absent from work due to illness. This is not very surprising, considering how many teachers are now regularly taken ill because of the high rate of HIV infection. In fact, it is suspected that these teachers may deliberately push themselves too hard in order to accelerate the decline of their health and so cut their suffering short. They get depressed, lose the ability to self-actualise, and possibly adopt a negative perspective on life (Quach et al., 2023). Therefore, UNAIDS (2023) recommends to have a strong support system and a comprehensive approach. Programmes and policies aimed at meeting the needs of teachers—particularly those impacted by or infected with HIV/AIDS—both personally and professionally should be included in this, as it would enable them to carry out their vital roles in HIV/AIDS prevention.

Teachers have families and relatives, and they are deeply affected when one of their own contracts HIV/AIDS. Kafwanka, Nalule, and Michelo (2023) cite evidence to support the claim that the negative consequences of HIV/AIDS are multiplied by the fact that persons who have the illness also affect their friends, family, and the larger community. In this context, Quach et al. (2023), assert that the deaths of friends, family, and co-workers are to blame for the rise in teacher absenteeism. Although a

high mortality rate is the ultimate outcome of AIDS, it is the rate of morbidity that presents the greatest difficulties (UNAIDS, 2023).

HIV/AIDS is often stigmatised as a consequence of a person's immoral behaviour, which could be a major reason why people choose to remain silent about their status. Increased research will change people's mind-sets in this regard and an informative study on how teachers perceive their own problems in the workplace will contribute immensely to the change of socio-cultural beliefs. As anticipated by Muremela et al. (2023), there will be a general teacher shortage. The major contributing factor to the shortfall has been attributed to mortality at the hands of HIV/AIDS. Attrition amongst teachers may be the result of employee termination or resignation but mortality remains the primary cause.

Teachers Living with HIV/AIDS

Teachers' health continues to be threatened and Moyo and Perumal (2020) assert that teachers living with HIV/AIDS are faced with several challenges which are blurred by what society expects from teachers as sources of knowledge.

It is without doubt that the Department of Education must urgently put antiretroviral treatment programmes in place to save its scarce human resources. The only conclusive and comprehensive research carried out to assess the risk of HIV/AIDS to teachers was carried out in (HSRC, 2008). The scarcity of such informative research may lead to complacency. Teacher-related HIV/AIDS statistics must be readily available and up to date as such information can be a powerful deterrent against behaviours that would place teachers at risk of contracting the disease. Moreover, the silence resultant of insufficient information may send the wrong message, creating the false impression that HIV/AIDS is under control whilst it continues to take its devastating toll.

Although HIV infection was set to rise as estimated by Statistics South Africa (2018), the good news is that HSRC (2023) found that, in South Africa, the proportion of the total population living with HIV/AIDS decreased from 14.0% in 2017 to 12.7% in 2022.

This means that, compared to 7.9 million in 2017, there are roughly 7.8 million HIV-positive individuals living in South Africa. A robust programme is called for to initiate behaviour change in teachers, support the infected and affected, and put empowering policies in place. Principals may have to work with teachers who are infected by HIV unknowingly, especially if infection is still in its early stages. Teachers could hesitate to get tested or reveal their status until HIV has progressed to full-blown AIDS. Teachers may only miss a few days of work before this occurs, which prevents principals from understanding the severity of the issues that will arise. (Kafwanka, Nalule, & Michelo, 2023).

School Principals

The effects of HIV/AIDS remain prevalent and posing a concern to school leadership. Because of their position, school principals bear the brunt of the challenges faced by the various levels of management within the education system.

They encounter teachers who are unwilling to reveal they are HIV positive (Ndlovu & Potokri, 2023). Principals are responsible for putting many complex educational policies into practice. They get overwhelmed with responsibilities because of the additional roles they play in response to the HIV/AIDS pandemic among their teaching staff members. As the only known illness of its kind, HIV/AIDS has posed significant issues for school leaders, who must deal with an increasing number of teachers who are HIV positive daily (Kafwanka et al., 2023). HIV/AIDS-related responsibilities are more complex than those in any other school leadership role because of the long-standing culture of silence around the illness.

Principals must deal with the negative effects of the HIV/AIDS pandemic as it continues to emerge. The primary pillars of the education system, teachers, are allegedly under risk, and this is having an impact on the school leadership structure. According to Hallinger (2023), low academic accomplishment may have a negative impact on principals' self-actualisation. The principals must persuade their teachers to adopt a more accepting view of the epidemic. Principals can accomplish this by

forming a solid partnership with other community members and department heads. This is a management domain where confidentiality and sensitivity are fundamental. Teachers must be encouraged to discuss their condition by their principals. To ensure that newly appointed teachers inherit the corporate culture of the school, it is imperative that educators unify under their leadership. It is imperative for principals to focus on eliminating biases (Bush, 2023) that result in unfavourable perceptions of individuals living with HIV/AIDS.

Research Design and Methodology

To address the research problem, a narrative inquiry situated within the qualitative research approach was conducted to explore the expectations of teachers living with HIV/AIDS. Qualitative research is naturalistic, as it studies people in their own environments, within naturally occurring settings (Nasri, 2023). Qualitative research is based on the assumption that multiple realities are socially constructed. Thus, qualitative research uses interpretation to make the world visible (Nasri, 2023). Rich description is directly linked to the social context in which researchers immerse themselves. Meaning cannot be made without a rich contextual description. With qualitative research, the goal is to infer large conclusions from little yet intricately detailed evidence to support larger claims as explained by Lichtman (2023).

Since it carries a wealth of meanings, the narrative inquiry design was selected since it is essential to human social existence (Pyo et al., 2023). This research design is used to acquire insightful understandings of how individual people derive meaning from different events. The relationship between the researcher and the participants is central to the study and understanding of human experience. As it stands, narrative inquiry provides a means of empowering the voiceless and weak, such as marginalised communities or children (Blix et al., 2023).

In this case teachers living with HIV/AIDS are located on the margins of school life because of their often stigmatized status due to their health condition. They occupy a very precarious position in relation to the authority of the principal and having to navigate and request for recognition can be very complicated. Their health condition

necessitates a negotiation of their new expectations. Their new demands designed to meet their work obligations are likely to be negotiated on an uneven playing field. Thus, the goal of narrative inquiry is to illuminate light on a person's actual experiences and provide a distinct, nuanced, and rich knowledge of social situation (Pyo et al., 2023).

Sampling and Site Selection

This research study obtained data from teachers living with HIV/AIDS in the Gauteng province of South Africa. Given the prominence of sensitivity around HIV/AIDS issues, network sampling was chosen to sample teachers living with HIV/AIDS. According to LeCompte (2008), network sampling sees primary participants naming other people in their social or other networks. In this context, Gierczyk et al. (2023) affirm that network sampling can be useful in finding difficult-to-reach, hidden, marginalised, and socially stigmatised populations (such as those affected by AIDS). The researcher selected one teacher living with HIV/AIDS through experience and knowledge and then introduced to seven other teachers through networks.

Qualitative research coheres with the interpretation of small number of information-rich data sources. Below Table 1 represents the biographical details of the eight participants. The ages of the eight participants ranged from 37 to 59. Their cumulative years of teaching experience ranged from four to forty. Three of the participants held Senior Teachers' Diplomas (STD) and Advanced Diplomas in Education (ACE). Out of the four individuals who held Diplomas in Education (Dip in Ed.), two held bachelor's degrees (B. Ed.). There were five married participants, one divorced, one widowed, and one single. Two participants were selected from special schools, three from primary schools, and three from secondary schools, all of which were public schools.

Table 1: Biographical details of Participants

Participant	Age	Teaching experience	Qualifications	Marital status
1	46	15	STD and ACE	Married
2	59	40	STD and ACE	Divorced
3	42	12	Diploma in Education	Married
4	41	4	STD and ACE	Single
5	46	21	Dip in Ed., BSc SPED, B.Ed. Honours	Married
6	37	13	Dip in Ed. BSc SPED	Married
7	40	10	Dip in Education	Single
8	43	15	B. Ed. degree	Widow

Data Collection

Since the purpose of our research was to comprehend a highly sensitive phenomenon, i decided to employ narrative interviews as a data collection method since they allow us to extract lived experiences and stories with a clear plot, specific social interactions, and a temporally unfolding order (Hense, 2023). The interviews were face-to-face and semi-structured. The narrative interview's conversational style gave interviewees the space and opportunity to retell their own stories and realities in their own words (Freda, Lemmo, Auriemma, De Luca Picione, & Martino 2023). Interviews were conducted using the idea propounded by Hense (2023) that interviewers must be adaptable and receptive, viewing the interviewee as a fellow human being with valuable insights to share. When interacting with them, participants were shown reciprocity and sensitivity The use of open-ended questions facilitated participants' expression of their views (Freda et al., 2023). The questions asked included

biographical information, experiences and knowledge about HIV/AIDS, challenges faced, disclose at work, how your family responded, services are available at work, concern about the management of HIV/AIDS in school, perception of the principal's role, leadership challenges raised by managing HIV/AIDS and recommendations. It is the skilfulness of the researcher that facilitates the extraction of rich data, especially from traditionally marginalised individuals. Raw narratives draw particular attention to details that could be overlooked by or inaccessible via methods such as surveys (Hense, 2023).

Data Analysis

The data were analysed according to the qualitative content analysis method. The interviews were digitally recorded and transcribed verbatim. Verbatim transcripts were numbered line by line. Several transcript analyses led to the acquisition of a collection of codes. Themes and sub-themes were established by grouping the codes into categories (Serafini, & Reid, 2023). The goal of the content analysis method is to simplify and make sense of data by extracting meaning from it (Jerzak, King, & Strezhnev, 2023). Many scholars confirm that when working with a diverse range of textual material, such as transcripts from interviews, content analysis is the best approach (see for example, Jerzak et al., 2023; Serafini, & Reid, 2023). The themes provided insights into the expectations of teachers living with HIV/AIDS.

Trustworthiness

In this study, the Tracy (2010) model for qualitative research was used to achieve trustworthiness. The participants signed declarations of consent, which contained a description of the purpose of the study and details of the interview sessions. Anonymity, voluntary involvement, and the right to withdraw from the study without consequences were all guaranteed in the permission form (Nasri, 2023). For the sake of sincerity in this study, a transparent audit trail was made available. All the data was referenced by numbering all the lines of verbatim transcripts. The researcher kept a reflective journal about their emotions and sense-making. Eight teachers living with HIV/AIDS were sampled through network sampling and unique and rare data were

gathered. Building rapport with the participants allowed for the collection of important data. Each participant was interviewed more than once.

Ethical Considerations

An ethical clearance application was submitted to the University of South Africa's College of Education Research Ethics Committee. Once the Research Ethics Committee approved the study, approval was obtained from the Gauteng Department of Education through an application form that bore the aims, timetable of research, and proposed data gathering techniques of the study. Thereafter, access to the teachers and their schools was requested and granted. Participants signed declarations of consent, which contained assurance of anonymity, voluntary participation, and right of withdrawal from this study without prejudice. Data was stored in a password-protected personal computer, and duplicates were kept on an external hard drive and a flash drive. The data was treated in a manner that protected the confidentiality and anonymity of my participants.

Findings

All the teachers who participated in this study indicated that they had expectations from their principals. The eight teachers were given pseudonyms from 1 to 8. Data is presented according to three emerging themes; care and support, principals as role models and lowering workload.

Care and Support

Every teacher participant interviewed indicated that teachers living with HIV/AIDS have expectations from their principals. Teacher 5 expressed that:

The principals can initiate programmes that can see the school being the disseminator of knowledge. I disclosed to him because I feel he can support me and I wanted him to get it from me. He needs to have an ear to listen to all our problems. I think the principal has the power to set the tone. They can use resources at their disposal to conduct enrichment programmes. They are always visible in society. They are associated with academic knowledge as well as general knowledge.

