


Technological literacy and its influence on teachers' adoption of a blended learning approach



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Background: The teachers in one sub-district in the North West province lacked technological knowledge and skills thus did not adopt a blended learning approach in their daily teaching. A partnership between the University of South Africa (Unisa) and schools in the district was forged to train teachers to acquire technological knowledge and skills.

Objectives: To identify which online tools Unisa imparted to teachers, investigate how the acquired skills and knowledge helped teachers to adopt a blended learning approach and find out challenges that go with the application of technology.

Method: Data were obtained through observation, one-on-one individual interviews and focus group discussions.

Results: The Unisa training helped develop teachers' knowledge and skills in the use of TEAMS, Emails, WhatsApp, you tube and the electronic content- material. Teachers gave learners the electronic content (presentation slides and You-videos, question banks) for revision purposes. During the outbreak of coronavirus disease 2019 (COVID-19) learners were given work to do while at home using WhatsApp.

Conclusion: The article concludes by indicating that partnerships between schools and institutions of higher learning are a necessity to empower teachers on the use of technology which will lead to the use of a blended learning approach.

Contribution: The article adds to the body of knowledge by indicating the need for retraining of teachers especially on technological skills to prepare them for 4th Industrial Revolution and meet the needs of the new cohort of learners-born after technology.

Keywords: blended learning; online literacy; partnership; professional development; project; teachers; teaching; technology.

Introduction

A blended learning approach is practised less in South African schools than in most developed countries such as the United Kingdom and Bulgaria (Barbour et al. 2011; Ersin, Atay & Mede 2020; Fedynich 2013). The study reported on in this article, focused on how a collaborative partnership between the University of South Africa (Unisa) and the Department of Education (DoE) led to teacher empowerment in respect of basic technological skills, which enabled teachers to adopt of a blended learning approach that became more useful during the outbreak of the coronavirus disease 2019 (COVID-19) pandemic. The forged partnership came in the form of a community engagement project initiated by the university team to bridge Life sciences teachers' knowledge and skills gaps. The impact of the university's professional development especially on technological literacy became more visible during the lock down period, the time during which these teachers were able to use the acquired technological literacy skills to engage with learners. The ability to adopt a blended approach relies on teachers' proficiency in using the technological skills, and the existing literature affirms that in the South African context teachers lack such skills (Hlatshwayo 2022; Nkademeng 2022; Shava 2022). Even though South Africa did not do much to embrace the third technological revolution (Hlatshwayo 2022) there is evidence that during the outbreak of the COVID-19 pandemic, the use of technology benefitted mostly the institutions of higher learning (Shava 2022) with little or no use in government schools (Adov & Maeots 2021; Winter et al. 2021). Given the level of teachers' technological literacy in the South African schools, where most teachers did not get training on how to use the technological tools (Ankiewicz 2020), the study investigated how the university team's intervention ameliorated the situation. The study will provide the background to assess the feasibility of the DoE's recent

Note: Special Collection: Rethinking literacy and pedagogic agency in the 4IR.

initiative to provide every school child in South Africa with digital workbooks and textbooks on a tablet device (Ramaphosa 2019).

A preponderance of literature exists which sheds light on teachers' experiences in a technology-mediated teaching context during the COVID-19 pandemic and a lot of challenges were reported (Adov & Maeots 2021; Marpa 2021; Winter et al. 2021) the lack of technological expertise (Shava 2022) being one of them. In his Doctoral Thesis Nkadameng (2022) proposed Blended Learning Model to help teachers adopt blended learning approach in schools. Literature confirmed that technological literacy and the application of the blended learning can heighten learner interest, enjoyment, and motivation (Batumalai & Maat 2020; Blau, Shamir-Inbal & Avdiel 2020; Chang, Chen & Chiang 2019; Collins & Halverson 2018). In addition, the research conducted by Silva, Kawai and De Villiers (2023) indicated how the adoption of a blended learning approach could reduce time and costs during curriculum implementation.

Limited research has been done on how partnerships between educational entities can promote technological literacy. The present study seeks to address that gap in the body of literature, by investigating how a partnership between Unisa and the DoE helped to impart technological literacy skills which enabled Life Sciences teachers to adopt a blended learning approach to teaching and learning at their respective schools. The study aims to help academics and government officials recognise the importance of teacher in-service training on the use of technological skills to improve scholastic performance and prepare schools for unforeseen circumstances. This study responds to the call for research which seeks to bring about a shift from traditional modes of teaching and learning to the use of digital learning platforms to supplement face-to-face engagement (Department of Basic Education [DBE] 2018; UNESCO 2011; World Bank 2020). The findings of this undertaking will enable e-learning platform providers to recognise the value and effectiveness of a blended learning approach and will identify the type of technological skills that can have an impact on its use.

The research question formulated for the study, was: How did teachers' empowerment in technological literacy skills assist them with the adoption of a blended learning approach?

The sub-questions for this study, were:

- Which online tools did Unisa use to develop teachers' confidence in adopting a blended learning approach?
- How did the acquisition of online skills help teachers to supplement their traditional teaching methodologies with online teaching?
- What challenges did teachers face in adopting a blended learning approach, and which strategies were used to mitigate them?

Literature review

Technological literacy for the professional development of in-service teachers

Learning how to use digital technology has become a vital steppingstone to being 'literate' in the 21st century (Goodwin-Jones 2000; Isaacs 2020). This is due to global demands, and new cohorts of learners who have made the teaching fraternity realise the inefficiency of the current traditional teaching methodology. The terms 'electronic literacy', 'technological literacy' and 'digital literacy' are used interchangeably, with definitions ranging from the acquisition and use of various technological tools for quality teaching (Blau & Shamir-Inbal 2017), to the development of basic skills in core personal computer (PC) and internet applications (Goodwin-Jones 2000), as well as expectations of what people can do on their computers or the local network or the internet, etc. Butler, Hallissy and Hurley (2018) have seen technology Literacy as a requirement that would enable students to use ICT to learn more efficiently. Initiatives to provide Digital Learning Framework for Schools (UNESCO 2011) aimed at encouraging the use of technology by teachers within their practices.

The study embraces the digital learning framework (DBE 2018), by unpacking the role of Unisa's technological skills development project in influencing Life Sciences teachers to acquire skills in implementing blended learning. South Africa as a country has faced the long-standing challenge of producing competent teachers who are able to offer online teaching and quality instruction (Hofmeyr & Draper 2015). The above assertion is confirmed by the World Bank (2020) report indicating South Africa's poor access towards technology. Prior to this report, debates have been going on for an example the 2018 ANC conference regarding South Africa's lack of ICT infrastructure (Hlatshwayo 2022). To try and improve technological literacy in the South African schools, in-service training in the form of professional development is deemed an important means of helping in-service teachers to integrate technology in their daily engagement with learners (Nkadameng 2022). To this effect the (DBE 2018) developed the Professional Development Framework for Digital Learning to support teachers with integration of digital tools and resources. Several professional developments of teachers failed because they were not informed by an understanding of what knowledge teachers require (Bertram 2011). A preponderance of literature regards effective professional development as an informed coaching where there is a collaborative relationship between a coach and a trainee that culminates with a pedagogical performance (Bastian & Marks 2017; Ehsanipour & Zaccarelli 2017; Mitchell et al. 2021). Professional development aimed at enhancing a deeper learning of online skills will be enhanced only if teachers are provided with the time, support, and space (Ehsanipour & Zaccarelli 2017).

However, a wide range of studies have pinpointed the unavailability of resources and inadequate school

infrastructure as factors which hamper teachers' efforts to implement technology (Glazer, Hannafin & Song 2005; Grant et al. 2015; Staples, Pugach & Himes 2005).