Teacher 2 narrated:

People fail to understand what support we need. I think that way… if we get support it makes one to feel stronger. For example, support groups whereby people talk more about supporting one another.

Teacher 6 had this to say:

I think if ever people have people living with HIV/AIDS with them, maybe they should particularly be given a lot of support from school level to district level.

The above excerpts show that teachers have huge expectations from their principals. Nevertheless, they expressed sincere appreciation of the ARV programme that has recently been rolled out. There has been much discussion in the literature around the expectations that teachers living with HIV/AIDS have of their principals. There are appropriate things that school leaders can do in the face of the HIV/AIDS pandemic (Bwalya, & Mulubale, 2023; Moyo & Perumal, 2020). A specific type of leadership is required for schools to serve as means of care and support for teachers and students.

In addition, teachers must experience the power of effective leadership (Hallinger, 2023). Indeed, teacher 4 described her expectations as follows:

Principals can engage the community; they can bring people together. Really it is a challenge. The principal has the duty to bring in experts regarding the problem, for instance, psychologists, social workers; those people who have expertise to come and maybe motivate educators and learners regarding this kind of situation.

In addition, what teacher 7 had to say about his expectations of his principal cannot be ignored:

He is sure that we need information regarding this, even though he might not have enough knowledge he might inquire. He needs to go out and look for information and support what I want. He needs to look after his staff.

The above responses of teachers living with HIV/AIDS indicated high expectations of principals. These sentiments show that principals are expected to provide support for their teachers. Principals are regarded as possessing solutions to the problems experienced by teachers living with HIV/AIDS.

Principals as Role Models

Hallinger (2023) assert that if principals offer their teachers undivided attention, listen to their concerns, and prioritise them on their agendas, teachers will trust them. As discussed by Hallinger (2023), teachers need coaching and advice from their principals. By the same token, however, Bush (2023) note that individuals follow leaders because they feel a sense of purpose, which suggests that in their absence, they have low self-esteem and weak self-images. As asserted by Moyo and Perumal (2020), teachers living with HIV/AIDS provide difficulties for principals, especially when the teachers take advantage of their conditions to obtain special treatment. Bush and Anania (2023) caution that teachers might feel compelled to promote the ideals of the vulnerable group. In her interviews, teacher 1 stressed that principals make a huge difference:

They have the potential and they can make a huge contribution. It all depends on how much they care. Their strategic position allows them to influence communities, I have seen principals go an extra mile. Their voices are easily heard. The principal as a leader should set good examples and be a role model. The principal binds people together. He influences people's perceptions towards achieving goals. Although they cannot answer but we look up to them they are more experienced and they are connected to other professionals due to their influential positions. They contribution to educating people about HIV/AIDS cannot be undermined.

It is expected of principals to go the extra mile and above, with emphasis on the idea that this shows how much they care. Furthermore, Bush and Anania (2023) insist that it is crucial to adopt a management and leadership style that values the individuals in the organisation as much as the abilities and knowledge they possess.

As remarked by Gouda (2023) interpersonal relations enable caring. High morale is a necessary condition for teachers' personal welfare, which is improved when they receive care (Hallinger, 2023). The statements of various participants support this claim, teacher 3 stated:

Really, it is an extra duty. However, because principals have the capacity to lead by example, they are able to inform people and educate society at large. They arrange relief teachers for in case some teachers are absent.

Teacher 8 noted:

But being the manager or the headmaster I think he is supposed to be more knowledgeable because he is dealing with subordinates; in effect he is the father.

It was commonly stated by the teacher participants that principals can influence surrounding communities to send their children to their schools and that, likewise, they can use their influential positions to change people’s minds. Teacher 5 said:

I think they play an important role in educating the community at large. They are role models; they produce products into the society and they must be seen to possess knowledge that enriches communities. Of course I with the condition that I have, I look up to him. It is easy for people of his level to outsource expertise to help their staff.

Teacher 6 explained:

I think the principal has the power to set the tone. He has the power to pull people towards the set goals. Indeed, they are role models; they have the power and they have the authority… They can use resources at their disposal to conduct enrichment programmes.

Therefore, it is evident that principals have the ability to influence people and change their mind-sets.

Lowering Workload

The literature also points out that leaders encounter difficulties in carrying out their responsibilities in an ethical and efficient manner because they are accountable to and obligated to provide for their subordinates (Tomkins, & Bristow, 2023). While it is clear that teachers look up to their principals, the question of whether or not the teachers themselves are playing their part, for instance, by disclosing their status and taking initiative in support programmes. According to Ferrario et al. (2023), an ethics of care would probably argue that helping someone whose stress we are seeing is more important to us than helping someone we do not know.

As was indicated earlier caring relations are fundamental to human existence and consciousness and consist of two parties; that is, the carer and cared-for (Noddings, 2009).

One of the teachers' (teacher 5) responses below further expand on teachers' expectations of their principals:

In terms of work-related issues; they must check whether you are coping with your work as an educator with this chronic disease so that if you are not coping with your work with this chronic disease needs a lighter load.

Teacher 3 also narrated:

If you are not coping, they must determine what kind of support do you need in relation to the workload that you are facing for example maybe I'm teaching at a high school level maybe there is a lot of subjects workload and I must support this, I must support that and mark and so this means all these things only find me in an over loaded situation and then it affects also my health and thinking.

The above comments show that teachers living with HIV/AIDS look up to their principals. Teacher 1 highlighted:

The number of classes I teach are too many. I also have exam classes and sometimes I have to offer extra lessons. I'm not well for such a load. Day-by-day it becomes heavy. Although I am trying. Maybe if I could be relieved of the exam classes, it will be much better.

The role of moral growth and empathy in caring is emphasised by Ferrario et al. (2023). In addition, Noddings (2009) proposes the practice of "engrossment", whereby a person considers others in such a way as to gain an in-depth understanding of them. This argument is consistent with research that explains the moral value of caring relationships and the ethics of care theory, which aims to preserve relationships by promoting the welfare of individuals providing and receiving care while fostering social connections (Ratliff, 2023).

It can be concluded that teachers living with HIV/AIDS expect their principals to offer them care and support, lower their workload and look up to them as role models. Inadequate moral support and/or sound relationships have kept teachers from approaching their principals.

Discussion

This research shows that teacher living with HIV/AIDS have expectations from their principals. Teachers expressed similar emotions and experiences. They shared common perceptions about the roles of their principals, of whom they held high expectations. Principals as leaders are required to be proactive and deal with the issues of HIV/AIDS amongst their teachers. Principals account for failure and conflict. Principals facilitate behaviour change in teachers. Some researchers observe that a caring role is embedded in the leadership and/or management function of the principal. The South African government has rolled out the biggest ARV programme and one-a-day ARV treatment. Principals influence and inspire teachers to focus in the direction of common goals. Principals as leaders have an obligation to accept challenge of HIV/AIDS and manage.

Principals are encouraged by the ethics of care theory to speak to the oppressed and abandoned (Noddings, 2009) who in this case are teachers living with HIV/AIDS who need support. The ethics of care approach places emphasis on direct connections with the cared-for and on considering their fears, thoughts and desires. As with any long-term sickness, the literature attests that PLWH make an effort to reconcile with their circumstances by trying to piece together their broken identities (Bwalya & Mulubale, 2023). Teachers need support and awareness to deal with the embarrassment of living with HIV/AIDS. Principals expect teachers to disclose to facilitate the establishment of a good working relationship. Thus, Ferrario et al. (2023) puts forward that the foundation of care ethics is the idea that humans are relational, responsive beings by nature, and that interdependence or connectivity characterises the human condition. Teachers find themselves in what Moyo and Perumal (2020) known as biographical ambiguity, a condition in which teachers must live with the stigma attached to HIV/AIDS and feel ashamed and uneasy. Nonetheless, Ratliff (2023) contends that reciprocity and responsiveness enable the carer to ascertain the state of mind of the person receiving care. Principals are obliged to come up with a way of probing their teachers when they see that they are not well. Principals must be approachable to make it easier for teachers to approach them to avoid teachers opting to disclose to their departmental heads. Furthermore, how principals respond to teachers'

problems contributes to the establishment of relationships rooted in humanitarianism as advocated by the transformational leadership. Bush (2023) highlights how teachers who feel respected by their principals are more inclined to devote themselves to their profession.

The transformational leadership approach holds that professionals should be placed on an open platform from which they can contribute to the wider decision-making process (Bush, 2008). According to this view, shared decisions are likely to be better informed and are also much more likely to be implemented effectively. Noddings (2003) insists on ethical caring - when people meet others morally out of natural caring and remain in the caring relationship.

Based on the research findings, it is evident that teachers have high expectations of their principals. Teachers living with HIV/AIDS look up to their principals; they perceive their principals as the answer to the problems they face. Principals are expected to play an important role in educating the teachers and the community at large about HIV/AIDS. Teachers argue that principals can perform extra duties through good time management and that they can use their status to implement change. The literature asserts that management/ leadership approach should be followed where the people within the organisation are regarded as important and not only the skills and knowledge they can offer.

Principals can influence surrounding communities to send their children to their schools and that, likewise, they can use their influential positions to change people's minds. The principals can reach out to professionals like counsellors and psychologists to give support to their teachers. They have the power to outsource resources and experts. Principals have the expertise to motivate their teachers, due to the demands of their jobs, principals are often too overworked to take full advantage of this. It is noted in the literature that, since leaders have the duty to care for their subordinates in addition to being responsible for them, they are faced with challenges of being ethical and effective in their duties.

According to some scholars, transformational leadership has a significant impact on teachers' perceptions of the state of schools, their responsibility to make changes, and the teaching and learning that occurs throughout the entire school (see for example, Deng et al., 2023; Greimel et al., 2023). In this context, the ethics of care theory is described by Ferrario et al. (2023) as the direct response of moral people to needs they notice. In the case of an infant who is about to fall into a well, they leap to save the child without consulting principles or referring to formal connections. As has been highlighted in the data, teachers have expectations of their principals.

The empirical data shows that although the teachers understand the sensitivity of dealing with HIV/AIDS, they expect principals to be able to see that teachers are not coping with their work. Teachers look up to principals as possibly having answers to problems they face due to HIV/AIDS. Principals often fall short of achieving these goals, and research indicates that they face significant difficulties when assisting teachers who are HIV/AIDS positive (Moyo & Perumal, 2020). Principals are leaders who should set good examples and be good role models. Some researchers concur that when teachers are cared for, it enhances their personal wellbeing, which is an indispensable prerequisite for high morale.

Teachers clearly stated that it is principals' duty to bind teachers together and influence people’s perceptions towards achieving goals. Principals should stimulate teachers to feel and act like leaders to give them an overall sense of purpose in managing HIV/AIDS. Teachers have duties delegated to them according to their strengths so that every teacher has a responsibility. Other researchers in the literature describe caring relationships as bound by moral significance and the ethics of care theory as striving to maintain relationships by encouraging the welfare of the ones giving care and those receiving it while networking social relations.

Teachers’ perceptions depict principals as having a role to play in dealing with HIV/AIDS-related issues. Principals influence change through their positions. Likewise, the principals can initiate programmes that can make schools into disseminators of

information, taking the lead in HIV/AIDS campaigns. Other researchers conclude that for schools to function as modes of care and support, a particular form of leadership is required. There are reasonable actions that school principals can take in the face of HIV/AIDS crisis.

Conclusion

This study aimed at exploring the expectations of teachers living with HIV/AIDS from the school principals. The conclusion drawn from the empirical data is that teachers expect principals to reduce their workload, be role models, be resourceful, care and support, initiate programmes, be tolerant and perform the extra duties. Teachers expect principals to support and tolerate their situation. Principals are expected to be more knowledgeable and regarded as possessing answers to problems experienced by teachers living with HIV/AIDS. Some researchers assert that teachers are faced with challenges of prejudiced perceptions.

Further research is required with the school principals to determine leadership and management strategies that equip them with necessary skills and knowledge to deal with HIV/AIDS-related issues in a more effective way. This study utilised a small sample of teachers living with HIV/AIDS in the Gauteng province. The aim was to achieve an in-depth understating of the research phenomenon and not a general perspective. The findings of this research can be transferred to other similar situations although generalisations cannot be made. Repeat of the same research conducted with a more representative sample of teachers from other areas of Gauteng Province as well as other South African provinces will be useful.

This research study confirms that teachers living with HIV/AIDS hold high expectations from their school principals. Due to the sensitivity of HIV/AIDS issues, the expectations are not easily noticeable. This qualitative study has generated empirical data from the participants that has paved way for a new understating of the expectations that teachers living with HIV/AIDS hold for their school principals. At a time when the teaching professional is reeling under the pressure of the impact of HIV/AIDS on its

core staff this research study has demonstrated the importance of equipping school principals with skills and strategies to be able to handle HIV/AIDS issues amongst their teachers. It is significant to note that when principals work with teachers who are suffering from HIV/AIDS they might need more than just their traditional skills of ethics of care. It maybe timely to explore further what leadership skills principals require to cope with the demands occasioned by HIV/AIDS in the school workplace.

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PEDAGOGICAL CONTENT KNOWLEDGE DEVELOPMENT WITHIN PRE-SERVICE MATHEMATICS TEACHER EDUCATION: A BIBLIOMETRIC ANALYSIS

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Abstract

This study explores the dynamic landscape of Pedagogical Content Knowledge (PCK) development in pre-service mathematics education, drawing attention to higher education institutions (HEIs), researchers, and policymakers. Analysing publications (2012-2024) in the Elsevier Scopus database, the bibliometric analysis employs keywords like PCK, development, mathematics, and pre-service teachers. Utilising VOSviewer, key clusters emerge, emphasising Technological Pedagogical Content Knowledge (TPACK), PCK, and teacher knowledge. Aligned with the fourth industrial revolution's onset in 2011, the study observes notable shifts in PCK development, responding to technological advancements. Post-2019 sees a surge in TPACK studies, reflecting heightened interest in technology education. The 2022 peak in publications correlates with the global attention drawn by the COVID-19 pandemic, prompting increased online teaching and learning. While the USA and Germany lead in PCK discourse, collaboration is advocated to enhance Africa's involvement. Emphasising digital literacy in the fourth industrial revolution, findings underscore the need to adapt curricula for a comprehensive 4IR understanding. Despite its novelty, cautious interpretation is advised due to reliance on a single database, contributing valuable insights to the growing body of scholarly knowledge on PCK development in pre-service mathematics education.

Keywords: Bibliometric analysis, Scopus data base, Pedagogical content knowledge (PCK), mathematics, pre-service teachers, Technological Pedagogical Content Knowledge (TPACK)

Introduction

When creating a mathematics lesson, educators select the lesson's objective and structure the session around it. In pursuit of this objective, they make decisions regarding the examples to employ and the approach to be taken with these examples. Additionally, teachers plan specific details, such as the utilization of the chalkboard and making choices about the duration an example will be displayed. Subsequently, they determine the questions to pose to learners, and while learners engage in tasks, teachers probe, offer hints, and provide explanations (Ball et al., 2008). In this process, teachers identify the essential knowledge required for the lesson, along with how this knowledge should be comprehended and presented in the classroom. The integration of discipline-specific content knowledge with pedagogical knowledge is termed pedagogical content knowledge or PCK. PCK encompasses both procedural and conceptual content knowledge, as well as an understanding of learners and the curriculum (Ball et al., 2008). Consequently, it is imperative to equip pre-service teachers with the skills to recognize the content knowledge necessary for teaching and understand how this knowledge can be applied in the classroom (Ball et al., 2008).

The concept of PCK in the realm of developing pre-service teachers is not a recent research focus. Lee Shulman introduced the concept in 1986 as a response to what he identified as the 'missing paradigm' in teacher education. Shulman emphasized the significance of subject matter knowledge and argued that effective teaching requires more than just content knowledge and pedagogy. PCK was positioned as one of seven categories within the knowledge base of teachers, distinguished by its role in selecting the most useful forms of representation and formulation of subject matter to make it comprehensible to others (Shulman, 1986). The remaining six categories encompass content knowledge, general pedagogical knowledge, curriculum knowledge, knowledge of learners, knowledge of educational contexts, and knowledge of educational ends, purposes, values, and their philosophical and historical grounds. PCK was deemed crucial as it differentiates the content specialist from the pedagogue, focusing on knowledge of instructional strategies and representations coupled with knowledge of students (Shulman, 1986). Teachers necessitate knowledge of concepts and strategies tailored for specific grade levels and student demographics. This

comprehensive understanding, coupled with expertise in "developing, using, and adapting teaching procedures, strategies, and approaches" for specific lessons, is linked to the synthesis of content and pedagogy described as PCK by Shulman (1986) and Shulman (1987). PCK in mathematics differs from both a mathematician's knowledge of mathematics and general teaching pedagogy, signifying the transformation of subject matter knowledge into valuable resources for effective teaching and learning (Shulman, 1987). Over the years, discussions about PCK and pre-service teacher education have gained prominence due to their crucial role in developing the next generation of teachers. Researchers in higher education have shown increased interest in engaging with the continuous growth of knowledge. Consequently, Shulman's conceptualization of PCK has been examined in various ways to enhance outcomes for mathematics pre-service teachers. A surge of PCK studies has focused on conceptualizing mathematical knowledge for teaching (Ball et al., 2008).

Systematic reviews of existing PCK literature can contribute to the development of current understanding for exploring ways to enhance pre-service teachers' PCK. Previous studies have yielded diverse findings, with Depaepe, Verschaffel, and Kelchtermans (2013) discussing different conceptualisations of PCK and their impact on empirical investigations of PCK methodology. Mecoli (2013) reviewed studies on how prospective teachers acquire PCK through coursework, indicating that instructing novice educators on applying this concept is both possible and potentially advantageous. However, the effectiveness of such teaching efforts may vary across different contexts or situations. The inclusion of PCK in teacher education offers several benefits, including providing educators with opportunities to reflect on their practice, equipping pre-service teachers for future PCK acquisitions, and allowing exploration of the distinction between rote memorisation and conceptual understanding (Geddis & Wood, 1997; Kinach, 2002). Challenges in introducing PCK to pre-service teachers include insufficient subject matter knowledge, difficulty in identifying knowledge gaps, and issues in technological PCK where pre-service teachers may not feel adequately prepared (Schwartz & Lederman, 2002; Davis, 2003;

Angeli & Valanides, 2005. Wang, Schmidt-Crawford and Jin (2018, pg. 234) conducted a literature review on studies exploring pre-service teachers' TPACK development through various research methods. Consistent themes across these methods included modelling and documenting pre-service teachers' TPACK development in relation to the seven knowledge domains. This analysis does not aim to be a comprehensive account of Shulman-influenced research, nor does it function as a critical assessment. Instead, its objective is to present academic endeavours extending Shulman's framework, investigating PCK development in mathematics pre-service teachers during teacher education. While previous studies were impactful, addressing specific aspects and relying on subjective findings, this paper conducts a more comprehensive review using a bibliometric approach to analyse PCK and pre-service teacher education articles from 2012 to 2024. This method aims to chart research directions and focus areas, providing a thorough understanding of key trends and patterns. By utilising the bibliometric approach, the paper identifies leading authors and gauges collaboration levels in this research domain, exploring current trends in PCK and mathematics pre-service teacher education studies. It also provides recommendations on how the African continent can contribute to advancing ongoing research in this area.

Literature Review

Systematic reviews of existing PCK literature can contribute to the development of the current understanding for exploring ways to enhance pre-service teachers' PCK, yielding diverse findings. Depaepe et al. (2013) present a comprehensive review of empirical research on pedagogical content knowledge (PCK) in mathematics education, focusing on studies published in English peer-reviewed journals. They analysed 60 research articles selected from three databases: ERIC, PsycInfo, and Web of Science. The review addresses two main research questions: the conceptualization and the investigation of PCK in mathematics education. They found general agreement on PCK's core components, such as knowledge of students' misconceptions and instructional strategies, though there is debate over additional components like curriculum knowledge and content knowledge. The review highlights a paradigmatic split between cognitive and situated perspectives on PCK, each

influencing research methodologies and outcomes differently. The authors emphasize the necessity for clear conceptualization and methodological alignment in PCK research, acknowledging the strengths and pitfalls of both perspectives. This review underscores the importance of PCK in effective mathematics teaching and teacher education.

Mecoli (2013) offers a comprehensive review of the impact of Shulman's Pedagogical Content Knowledge (PCK) framework on preservice teacher education, especially in science, mathematics, and technology. Building on Grossman's (1990) findings on the benefits of rigorous teacher education programs, the review synthesizes various studies to explore PCK acquisition through coursework. These studies highlight the complexity of developing PCK, emphasizing that it involves more than just disciplinary knowledge. Effective PCK development requires understanding learner misconceptions, integrating theoretical constructs into practical teaching, and using reflective practices. Despite these insights, Mecoli notes persistent challenges, including fragmented knowledge integration in teacher education programs. Angeli and Valanides (2005) and So and Kim (2009) reveal difficulties in aligning subject, pedagogical, and technological knowledge, advocating for further research. Ball, et al. (2008) emphasizes integrating theoretical knowledge with pedagogical methods to address this fragmentation. Overall, Mecoli underscores significant hurdles in adequately preparing preservice teachers despite the benefits of PCK.

Yigit (2014) reviews the development of preservice mathematics teachers' Technological Pedagogical Content Knowledge (TPACK) and its impact on their teaching. Despite limited research on TPACK in mathematics education, findings suggest that actively involving preservice teachers in technology-enhanced lessons is crucial for TPACK development. Niess et al. (2009) propose TPACK standards and a development model to support preservice teachers, offering a framework for assessing and enhancing TPACK. However, challenges remain in measuring TPACK development, emphasizing the need for clearer measurement methods. Overall, this

review provides valuable insights for improving preservice teachers' TPACK development and future teaching experiences.

A bibliometric analysis conducted by Su (2023) to examine trends in preservice teachers' Technological Pedagogical Content Knowledge (TPACK) research analyses 112 Scopus-indexed articles. The study identifies research patterns, prolific countries, and influential journals. Findings reveal a dominance of developed nations in TPACK literature, with a focus on teacher education and educational technology. Despite a growing interest in TPACK, areas like self-regulated learning and teachers' attitudes toward technology remain underexplored. This review offers valuable insights for researchers, aiding in understanding the landscape of TPACK research and identifying potential collaborators and research topics. The inclusion of PCK in teacher education offers several benefits, including enhancing teaching effectiveness through integrating pedagogical strategies with subject matter knowledge, fostering reflective practice, and enabling effective integration of educational technology for enhanced student engagement and achievement. Challenges in introducing PCK to pre-service teachers include insufficient subject matter knowledge, difficulty in identifying knowledge gaps, and issues in technological PCK where pre-service teachers may not feel adequately prepared. The bibliometric method aims to chart research directions and focus areas, providing a thorough understanding of key trends and patterns.

Despite the existence of two systematic reviews on pre-service teachers and PCK literature (e.g., Depaepe et al., 2013; Mecoli, 2013) and further studies that examine the development of preservice mathematics teachers' Technological Pedagogical Content Knowledge (TPACK) and its impact on their teaching (refer to Yigit, 2014), as well as bibliometric reviews focusing on TPACK (see Su, 2023). Notably, there are no apparent studies discussing the development of preservice teachers' pedagogical content knowledge using bibliometric analysis. Therefore, the aim of this bibliometric analysis is to assess recent trends and focus areas in Pedagogical Content Knowledge (PCK) development among mathematics pre-service teachers. Using the Scopus database, it maps key knowledge areas and co-occurring keywords over the past

decade, aligning with technological advancements and the onset of the fourth industrial revolution.