Partnership collaborations for teacher empowerment

Bozeman and Boardman (2014) define collaboration as a social process whereby people pool their human capital, with the objective of producing knowledge. Inter-organisational collaboration is an important practice in any workplace, as it facilitates working as a team (De Dreu & Van Vianen 2001) to solve complex problems. For example, collaborations represent a means for governments to cope with resource scarcity, by enabling them to engage private organisations for that purpose (Brinkerhoff 2002; Bovaird 2004; Mitchell 2014). In this study, Bardach's (1999) definition of collaboration is used: it is described as a joint activity, by two or more collaborating agencies, with a view to increasing their public value by working together, rather than separately. In the South African context, the South African Council of Educators (SACE) propagated for an externally initiated partnership as one of the envisaged Action Plan for the Achievement of the Framework Outcomes (DBE 2018:18). The study focuses on a collaborative partnership between Unisa and government schools, where the university offered supplementary training on technological skills for teachers who were already in service (Dhakal 2016), to help them deal with changes to the curriculum and teaching methodologies. This, because many teachers lack the knowledge and skills necessary to deal with the new approaches and requisite content (Desimone 2011).

Research conducted by Towe et al. (2016) indicated the importance of government policies that promote cross-sector collaboration, in attaining long-term benefits. A cross sector collaboration that existed between a university and a local high school enhanced digital literacy skill to 9–12th graders (Truesdell & Birch 2019). Through the use of a direct observation of teaching by experts, or online videos of lessons taught by expert teachers (Bausmith & Barry 2011) teachers and learners can acquire technological skills.

Adoption of a blended learning approach to improve the teaching and learning encounter

Blended learning is defined as learning that combines two modes of instruction: online and face-to-face (Barbour et al. 2011; Hrastinski 2019). Rahman, Hussein and Aluwi (2015) define blended learning as delivering content on both a face-to-face environment as well as using technology like video recordings, live sessions via video conferencing technology etc. For the sake of this study, the definition by Rahman et al. (2015) will be used, as the study addresses teachers' views on how Unisa's technological literacy training enabled them to employ a variety of online teaching mechanisms to supplement traditional teaching methodologies. Bektashi (2018) describes the integration of technology to supplement traditional teaching as a wise

move, because it enhances three presences in the community of inquiry, namely the social, cognitive and teaching presences. Baturalai and Maat (2020) identify several information and communication technologies (ICT) and resources that helped learners to better understand the subject of Mathematics, by using computer software, videos, tablets, cell phones, emails and virtual learning via online platforms. The use of the above ICTs has caught the attention of many researchers who have identified a number of advantages in using such tools, including that the teacher and learner do not need to be in the same location, they are cost-effective because no travelling is involved, and they constitute faster ways of disseminating information (Baturalai & Maat 2020; Ersin et al. 2020; Fedynich 2013; Kastner 2019; Kim 2020). Currently, with teachers and learners alike suffering low morale due to the COVID-19 pandemic, adopting a blended learning approach is a convenient teaching approach, because it captures learners' attention – even of those who are passive in the traditional classroom (Fedynich 2013; Kastner 2019).

A study of the literature revealed many of the challenges facing schools as they work to adopt a blended learning approach to teaching and learning. A lack of technological skills on the part of teachers and learners has prevented the integration of technology in the educational milieu (Ankiewicz 2020; Usher 2020). In an effort to resolve this hindrance, literature suggests that training in online skills should start with teachers at training colleges, prior to technology education being introduced in schools (Adov & Maeots 2021; Barbour et al. 2011; Winter et al. 2021). Another challenge is the lack of access to the internet and data, especially among poor communities. The training and use of technology is beset with challenges one of them being that the fact that many African governments are reluctant to promote a blended learning approach, given the concomitant financial implications (Adov & Maeots 2021; Marpa 2021; Winter et al. 2021). In the South African context, literature affirms that teachers have access to mobile technologies, but they are not trained sufficiently to integrate technologies in their teaching of subjects (Isaacs 2020).

Mentoring by institutions of higher learning is indispensable, because such entities can supplement schools' lack of resources and facilities, and by providing teacher training in online skills, the formal education sector can adopt a blended learning approach to teaching and learning which will enable them to continue its work, even at a distance (Ersin et al. 2020).

Theoretical framework

The study focuses on the acquisition of technological skills to improve the teaching and learning encounter in schools. It is underpinned by Fullan's (2007) change theory as a force for scholastic improvement. According to Fullan (2007), change theory is an action theory which aims to achieve a desired goal, namely, to identify weak elements in an approach,

before working to improve it by using seven core premises which underpin the use of change knowledge (Fullan 2007:11). The seven-core premises are:

1. A focus on motivation
2. Capacity building, with a focus on results
3. Learning in context
4. Changing the context
5. A bias for reflective action
6. Tri-level engagement
7. Persistence and flexibility in staying the course.