Theoretical Framework

A bibliometric review functions as the theoretical framework for this study, providing a rigorous approach to examining scientific literature through quantitative methods to identify patterns, trends, and the intellectual structure of a research domain (Aria & Cuccurullo, 2017; Donthu, Kumar, Mukherjee, Pandey, & Lim, 2021). This method allowed me to explore the evolutionary nuances in the field of Pedagogical Content Knowledge (PCK) and mathematics pre-service teacher education studies, highlighting emerging areas within this discipline. The framework utilizes variables such as publication counts, citation metrics, and thematic mapping to pinpoint influential works, emerging trends, and central research areas.

Research Methodology

This study aimed to investigate the primary focus areas in published works related to the development of PCK in pre-service mathematics education. Employing a bibliometric approach, the research sought to identify and map key knowledge areas and co-occurring keywords, revealing research trends and patterns. This method allowed for a quantitative and comprehensive exploration of existing literature, overcoming the limitations of a manual review (Aghimien et al., 2019; Akinlolu & Haupt., 2020). The four-step process employed in this bibliometric analysis involved applying techniques for data collection, analysis, followed by visualisation and the discussion of findings.

Data Collection

For data collection, the study relied on existing literature available in the Scopus database. The growing trend in utilising Scopus data is attributed to its comprehensive coverage across various scientific disciplines, making it a prominent database for literature retrieval (Mongeon & Paul-Hus, 2016). Recognised for its extensive reach and reliance on trustworthy online sources, Scopus is acknowledged as one of the

largest databases of its kind. Additionally, Scopus offers faster index processing compared to other significant scholarly databases like Google Scholar and Web of Science (ISI) (Meho & Rogers, 2008). The Scopus database features tools for tracking, analysing, and visualising research. Significant attention was given to formulating an exact search statement to avoid overlooking crucial documents in superficial searches. By utilising the Scopus database, the retrieval schema was inputted into the Scopus catalogue: (TITLE-ABS-KEY ("PCK" OR "pedagogical content knowledge" OR "specialised knowledge" OR "mathematics knowledge" OR "mathematics knowledge for teaching" OR "MKT") AND TITLE-ABS-KEY ("pre-service teachers" OR "pre-service teacher" OR "teacher education" OR "initial teacher education" OR "higher education" OR "PST") AND TITLE-ABS-KEY ("mathematics" OR "math" OR "maths") AND TITLE-ABS-KEY ("development of" OR "PCK development" OR "training" OR "developing")) AND PUBYEAR > 2012 AND PUBYEAR < 2024. The study considered the timeframe from 2012 to 2024.

Data Analysis

In February 2024, a literature search yielded 181 articles, with keywords extracted as a CSV file for analysis. The CSV file contained all metadata common to articles, including DOI numbers and other relevant characteristics. To explore research on PCK development in pre-service mathematics education, the study utilised the VOS viewer text mining tool to examine bibliometric connections and outcomes. These outcomes included quantifying publications, analysing publications by country and document source, identifying focus areas based on publication date, examining highly cited publications, and assessing keyword occurrence. Table 1 provides a brief summary of the analysis conducted, the tools used, and the intended objectives for their utilisation.

Table 1: Bibliometric Analysis Conducted Using VOSviewer *- adapted from Aliu, Aigbavboa and Thwala (2021)*

Analysis of	Intended objectives
Number of publications	To assess publication frequency
Number of publications per country	To unveil areas where studies on PCK in mathematics pre-service teacher education have been prevalent.
Publication per document source	To uncover the primary origins of PCK in mathematics pre-service teacher education research.
Number of publications per author and the network of co-authorship.	To investigate the primary authors and collaborative contributors in published studies on PCK in pre-service teacher education
Keywords co-occurrence	To explore leading research themes
The emphasis of research is determined by the publication year.	Exploring thematic trends

Visualisation and Discussion of Findings

Publications per year

Out of the 181 articles extracted on the subject of PCK development with pre-service teachers, 139 were from journal articles, 20 from book chapters, and 12 originated from conference proceedings. The categories include five conference reviews, three reviews, one note, and one book. The trend in PCK development in pre-service teacher publications from 2013 to 2024 is illustrated in Figure 1. The graph demonstrates a sharp decrease in publications from 2013 to 2014, with only four publications in 2014, followed by a subsequent increase to 15 publications in 2015. The graph then depicts a consistent fluctuation in the publication count between 2015 and 2017, with 45 articles published during this timeframe, indicating a growing interest in PCK development studies in pre-service mathematics education. The graph also illustrates a notable surge in publications from 2020 to 2022, with 34 articles specifically focused

on PCK development within the pre-service mathematics education domain. It is noteworthy that the COVID-19 pandemic might have played a role in the heightened number of articles during that specific period.

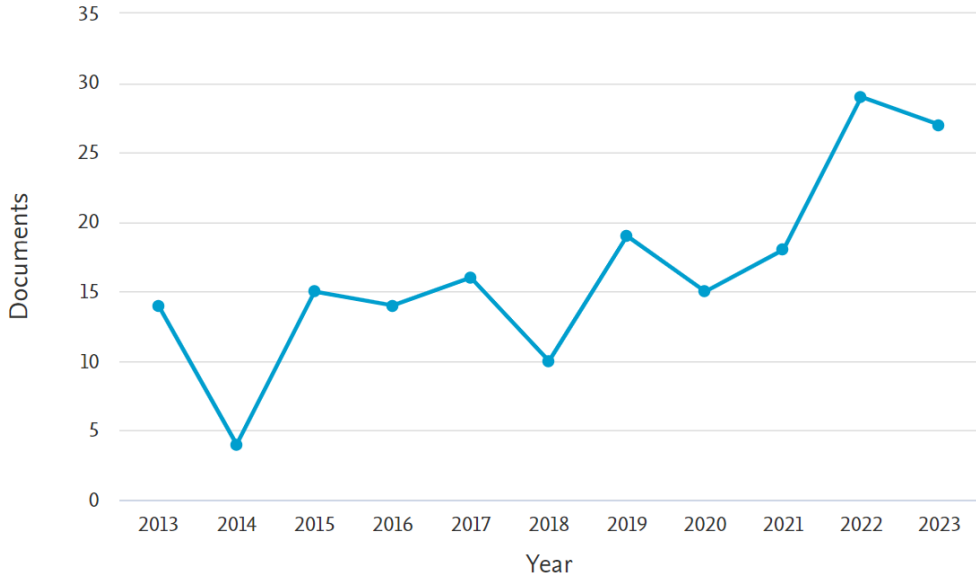

Figure 1: Annual Publication Count (2013–2024)

The Network of Publications per Country

To prevent any potential overlap arising from articles with multiple country affiliations, a criterion was established requiring a minimum of two publications and at least six citations per country of origin. By applying these criteria, 20 countries from 41 countries successfully met the threshold, as detailed in Table 2. Furthermore, countries with only one article over the course of a decade were excluded due to the potential presence of overlapping content.

Table 2: Number of Publications per Country

Country	Documents	Citations	Total Link Strength
Germany	25	697	9
Norway	6	206	6
Australia	12	149	5
United States	42	307	4
Turkey	12	84	2
Taiwan	5	16	2
Belgium	2	26	2
Netherlands	2	68	2
Brazil	10	14	1
Indonesia	10	47	1
Chile	8	46	1
South Africa	8	28	1
China	4	10	1
Ireland	4	82	1
Ghana	2	29	1
Tanzania	2	57	1
Spain	17	51	0
Finland	4	28	0
Canada	2	6	0
South Korea	2	7	0

The leading countries in the field of PCK development in mathematics pre-service education studies, each with a minimum of two documents, are the United States (42 articles, 307 citations), Germany (25 articles, 697 citations), and Spain (17 articles, 51 citations), as detailed in Table 2.

The determination of the total link strength is essential in assigning weightage to an attribute (Aliu, Aigbavboa & Thwala, 2021). Germany, with a total link strength of 9, emerges as the most influential contributor to PCK development in mathematics pre-service education studies, underscoring its significance.

Despite Norway's publication of only six articles, resulting in 206 citations, a total link strength of 6 underscores the impact of these publications on the body of PCK knowledge.

Furthermore, Figure 2 illustrates that South Africa reached the threshold, indicating a significant knowledge contribution to the discourse on PCK development in mathematics pre-service education. However, the absence of link strength for Spain, Finland, Canada, and South Korea suggests a knowledge gap in the discussion of PCK in mathematics pre-service education studies across countries.

The Publications per Document Source

Subsequently, an examination of the aggregate number of papers extracted by source title was performed. This analysis, as described by Hosseini et al. (2018), aims to furnish researchers with insights into the prominent journals for publishing or accessing works related to PCK development in mathematics pre-service education studies. Out of the 181 extracted articles, they were distributed across 114 distinct journals, with 83 of them featuring only a single publication within the specified time frame.

Table 3: Number of Publications per Source

Journal Title	Documents	Citations	Journal Impact Factor
Eurasia Journal of Mathematics, Science and Technology Education	7	42	2.91
Journal of Mathematics Teacher Education	5	72	2.30
International Journal of Science and Mathematics Education	5	221	2.07
Acta Scientiae	5	0	0.52
Mathematics Enthusiast	5	42	0.43
Education Sciences	4	20	3.66
Mathematics	4	13	2.592
International Journal of Mathematical Education in Science and Technology	4	47	1.33
Teaching and Teacher Education	3	73	4.80
Mathematics Education Research Journal	3	65	2.36
Teacher Development	3	40	1.62
Perspectives in Education	3	10	0.94
Estudios Pedagogicos	3	11	0.61
Bolema - Mathematics Education Bulletin	3	12	0.48
Journal of Physics: Conference Series	3	14	0.48

Table 3 provides an in-depth breakdown exclusively focusing on sources with a minimum of three published papers. The Eurasia Journal of Mathematics, Science and Technology Education (EJMSTE) emerges prominently in Table 3, demonstrating a notable presence with seven publications and 42 citations. This underscores its leading position in the domain of PCK development in mathematics pre-service education studies. Additionally, the International Journal of Science and Mathematics

Education (IJSME) stands out, featuring five publications and 221 citations. Teaching and teacher education, scoring 4.80 in impact factor, stands out as the journal of utmost significance within the scientific community. This underscores its elevated importance in scholarly circles.

The Publications with the Highest Number of Citations

A more comprehensive examination was conducted to identify publications with the highest citation frequencies, aiming to discern the pre-service teacher education documents influencing PC development most significantly within the specified timeframe. The study specifically focused on publications cited at least 20 times, seeking those with substantial visibility, as outlined in Table 4. Out of the 181 scrutinised documents, 19 publications exceeded this citation threshold, with the top ten highlighted. It is notable that, even though not utilised as a keyword in the Scopus search, Table 4 indicates that a majority of publications in the field of PCK development in pre-service teacher mathematics education primarily revolve around integrating information and communication technology (ICT) with TPACK. This observation is supported by the findings of Lee, Chung and Wei (2022), who emphasise that teacher education research initially focused on pre-service teacher knowledge development but has gradually shifted in recent years to delve into more specific subject knowledge. This shift underscores the application of the TPACK implementation strategy in teacher education to evaluate the knowledge levels of pre-service teachers better. The authors argue, "Identifying teacher TPACK through teaching activities has several advantages. Teachers must use their knowledge in real-world situations when using this approach. Studying planning activity performance is beneficial because it captures teachers' pedagogical reasoning intents, decision-making about how to connect learning goals with pedagogical tactics, as well as their tool selection and use" (Lee, Chung, & Wei, 2022, p. 11). Notably, South African research did not meet the threshold, possibly due to the context-specific challenges in South Africa where technology is not readily available in classrooms, and issues such as load shedding and electricity costs prevail. A finding supported by Su (2023, p. 8) who showed that the majority of studies focused on pre-service teachers TPACK "was authored in developed societies: the United States (43 publications), Turkey (29

publications), Australia (8 publications), Hong Kong (8 publications), and Singapore (7 publications)." Su (2023) explains that possible factors influencing developing countries' interest in pre-service teachers' TPACK include research funding, resources, and social environments.

Table 4: The Publications with the Highest Number of Citations

Source	Source Title	Citations	Method	Research area
Kleickmann, T., Richter, D., Kunter, M., Elsner, J., Besser, M., Krauss, S., & Baumert, J. (2013).	Teachers' content knowledge and pedagogical content knowledge: The role of structural differences in teacher education.	300	mixed-methods research design.	PCK, pre-service teachers
Kaiser, G., Busse, A., Hoth, J., König, J., & Blömeke, S. (2015).	About the complexities of video-based assessments: Theoretical and methodological approaches to overcoming shortcomings of research on teachers' competence	118	mixed-methods research design.	Pre-service teachers
Leavy, A. M., & Hourigan, M. (2016).	Using lesson study to support knowledge development in initial teacher education: Insights from early number classrooms	58	mixed-methods research design.	PCK, pre-service teachers

Zelkowski, J., Gleason, J., Cox, D. C., & Bismarck, S. (2013).	Developing and Validating a Reliable TPACK Instrument for Secondary Mathematics Pre-service Teachers	47	mixed-methods research design.	TPACK, pre-service teachers
Kafyulilo, A., Fisser, P., Pieters, J., & Voogt, J. (2015).	ICT Use in Science and Mathematics Teacher Education in Tanzania: Developing Technological Pedagogical Content Knowledge	46	mixed-methods research design.	TPACK, pre-service teachers
Dockendorff, M., & Solar, H. (2018).	ICT integration in mathematics initial teacher training and its impact on visualisation: the case of GeoGebra	35	Case-study, mixed-methods	Technology integration into education, pre-service teachers
Finger, G., Jamieson-Proctor, R., Cavanagh, R., Albion, P., Grimbeek, P., Bond, T., ... & Lloyd, M. (2013).	Teaching Teachers for the Future (TTF) Project TPACK Survey: Summary of the key findings.	33	Quantitative survey	TPACK, pre-service teachers
Chai, C. S., Rahmawati, Y., & Jong, M. S. Y. (2020)	Indonesian Science, Mathematics, and Engineering Pre-service Teachers' Experiences in STEM-TPACK Design-Based Learning	30	mixed-methods research design.	TPACK, pre-service teachers

Chinnappan, M., & Forrester, T. (2014)	Generating procedural and conceptual knowledge of fractions by pre-service teachers.	27	mixed-methods research design.	Procedural knowledge, conceptual knowledge, pre-service teachers.
Thomson, M. M., DiFrancesca, D., Carrier, S., & Lee, C. (2017).	Teaching efficacy: Exploring relationships between mathematics and science self-efficacy beliefs, PCK and domain knowledge among pre-service teachers from the United States.	24	mixed-methods research design.	PCK, STEM, Domain specific efficacy
Leavy, A. (2015).	Looking at practice: revealing the knowledge demands of teaching data handling in the primary classroom.	23	mixed-methods research design.	Teacher knowledge, pre-service teachers
König, J., Doll, J., Buchholtz, N., Förster, S., Kaspar, K., Rühl, A. M., & Kaiser, G. (2017).	Pedagogical knowledge versus didactic knowledge? Structure of professional knowledge among prospective German, English and mathematics teachers during their studies.	22	mixed-methods research design.	Pedagogical knowledge and subject specific PCK.

Agyei, D. D., & Voogt, J. M. (2015).	Pre-service teachers' TPACK competencies for spreadsheet integration: insights from a mathematics-specific instructional technology course	22	mixed-methods research design.	TPACK, pre-service teachers
Norton, S. (2019)	The relationship between mathematical content knowledge and mathematical pedagogical content knowledge of pre-service primary teachers	20	mixed-methods research design.	MCK (mathematical content knowledge) and MPCK (mathematical pedagogical content knowledge)
Thomson, M. M., DiFrancesca, D., Carrier, S., & Lee, C. (2017).	Teaching efficacy: Exploring relationships between mathematics and science self-efficacy beliefs, PCK and domain knowledge among pre-service teachers from the United States.	24	mixed-methods research design.	PCK, Domain specific efficacy

Examination of the Concurrent Occurrence of Keywords

Additionally, leveraging bibliographic data collected, a co-occurrence map was devised to analyse the correlation among keywords for extraction. The selection of research keywords in the development of PCK in pre-service mathematics education delineates the focal points and trajectories of the concept, aiding in the organisation of pivotal themes within discussions on PCK development in pre-service mathematics education. These keyword clusters or categories will elucidate the diverse trends and

dimensions of PCK development in pre-service mathematics education within the specified timeframe. In this investigation, the default number of keywords extracted was set at 5. Thus, to be eligible for extraction, a keyword must exhibit at least five co-occurrences among indexed author and source keywords. The analysis unveiled 587 keywords across all 181 articles extracted. Among these, 22 keywords met the five co-occurrence threshold and were amalgamated into four clusters. Illustrated in Figure 3, the size of nodes denotes the frequency of keyword occurrence, indicating that larger nodes signify more frequent keyword occurrences. Furthermore, the lines depict their co-occurrence relationships, with thicker lines denoting stronger relationships.

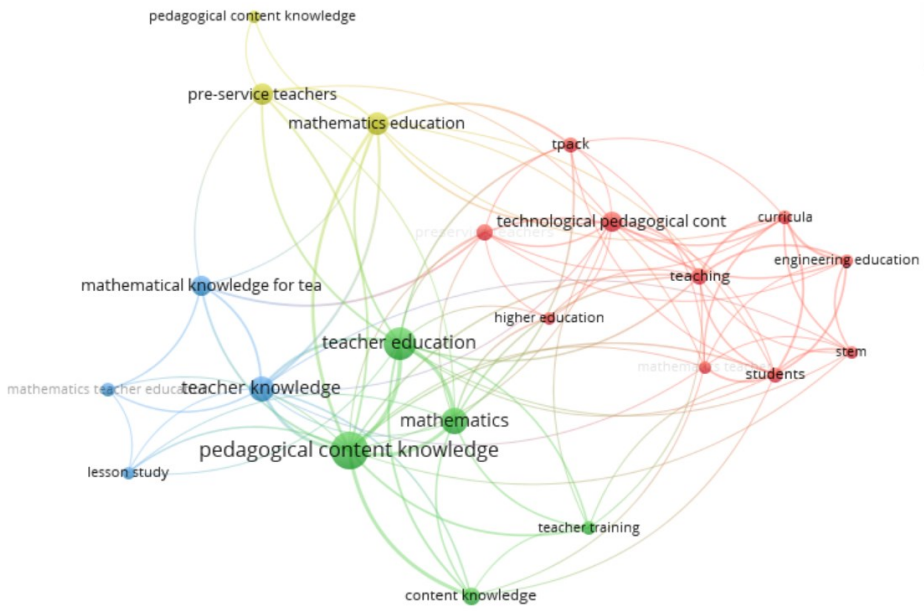

Figure 2: Network Visualisation Map for Co-occurring Keywords.

Cluster 1 – Technological Pedagogical Content Knowledge (TPACK): Represented by the highlighted segment on the map, this category comprises 10 co-occurring keywords centred around incorporating technology into pre-service teacher education. Essential terms strongly associated with the central keyword include TPACK, STEM, engineering education, teaching, pre-service teachers, curricula, and

higher education. Grounded in these terms, this category encompasses strategies for integrating technological pedagogical content, providing future educators with the necessary knowledge and skills to incorporate technology into their teaching methods seamlessly. A study conducted by Agyei and Voogt (2015) demonstrated that pre-service math teachers, after participating in a technology-focused course, improved their ability to integrate spreadsheets into teaching through hands-on practice and feedback. Chai, Rahmawati and Jong (2020) showcased how Indonesian STEM pre-service teachers collaboratively designed websites, enhancing their TPACK skills and effectiveness in integrating technology into science, math, and engineering education. Some studies recommend a TPACK framework, encompassing teacher pedagogical knowledge, teacher knowledge, PCK, and teacher content knowledge to evaluate pre-service teachers' capacity to teach Mathematics (Larkin et al., 2012). Zelkowski et al. (2013) developed and validated a survey tool generating 47 citations, focusing on TPACK (TPACK) assessment for pre-service secondary math teachers. This study contributes a validated tool for enhancing TPACK competencies in math education. Additional research (e.g. Finger et al., 2010; Zelkowskiet al, 2013; Dong et al., 2015) utilises surveys to assess pre-service teachers' perceptions of TPACK constructs. As noted earlier and supported by the bibliometric study by Su (2023), research on TPACK is predominantly concentrated in developed countries.

Cluster 2 – Pedagogical Content Knowledge (PCK): Represented by the green section on the map, this cluster comprises five co-occurring keywords focused on PCK development for mathematics pre-service teachers. Noteworthy keywords strongly associated with the primary term include content knowledge, mathematics, PCK, teacher education, and teacher training. Stemming from these keywords, this cluster encompasses terms related to PCK that have the potential to contribute to the development of pre-service mathematics teachers. Several studies, including the one conducted by Kul et al. (2019), explore the relationship between mathematical knowledge and the PCK necessary for teaching mathematics. The findings underscore the importance of educators being well-versed not only in content but also in pedagogical aspects. Research by Kleickmann et al. (2013) with 300 citations investigates teachers' subject matter knowledge (content knowledge and PCK) in

mathematics, examining its development across different teacher populations and phases of teacher education in Germany. The research reveals significant differences in CK and PCK, emphasising the impact of formal and non-formal learning opportunities during initial teacher education. The findings underscore the importance of addressing social inequalities in teacher competence, emphasising the need for improved teacher preparation and recruitment processes. The study acknowledges limitations, urging further research on the quality of learning opportunities and advocating for longitudinal studies to disentangle the effects of teacher education on PCK development. Research by Leavy and Hourigan (2016) examines a Lesson Study with 25 pre-service primary teachers, focusing on developing PCK during early number lessons. Lesson Study enhances mathematics PCK, especially in the knowledge of content and students (KCS) and knowledge of content and teaching (KCT) subdomains, fostering robust pedagogical understandings beyond the study context. It is noteworthy that the utilisation of lesson study as an effective method of data collection appears to be widespread in research endeavours centred on mathematical knowledge for teaching, particularly within Cluster 3.

Cluster 3, identified as teacher knowledge on the map, is represented by the blue area and comprises three keywords: mathematical knowledge for teaching, lesson study, and mathematics teacher education. A significant redefinition of teachers' PCK in mathematics education, as highlighted by Depaepe et al. (2013), has been accomplished through overarching constructs like Mathematical Knowledge for Teaching (MKT) or Content Knowledge for Teaching Mathematics (CKTM) developed by researchers Ball et al. (2008), Hill, Ball and Schilling (2008), and Hill, Rowan and Ball (2005).

MKT incorporates both CK and PCK, distinguishing it from Shulman's PCK in key aspects. Unlike Shulman's purely theoretical PCK, MKT emerged from refining and empirically validating PCK. In the MKT model, PCK and CK are integrated under the overarching category of MKT, with curriculum knowledge included as part of PCK components. MKT offers three merits: empirical grounding to PCK through research

on teachers' mathematical knowledge, operationalising Shulman's concept via the MKT-test, and providing evidence for a positive relation between teachers' PCK and student outcomes.