According to Fullan (2007), for an individual or a group to change, motivation is what drives someone to put in the effort needed to achieve the desired outcome or result. Even if it takes time and involves both ups and downs in the process of effecting change, motivation is key to the process. Once that first step has been accomplished, the remaining six premises will be more easily achievable. One of the actions aimed at enhancing motivation in adopting a certain teaching and learning technique, is to encourage collaboration among learners through the creation of an environment where they and their peers, or they and their educators, can collaborate using e-mail or group discussions (Hoic-Bozic, Mornar & Boticki 2009). The second step in bringing about a change in action requires individuals (or a collective) to be granted access to the knowledge and resources needed to develop new capacities – what Fullan (2007) refers to as capacity building. Garrison (2018a) proposes the acquisition of technological skills as a capacity-building exercise that will change a passive lecture to one that requires thinking and collaborative learning. For example, if a change of action needed to adopt a blended learning approach in teaching and learning, teachers need to be empowered in using technology-based skills. That will become possible when resources such as computers and Wi-Fi or data are made available. As Elmore (2004) advises, no external accountability scheme can be successful in the absence of internal accountability – the latter is merely capacity building, with a focus on results.

Third, reforms aimed at embracing change must build in several opportunities for 'learning in context', which involves engaging in lifelong and sustained learning about people's practice in their work settings and changing the prevailing culture of administration and teaching in schools. The process of cultural change depends fundamentally on a modelling of the new values and behaviours which should replace or displace existing ones (Fullan 2007:11). In this way, learning in context changes the very context itself. An example is the shaping of educational policy needs, to meet the intended objective (Bereiter & Scardamalia 2005).

Fourth, according to Fullan (2007), theories of action must also have the capacity to change the larger context, which refers to lateral capacity building in which schools and districts learn from one another. Collaboration among principals and teachers, and with their colleagues at neighbouring schools, will bring about change on a large scale.

Fifth, bias for reflective action is another premise which involves striving to produce outcomes of a quality, that will have an impact on learning. Purposeful thinking is what counts, not the mere doing. Reflective action can be achieved through one of the presences outlined in Garrison, Anderson and Archer's (2000) theory of a community of inquiry, where cognitive presence refers to the extent to which individuals construct and confirm meaning through sustained reflection and discourse. The theory consists of four phases, namely the triggering event, exploration, integration and resolution (Akyol, Garrison & Ozden 2009). The curriculum implementation challenges triggered teachers' willingness to explore ways of integrating traditional methodologies with online teaching.

Sixth, Fullan (2007) proposes that tri-level engagement is essential for reforming a system such as the school/community, district or state. The goal should be to pursue strategies that promote mutual interaction and influence within and across all three levels.

Lastly, persistence and flexibility in staying the course is a reminder that rigid persistence can elicit pushback in equal or greater measure. Failure to keep going in the face of inevitable barriers means that very little will get done in the end.

The theory is relevant to this article, because it involves a change in the culture of teaching and learning, by encouraging teachers to acquire technological skills to improve performance in schools.

Research methods and design

Research context and participants

The Department of Adult Basic Education and Youth Development focuses on adult learning (as espoused by Malcolm Knowles) at the Unisa. The department develops projects as outreach programmes which aim to empower teacher communities in terms of both content and skills. To that end, Unisa initiated a partnership with the DoE, aimed at the professional development of in-service Life Sciences teachers. One of the skills developed as part of this project, is technological literacy.

This research study received ethical clearance from the College of Education's Ethics Committee at Unisa, for all components of the evaluation. Permission to conduct research at the research sites was sought from the DoE before the project commenced, and the volunteer Life Sciences teachers who participated in the study, whose anonymity was guaranteed, were purposefully selected. The population of the study was teachers in a sub-district of one province whose learners and teachers did not receive tablets. The sample consisted of 20 Life Science teachers, plus a circuit manager and a coordinator ($n = 22$). Sixteen of the teachers hold only a diploma qualification and their age range between 45 years and 58 years. The other four's age ranges

from 28 years and 32 years and they all hold a bachelor's degree in education. After the purpose of the study had been explained to the participants, they were requested to sign consent forms and were informed of their right to opt out of the study at any time, without fear of penalty.