However, objections have been raised, expressing concerns about the theoretical delineations within the MKT framework, such as the correlation between Specialised Content Knowledge (SCK) and PCK. Additionally, factor analyses have raised doubts about the existence of discrete MKT categories. Despite ongoing discussions regarding PCK's definition, it maintains significance in educational inquiry, especially in the fields of science and mathematics (Ball et al., 2008; Kind, 2009; Schneider & Plasman, 2011; Graeber & Tirosh, 2008).

Cluster 4: The yellow area on the map signifies an emphasis on PCK in mathematics pre-service education (keywords: [pedagogical content knowledge], [pre-service education], [mathematics education])

Publication Year and Relevant Research Focus

Following the overlay visualisation network map illustrating co-occurring keywords is depicted in Figure 4. This analysis accounts for various publication years. Between 2018 and 2019, research emphasising PCK and teacher education predominated, represented by blue and purple clusters on the map, with a minimum of five occurrences. Key terms during this period include mathematical knowledge for teaching, teacher knowledge, pre-service teachers, and mathematics education. Conversely, starting in 2020, attention has shifted significantly toward TPACK and engineering education. The yellow cluster on the map signifies a focus on developing PCK in higher education. Recent efforts have directed PCK development for pre-service teachers towards technology, responding to the teaching and learning challenges post the COVID-19 pandemic. The transition towards PCK development in engineering education addresses concerns that engineering graduates lack real-world problem-solving skills and effective communication abilities (Griesel & Parker, 2009). This has prompted calls for reform, emphasising active learning, project-based learning, and bridging theory with practice. PCK is deemed essential for devising

effective teaching methodologies that tackle these issues, aiming to maximise educational value in classrooms.

Nonetheless, a shift in PCK development towards technological and engineering domains may impact research in developing countries. The extent to which these shifts can be leveraged for sustainable PCK development in such contexts remains uncertain. Therefore, these areas demand significant attention as the field of mathematics education faces mounting pressure to enhance its practices. As more studies on PCK emerge, there is hope that these concerns will be addressed.

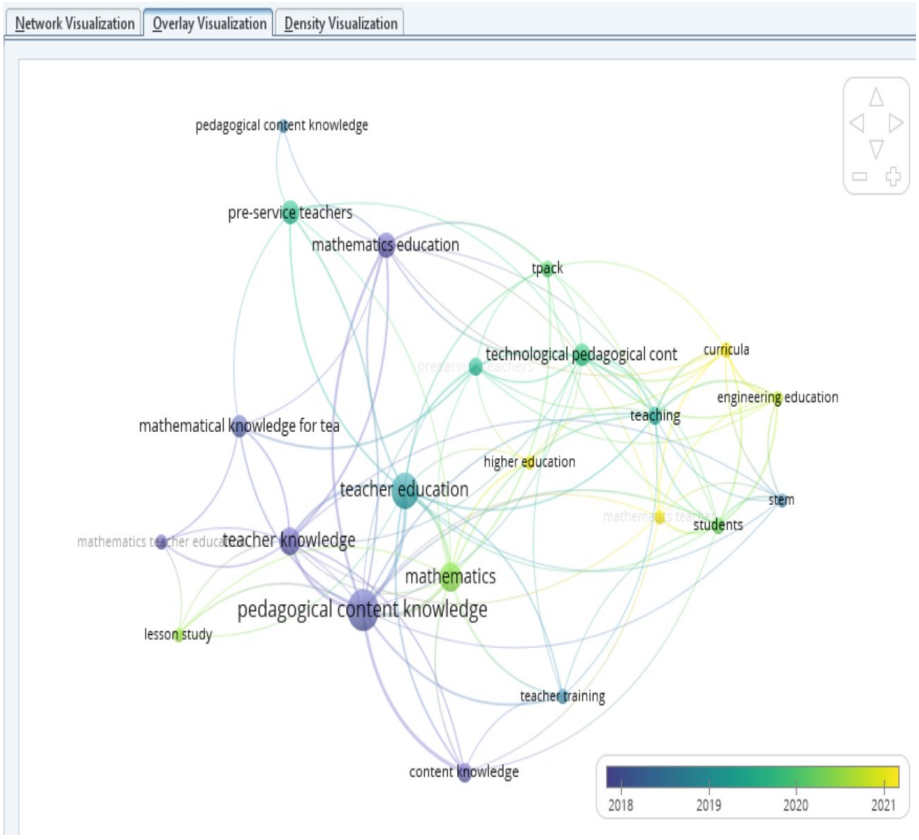

Figure 3: Visualisation map overlaying co-occurring keywords.

Conclusion

Historically, PCK in mathematics pre-service education studies emerged in the 1940s, driven by the imperative for academic programs to integrate subject matter expertise and effective pedagogy seamlessly. Discussions revolving around PCK and pre-service teacher education have gained momentum, recognising its pivotal role in shaping the next generation of educators. Consequently, researchers in higher education have increasingly delved into exploring the dynamic landscape of knowledge. Shulman's conceptualisation of PCK has undergone various inquiries aimed at enhancing outcomes for pre-service teachers, resulting in a surge of PCK studies.

Systematic reviews of existing PCK literature contribute to developing a contemporary understanding that propels the advancement of pre-service teachers' PCK development. Past studies have yielded diverse findings. Depaepe et al. (2013) deliberated on the varied conceptualisations of PCK and their impact on empirical investigations. Mecoli (2013) explored how prospective teachers acquire PCK through coursework. Despite the potential advantages of incorporating PCK into teacher education, persistent challenges exist, including inadequate subject matter knowledge among pre-service teachers (Schwartz & Lederman, 2002), the difficulty in identifying knowledge gaps (Davis, 2003), and insufficient preparation in TPACK (Angeli & Valanides, 2005; So & Kim, 2009). Wang, Schmidt-Crawford, and Jin (2018) reviewed studies exploring pre-service teachers' TPACK development through various research methods.

The primary aim of this study was to identify the status, research trends, and focal points in recent PCK development among mathematics pre-service teachers. This was achieved through bibliometric analysis, mapping key knowledge areas and co-occurring keywords within the past decade of PCK development studies indexed in the Scopus database. The selected timeframe aligns with the onset of the fourth industrial revolution in 2011, which instigated significant changes in PCK development, particularly in response to technological advancements. Findings indicate a consistent increase in studies on TPACK since 2019, reflecting a growing interest in PCK within technology education. Remarkably, 2022 witnessed the highest number of

publications in PCK development among mathematics pre-service teachers, partly attributed to the global attention garnered by the COVID-19 pandemic and the subsequent surge in online teaching and learning.

As the world embraces the technologies of the fourth industrial revolution, pre-service teachers and teacher educators must adapt to meet evolving demands. However, these developments are predominantly observed in developed countries, as evidenced by Su (2023). Notably, the USA and Germany have been influential in the discourse on PCK development among mathematics pre-service educators, evident in the volume of high-quality publications. Collaboration with scholars from leading countries is proposed as a means to elevate Africa's participation in the discussion, fostering the exchange of ideas, skills, and research techniques. Another avenue to bolster PCK development in Africa is through increased research efforts in engineering education, creating networking opportunities through conferences, workshops, and seminars. Furthermore, as mathematics education embraces the fourth industrial revolution, curricula should prioritise digital literacy to equip graduates with 4IR understanding.

A limitation of this study is its reliance on the Scopus database, requiring caution in generalising findings. Future research could broaden its scope by comparing findings across multiple databases to gain a comprehensive understanding of the discussion on PCK in mathematics pre-service education studies, thus mitigating potential discrepancies.

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THE ASSOCIATION OF ANXIETY, DEPRESSION AND SELF-ESTEEM WITH STUDENTS' NOMOPHOBIC BEHAVIOUR

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Abstract

As more people become increasingly dependent on their mobile phones, problematic behaviours such as anxiety and depression become more prevalent. These behaviours are categorized as nomophobia, which is especially prevalent among students. The aim of this study is to investigate the role of self-esteem, depression and anxiety on nomophobic behaviours among TVET college students. The study was conducted using a cross-sectional design, where data was collected from 202 students of the Technical and Vocation Education and Training College in Gauteng Province, South Africa, using a survey method and a structured questionnaire. SPSS was used to analyse the descriptive data and hypothesis testing was conducted using partial least squares (PLS) structural equation modelling (SEM). The SmartPLS analysis revealed a strong positive relationship between anxiety and depression (β =.54; p <.001). This result supports the notion that people suffering from anxiety often tend to avoid physical interactions, which is indicative of depression. The regression coefficient representing the relationship between anxiety and nomophobia (β = .474; p < .001) is statistically significant. In addition, the study revealed a significant relationship between self-esteem and anxiety (β =.62; p <.001). However, the relationships between depression and nomophobia (β =.146; p >.001) and between self-esteem and nomophobia (β =.07; p >.001) were not statistically significant. Overall, these findings align with prior research that established anxiety as the main driver of nomophobic behaviour. Contrary to common belief and the findings from previous studies, this research does not find depression and self-esteem as predictors of nomophobia. These results pave the way for future research.

Keywords*:* Nomphobia, Anxiety, Depression, Self-esteem, Psychological disorders

Introduction

As more people become increasingly dependent on their mobile phones, problematic behaviours such as nomophobia become more prevalent. These behaviours are caused by fear and anxiety, which fuel unhealthy mobile phone use and may impact the psychological health of individuals. Problematic or excessive mobile phone use occurs when an individual is incapable of controlling their usage of their mobile phone, which has adverse consequences in their everyday lives (Oviedo-Trespalacios et al., 2019). The problematic use of mobile phones contributes to nomophobia, a psychological disorder characterised by anxiety and fear.

According to Bhattacharya et al. (2019), nomophobia is a growing phenomenon in the digital age, and it refers to the fear of unbeing able to use one's mobile phone. Research shows that nomophobia impacts a person's social well-being, interactions, and psychological well-being. Others may suffer from anxiety, depression, social withdrawal, and low self-esteem if they are unable to use their phones (Mushtaque et al., 2022). For instance, Uysal, Özen and Madenoğlu (2016) confirm that some individuals feel anxious when their mobile phone battery runs low and become physically drained when they cannot access the phone, negatively impacting them. Studies show this phenomenon affects people of all ages but is prevalent among Technical and Vocational Education and Training (TVET) college students.

A handful of studies have shown that students are becoming more dependent on mobile phones. With the increasing use of mobile devices and their potential to impact mental health and well-being (Bhuvaneswari & Emiline Joy, 2021; Galhardo, 2022), higher education institutions face the challenge of responding to this trend by finding ways to manage this phenomenon. Therefore, the need for universities to implement policies and strategies to mitigate the negative effects of over-dependence on mobile devices is urgent.

Anxiety, depression and self-esteem have been reported to have a direct influence on nomophobia. Although studies of Aguilera-Manrique et al. (2018); Ayar et al. (2018)

and (Özdemir et al., 2018) have been conducted in various countries, including Turkey, India, and Pakistan amongst others with regard to nomophobia, the severe shortage of studies on nomophobia especially in South Africa TVET sector.

TVET colleges are critical in providing vocational training and education for students seeking employment or career advancement. Through TVET, students gain skills to prepare them for employment or further study. It is possible, however, that excessive mobile phone use may negatively affect students' academic performance at TVET colleges. Therefore, understanding the factors contributing to nomophobic behaviour among TVET college students is critical to developing effective interventions and promoting healthy mobile phone usage. Thus, this study aims to generate useful information and contribute valuable knowledge to the existing literature on nomophobia from two perspectives, namely, theoretical and practical perspectives.

By examining nomophobia from the perspective of one of the world's most promising developing countries, South Africa, where almost 95% of citizens own a mobile phone (GeoPoll, 2021) and spend an average of more than five hours a day on their phones (Exploding Topics, 2023), this study aims to provide a deeper understanding of the phenomenon. Lastly, it is expected that the results of this study will provide practitioners and higher education institutions with an understanding of the prevalence of nomophobia so that appropriate interventions can be devised.

Research Problem

Studies on nomophobia are often conducted elsewhere in the world. Studies, such as those undertaken by Aguilera-Manrique et al. (2018), Ayar et al. (2018), and Özdemir et al. (2018), have been carried out in several countries, including Turkey, India, and Pakistan. The authors of this study noted that there is a general lack of research examining the relationship between self-esteem, anxiety, depression, and nomophobic behaviour among students in South Africa, with the exception of the studies by Olasina and Kheswa (2021), Botha and Matwadia (2023), Hodes et al. (2022), Dietrich et al. (2021) and Olasina (2019a). In the literature searches, the

authors also found a study by Sarrimanolis (2023) that focused on the relationship between social media addiction and anxiety and depression. The authors were unable to find anything else on this topic in South African literature. This is somewhat concerning, considering that this phenomenon is becoming increasingly common in South Africa, particularly in higher educational institutions such as TVET colleges.

This study aims to gain a deeper understanding of nomophobia by analysing its impact on the educational sector of South Africa, a rapidly developing country where nearly 95% of the population owns a mobile phone (GeoPoll, 2021) and spends an average of over five hours per day using their phones (Exploding Topics, 2023). Lastly, it is expected that the results of this study will provide practitioners and higher education institutions with an understanding of the prevalence of nomophobia so that appropriate interventions can be devised and contribute valuable knowledge to the existing literature on nomophobia from two perspectives, namely, theoretical and practical.

Development of Hypotheses on Selected Factors Influencing Nomophobia in TVET Students

To investigate the selected factors thought to affect nomophobia in TVET students, this study draws on Bandura's Social Cognitive Theory (SCT) which will provide some support for the conceptual model and hypotheses. The development of hypotheses is further inspired by the literature that has identified several factors that influence nomophobia. SCT is a theoretical framework for analysing human motivation, thought, and action that suggests that cognition and other personal factors, and environmental influences all operate as interacting determinants that influence each other bidirectionally (Tsai, 2014). The theory suggests that a person's behaviour is partially shaped and controlled by the influences of social networks (i.e., social systems) and the person's cognition (e.g., expectations, beliefs) (Chiu, Hsu & Wang, 2006). It also assumes that the person is construing the situations differently and thus the same set of stimuli may provoke different responses from different people or from the same person at different times (Shu, Tu & Wang, 2011). The use of mobile phones is a precursor of nomophobia because it appears that people who use mobile phones

are not just using them for their functionality; they also treat them as a device to engage with other people via social networking sites and gaming to seek support, friendship and a sense of belongingness. The social cognitive theory thus helps explain why many people develop nomophobia.

Psychological behaviours such as anxiety, depression and self-control are associated with nomophobia. Identifying the factors influencing nomophobia can help identify strategies to manage and avoid the negative impact on a person's mental health, relationships and educational or occupational performance. In terms of anxiety, Farchakh et al., 2021) found out that people with anxiety tend to avoid physical interaction, opting to interact with others online, where they feel more comfortable. In general, anxiety is considered to be a negative emotional reaction that negatively affects someone's ability to perform a particular task (Gunasinghe & Nanayakkara, 2021). In this regard, Sweeney and Pine (2004) also posit that anxiety is an emotional state analogous to fear. The state of anxiety is characterised by the occurrence of fear-like symptoms that are out-of-proportion in terms of duration, degree of avoidance, or subjective distress with regard to the level of danger induced by the possible occurrence of the fear. Within the mobile phone context, anxiety refers to a person's anxious, uneasy, and uncomfortable feelings about using mobile devices (Huang, Jabor, Tang & Chang, 2022). Recent studies suggest that Anxiety is often one of the most common problems students face (Mushtaque et al., 2022). Some researchers empirically confirmed that anxiety is correlated with nomophobia. That is, people with high anxiety levels also had high levels of nomophobia (Uysal, Zen & Madenolu, 2016). Implicit in the foregoing definitions is how anxiety may influence nomophobia.

The research findings of Heriyani and Afrilia (2021) indicated that students feel anxious when they are losing the connectedness, when they cannot access their technology platforms and receive any notification on their mobile phones. Again, students become emotional, anxious and weep uncontrollably when they realise that their smart phone has been shifted to a strange place where one did not put it. According to Nelliyanil and Manjula (2020) regular mobile phone check causing

anxiety was discovered among college students with low self-esteem, and a high level of nomophobia. Students with low self-esteem and anxiety are more expected to show the nomophobic behaviour (Vagka et al., 2023).

In terms of depression, several studies have also indicated that depression may be a factor in the development of nomophobia. The use of mobile phones may create depression for a myriad of reasons. Depression may occur due to anxiety, nervousness, or anguish caused by not having contact with a mobile phone. The American Psychiatric Association (2000) explains that depression is a condition characterised by mood changes. Traditionally, the degree of depression experienced and the ways in which a person reacts to it can result in changes in appetite and weight, hypersomnia or insomnia, psychomotor agitation or retardation, loss of energy, feelings of worthlessness or guilt, decreased concentration, and thoughts of death or suicide. Hancock, Gee, Ciaccio and Lin (2008) believe that depression can be transmitted through technological interaction via a phenomenon known as "emotional contagion". While the term describes how one's mood can affect the mood of others who interact with that person (Hancock, Gee, Ciaccio & Lin, 2008), the term is also intended to describe the context in which the technology is being used. Mobile phones give users a sense of social presence by allowing them to share social information (e.g. social media, messaging), distract and relax them (music) and entertain them (e.g. games, movies) (Elhai, Levine, Dvorak & Hall, 2017). Information on emotional contagion is valuable to understanding depression, as people have a tendency to be affected by others' moods (Hancock, Gee, Ciaccio & Lin, 2008). This concept can be construed as depression. People who have a high level of social depression have a high level of uncontrollable feelings. Underlying the state of depression is the ability to deal with these feelings. Research shows that depression causes people to feel anxious and nervous. These feelings reflect a tendency towards nomophobia.

Past research has shown a relationship between nomophobia and depressive symptoms, while other studies have found no association. Many people spend

countless hours on their smartphones due to depression. de Wit et al. (2011) found that adults with major depressive disorder spend excessive amounts of leisure time on computers. As the level of depression increases, sufferers usually experience difficulty concentrating, feelings of worthlessness or excessive guilt, and recurrent thoughts of suicide or death (Santl, Brajkovic & Kopilaš, 2022). The greater the likelihood of mobile phone dependence, the more likely symptoms of depression will be one year later (Thomee, Harenstam, & Hagberg, 2011). It seems reasonable to suggest that individuals who suffer from high levels of depression are more likely to exhibit nomophobia (Tolan et al., 2021). It is possible that university students are exposed to depression related to mobile phone use. Therefore, in the context of students, nomophobia may be prevalent among students who are depressed and whose actions might be worsened by their depression (Yilmaz & Koçak, 2022).

In terms of self-esteem, research has provided some insights into the relationship between self-esteem and nomophobia. Self-esteem refers to a person's appraisal of his or her value (Leary & Baumeister, 2000). This appraisal has an influence on how they relate to the self-image and the ideal self-image (Silber & Tippett, 1965). The individual ability of self-appraisal significantly affects the level of perceived time spent on mobile phones. Studies have found that low levels of self-esteem increase the use of mobile phones and Increase nomophobia. For instance, Gezgin et al. (2018) found that individuals with low self-esteem are more likely to suffer from nomophobia. This is mainly because they find it difficult to build social relationships, depend more on technology, and are more likely to display nomophobia. Karaoglan Yilmaz, Yilmaz and Erdogdu (2022) supported this finding by reporting that people with low self-esteem find it challenging to interact socially and, as a result, rely more heavily on technology. Meanwhile, individuals with higher self-esteem will easily control their use. It appears that reducing nomophobia may increase self-esteem (Özdemir et al., 2018) and as a result establish a relationship between nomophobia and self-esteem.

Research has revealed that when one is unable to communicate with the smartphone which is a component of nomophobia displays various symptoms such as low self-

esteem, anxiety, panic disorder and stress etc. (King et al., 2017; Argumosa-Villar, 2017). As demonstrated in the preceding literature review section, technological advances may impact individuals' social well-being and psychological disorders. Self-esteem is therefore expected to be a significant predictor of nomophobia. Following a review of prior research, this study proposes:

HI: The presence of nomophobia among TVET students in South Africa is positively Associated with anxiety

H2: TVET students' anxiety is associated with depression

H3: There is a relationship between anxiety and self-esteem in TVET students

H4: TVET students are more likely to develop nomophobia when depressed

H5: TVET students with self-esteem problems are more likely to develop nomophobia

H6: Anxiety mediates the relationship between nomophobic behaviour and self-esteem among TVET students in South Africa

Method

Participants

Demographic information was also collected from each respondent regarding his/her gender and age. During this study, 202 students in a variety of TVET programmes participated. Of the 202 respondents, 59% were female and 41% male. In terms of age, most (24.8%) were 21 years old, followed by those who were 20 years old (15.3%). According to the results, 14.4%, 13.4%, 10.4%, 9.9%, 8.4% and 3.5% of the study participants were 23 years, 22 years, 19 years, and those older than 24 years, 24 years, and 18 years old, respectively. They were mainly in the first year of the study (59.4%), followed by those in the second year (20.3%). A relatively small number of students (1.5%) was enrolled in the fifth year of study, while 12.9% and 5.9% were enrolled in the third and fourth years of study, respectively.

Measuring Instrument

The questionnaire items were derived from previous studies. A five-point rating scale was used to measure the questions in the instrument, with responses ranging from "strongly disagree" (1) to "strongly agree" (5). The questions used to measure

nomophobia were adapted from Yildirim and Correia (2015). Self-esteem items were adapted from the Rosenberg Self-Esteem Scale. For measuring depression, items from the CES-D scale developed by Radloff (1977) were utilized. the study adapted the Hamilton Anxiety Rating Scale developed by Hamilton (1959) to measure anxiety. The items used in this study were modified to fit the study's context. There were several items on the survey that participants were asked to respond to, including anxiety (e.g., '*I am nervous when I cannot communicate with other people'*), depression (e.g., '*I talk less than usual'*) and self-esteem (e.g., '*I think I am no good at all when I don't communicate with my friends'*). Lastly, to assess nomophobia, four dimensions were used: not being able to communicate; losing connectedness; not being able to access information; and giving up convenience.

Procedure

As part of the cross-sectional study, a convenience sample of students of a TVET college located within the Gauteng Province of South Africa was surveyed by means of a questionnaire. The participants were contacted directly and received a cover letter explaining the study's objectives. The consent process informed participants that participation was voluntary, anonymous, and confidential. A total of 202 usable questionnaires were returned.

Ethical Considerations

Approval was obtained from a TVET college in the Gauteng province. Participants in the study were provided with a clear understanding of the purpose of the research and what they should do if they no longer wished to participate.

Data Analysis

This study employed structural equation modelling using SmartPLS version 4 to analyse the data. A two-step approach was used in the analysis. First, the reflective measurement model had to be tested for reliability, convergent and discriminant validity. A confirmatory factor analysis was conducted to determine the loadings of the indicators. The structural model was evaluated in the second phase and

hypotheses were tested. The demographic data of the sample and the Cronbach alphas of the variables studied were analysed as part of a descriptive statistical analysis using version 28 of the SPSS statistical software.

Results

Since the psychometric properties of the measure used in this study have not yet been investigated in the South African student population, confirmatory factor analysis was conducted as a first step.

Assessment of Reliability

The measurement model excluded constructs whose coefficients were less than 0.5 (Chin 2010). Therefore, the indicator loading ANX5 was excluded from the model. The exclusion of this variable from the model resulted in the following loadings:

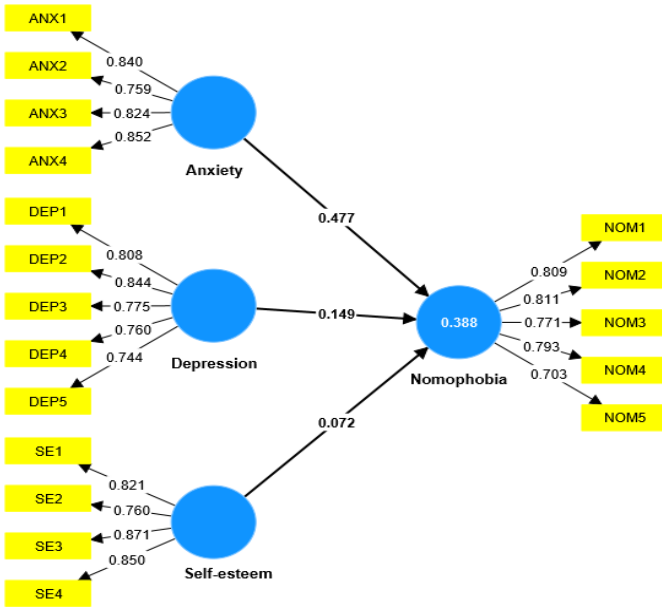

Figure 1: Confirmatory Factor Analysis

Figure 1 shows that all indicator values are above the minimum acceptable level of 0.5, and some are above the preferred level of 0.7 (Hulland, 1999). This confirms item reliability. Further reliability analysis was performed. This resulted in the calculation

of Cronbach's Alpha and composite reliability. The Table 1 displays the Cronbach Alpha coefficients and composite reliability coefficient.

Table 1: Results of Reliability Analysis

	Cronbach's Alpha	*Composite Reliability*
Anxiety	0.801	0.862
Depression	0.85	0.892
Nomophobia	0.826	0.87
Self-Esteem	0.845	0.895

Reliability analysis returned 0.801 for the anxiety scale, 0.85 for the depression scale, 0.826 for the nomophobia scale, and 0.845 for the self-esteem scale for confirming internal consistency reliability.

In addition to assessing internal consistency reliability, composite reliability (CR) was also assessed. It is recommended that the composite reliability be at least 0.7 (Bagozzi and Yi 1988). Based on the results of this study, the composite reliability for anxiety, depression, nosophobia and self-esteem was 0.862, 0.892, 0.87 and 0.895 respectively, indicating a high level of consistency within the constructs.

Evaluation of validity

Validity is assessed in two ways: convergent validity and discriminant validity. Convergent validity refers to the extent to which a construct can explain the variance of its items (Ringle, Sarstedt, Mitchell & Gudergan, 2020). Average variance extracted (AVE) is a metric used to assess the convergent validity of a construct (Sarstedt et al. 2021). Ideally, values should be above 0.50 (Bagozzi & Yi, 1988).

Convergent validity

Table 2 reports on the results of convergent validity

Table 2: Values of AVE

Construct	*AVE*
Anxiety	0.567
Depression	0.622
Nomophobia	0.528
Self-Esteem	0.683

As depicted in the table, anxiety, depression, nomophobia and self-esteem all had AVEs above the minimum score of 0.50. Consequently, the measures of the reflective constructs show convergent validity.

Discriminant validity

Discriminant validity refers to the extent to which a construct is empirically distinguishable from other constructs in the structural model (John & Reve, 1982). It is based on Fornell and Larcker's (1981) metric. This requires that the square root of the average variance extracted (AVE) for each latent variable is greater than its correlations. Finally, the discriminant validity of this study is assessed by measuring the heterotrait–monotrait (HTMT) values. The HTMT refers to the mean value of item correlations between constructs relative to the (geometric) mean of the average correlations for items measuring the same construct (Hair et al., 2019). A high HTMT value leads to problems with discriminant validity (Hair et al., 2021). Henseler, Ringle and Sarstedt (2014) suggested that values greater than 0.90 might indicate a lack of discriminant validity.

Based on Table 3, it is evident that discriminant validity was met for this study.

Table 3: Fornell and Larcker Discriminant Validity Analysis

	Anxiety	*Depression*	*Nomophobia*	*Self-Esteem*
Anxiety	0.753			
Depression	0.532	0.789		
Nomophobia	0.665	0.603	0.727	
Self-Esteem	0.615	0.728	0.689	0.826

The square root analysis of AVE resulted in values of 0.753, 0.789, 0.727 and 0.826 for anxiety, depression, nomophobia and self-esteem, respectively. These values are far greater than the correlations of the latent factors satisfying the requirements of Fornell and Larcker (1981).

The discriminant validity was further examined through the calculation of the HTMT values. The results of the HTMT computation are presented in Table 4 below.

Table 4 : Heterotrait–monotrait7 Discriminant Validity Analysis

	Anxiety	*Depression*	*Nomophobia*
Anxiety			
Depression	0.61		
Nomophobia	0.752	0.638	
Self-Esteem	0.731	0.847	0.725

Structural Model Analysis

In addition to examining the measurement model, it is equally important to examine the structural model. Before structural relationships can be evaluated, the assessment of the model's predictive accuracy is crucial. Predictive accuracy is assessed using R2 and Q2 values. Q2 values should generally be greater than zero, while Q2 values above 0, 0.25 and 0.50 indicate the model's small, medium and large predictive potential, respectively (Geisser, 1974; Stone, 1974). Regarding the R2, although several constructs are of interest in this study, nomophobia is the primary construct. Based on the results, the overall R2 was 58%, suggesting that anxiety, depression and self-esteem together can explain 58% of the variance in the endogenous construct

nomophobia. As for the Q2 value in this study, the Q2 value of 0.538 indicates a value greater than zero, demonstrating the high predictive accuracy of the PLS path model. Having demonstrated the explanatory and predictive power of the model, the next step is determining the statistical significance and relevance of the path coefficients.

Hypothesis testing

According to Hair et al. (2014), it is recommended that bootstrapping with 5,000 samples be performed to evaluate the structural model. A structural analysis was carried out according to the hypothetical relationships. The results of the analysis are presented in Table 5 below.

Direct Effect Analysis

Table 5: Results of Direct Effects Analysis

	Original Sample (0)	*Sample Mean*	*Standard Deviation*	*T Statistics*	*P values*
Anxiety->Depression	0.54	0.546	0.048	11.0326	0
Anxiety->Nomophobia	0.474	0.475	0.088	5.388	0
Anxiety->Self-Esteem	0.62	0.622	0.049	12.657	0
Depression->Nomophobia	0.146	0.15	0.087	1.674	0.094
Self-Esteem->Nomophobia	0.07	0.068	0.098	0.718	0.473

In this study, anxiety significantly and positively influences depression (β = .54; p <.001). The direct path coefficient from anxiety to depression (β = .474; p <.001) is significant. In addition, the study found that self-esteem and anxiety were positively related (β = .62; p <.001). Based on these results, hypotheses 1, 2 and 3 were supported. This was not the case despite the expectation that hypotheses 4 and 5 would be supported. Therefore, the data from this study do not support a relationship between depression and nomophobia (β = .146; p >.001). Furthermore, no direct

relationship between self-esteem and nomophobia (β = .07; p >.001) was found in this study. In addition to testing direct effects, this study also estimated the mediating role of anxiety using 5,000 bootstrap samples.

Indirect Relations

Anxiety was used to check the indirect relationship. The results are displayed in Table 6.

Table 6: Anxiety as a Mediator

	Original Sample (0)	*Sample Mean (M)*	*Standard Deviation*	*T Statistics*	*P Values*
Anxiety->Nomophobia	0.123	0.125	0.053	2.318	0.02

Based on the present study, anxiety significantly mediates the relationship between self-esteem and nomophobia.

Table 7: Summary of Hypotheses Testing

Hypotheses	*T Statistics*	*P Values*	*Impact*	Hypothesis Results
Anxiety->Depression	11.326	0.000	Positive	Supported
Anxiety->Nomophobia	5.388	0.000	Positive	Supported
Anxiety->Self-Esteem	12.657	0.000	Positive	Supported
Depression->Nomophobia	1.674	0.094	Positive	Rejected
Self-Esteem->Nomophobia	0.718	0.473	Positive	Rejected

Discussion

While nomophobia remains an understudied construct in South Africa, the concept is broadly accepted in literature from varied disciplines. Building on gaps in the literature, this study set out to empirically investigate the effects of anxiety, depression and self-esteem on nomophobia. The results of the study show that anxiety influences nomophobia. These results are in line with the study of Farchakh et al. (2021), who reported a relationship between anxiety and nomophobia.

There is a possibility that students suffering from nomophobia may experience worrying thoughts and even physiological symptoms such as headaches, nausea, sweating or insomnia when they are away from their mobile phones. The study makes the claim that communication is a proximal risk factor. Possibly, this is because communication is likely to play an important role in preventing anxiety-related disorders. Evidence suggests that technological advances are contributing to a decline in communication within families, leading to anxiety disorders and other mental health problems in the population (Robb et al., 2020). Educators and families must not ignore the significance of effective communication in reducing the incidence of mental illness.

Contrary to common belief and the findings from previous studies, this research does not find depression and self-esteem to have a significant relationship with nomophobia. Although the results of this study diverge from those of previous studies (Karaoglan Yilmaz et al., 2022; Yilmaz & Bekarolu, 2022), there is no cause for concern. Previous studies have shown that people who use their phones constantly and compulsively do not necessarily suffer from nomophobia, but some may do so for reasons such as searching for information on the internet (Jiang & Zhao, 2016). In this regard, perhaps there is a need to consider information search as a potential cause. Therefore, this study contends that time spent searching for information on the internet is one of the factors likely to lead to nomophobia. In this study, self-esteem, anxiety and depression explained only 58% of the variance in nomophobia. Educators

and researchers should consider the results of this study when examining nomophobia in the future to gain a better understanding of the other factors that may contribute. The need to identify other contributing factors to nomophobia is therefore urgent.

The findings of the current study report that anxiety significantly partially mediates the relationship between self-esteem and nomophobia. This means that people with higher anxiety levels are likely to be nomophobic (Uysal et al., 2016). It follows that people with low self-esteem are more likely to be anxious, which may increase the likelihood of becoming nomophobic (Nasab, Manshaee & Nadi, 2021). The findings of this study will be helpful to the TVET college in which the study was conducted as it will enable them to understand better why anxiety has been identified as one of the important factors contributing to nomophobia among students. They will be able to observe these students closely from an intervention perspective to identify any health-related problems.

Conclusion

The literature examined in this study revealed that nomophobia has become one of the most pervasive problematic behaviours in today's world. Additionally, the literature demonstrated that anxiety plays a fundamental role in the perpetuation of nomophobic behaviours. This study set out to explore the intricate relationships between anxiety, depression, self-esteem, and nomophobia among students in vocational education and training (TVET). Given the findings of this study, it is possible to draw the conclusion that anxiety is the root cause of nomophobia in South Africa, just as it is in other countries throughout the world. This has implications for finding interventions aimed at reducing anxiety levels among students and can be leveraged to mitigate problematic psychological and health issues.

Limitations and Future Research

There are a few considerations to note in the current study. Firstly, the participants were from a single technical and vocational education and training college, and they

were based in only one province, namely Gauteng. It would be beneficial to conduct future studies with a broader range of samples and incorporate more sampling locations to substantiate the findings. Secondly, even though self-esteem, anxiety and depression explained only 58% of the variance in nomophobia, the findings in this study point to a need to add other variables that may explain this variation. Lastly, in South Africa, a future examination of this phenomenon would be valuable to fully grasp its prevalence in the nation and understand its nature. Therefore, it is worthwhile to call on South African researchers to study this phenomenon in more detail in the future.

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