Research design and procedures

The study followed a qualitative research design, and a case study became an option because the researcher wanted to gain a comprehensive and deep knowledge within a group of Life Sciences teachers from schools in a specific area. Observation, one-on-one interviews, as well as focus group discussions were used to collect data for this study. First, a focus group was sampled for a general impression of how teachers regard the impact of technological literacy on their teaching. To bridge the information gap, individual interviews were held with the participants. Observation was used afterwards, to study their implementation of the skills acquired during the training. These data-collection tools revealed data pertaining to the online tools which Unisa used to strengthen teachers' technological literacy, the extent to which technological literacy led to the adoption of a blended learning approach to teaching and learning, and the challenges teachers experienced when using online tools.

The technological training approach

Training on how to use online tools took place during the lockdown period, when schools were closed and then again once they had reopened. Prior to the lockdown the partnership in question had already been established, and the school principals were already informed of the upcoming workshop through one principal who served as the coordinator. Prior to the lockdown, the participating teachers took part in an orientation programme on how to connect and attend meetings via Teams. While the schools were closed, Unisa offered participants data to enable them to participate in the training. Lessons were offered daily during 1 week of the lockdown, and after the reopening of schools, training took place twice a week for 3 weeks. The Unisa team spent an additional 2 days visiting schools and observing whether teachers were adopting a blended learning approach.

During the lessons, teachers were taught technological skills. They were also encouraged to activate email accounts and were trained on how to receive, write and send emails. Links for workshops and electronic Life Sciences material were sent via emails.

Research instruments

As indicated above, the data for the study were obtained through observation (20 participants) one-on-one individual interviews (with 10 participants) and focus group discussions (with ten participants). The participants' responses were tape-recorded, transcribed, and coded. The interview guide featured questions that focused on the types of technological

TABLE 1: Information gathered during observation of the use of technological tools.

Observed areas	Teacher responses after training		
	Training 1	Training 2	Training 3
Teachers who always replied to the emails sent by the researcher	2	4	16
Teachers who acknowledged receipt of e-content material	2	8	16
Teachers who acknowledged receipt of YouTube videos	2	9	16
Teachers who acknowledged receipt of question banks	2	9	16
Life Sciences e-learning material content sent to learners	0	2	8
YouTube videos sent to learners	0	6	20
Question banks sent to learners	0	6	20
Teachers who used overhead projectors	2	4	4
Teachers who assess learners using WhatsApp	0	8	16
Evidence of learners who sought clarity	0	2	4
Evidence of e-content material sent to colleagues within the subdistrict and other districts in the province	0	4	14

literacy skills acquired and used, as well as the challenges associated with the adoption of a blended learning approach. An observational tool (Table 1) to check whether or not the online tools were being used, was also developed.

Data analysis

The data from the one-on-one individual interviews as well as focus group interviews were analysed thematically using Saldaña (2016) method. Transcripts were developed, and notes from both sources of data were then used to present the findings. Three themes emerged from the data namely, tools used by Unisa to develop teachers' confidence in adopting a blended learning approach, How the online training helped teachers to adopt a blended learning approach and challenges faced by teachers in adopting a blended learning approach.

Ethical considerations

Ethical clearance to conduct this study was obtained from the University of South Africa, UNISA College of Education Ethics Review Committee (No 2018/06/13/90268571/03/MC.).

Results

Communication using emails

After the first training, only two teachers who had basic computer skills were able to communicate using email; the majority still needed to gain confidence in using a computer. Some participants still battled to activate their email accounts. Communication via email improved after further training. Even after the third training component, some teachers reported never communicating via emails.

Communication with learners, using WhatsApp

A week after the first training, no participant had used WhatsApp to communicate with a colleague or a learner, the reason being that some did not have the app or were in the process of activating it. Another challenge was creating a

group with the learners, some of whom had no smartphones, and had to ask permission to use a family member's phone. Communication among the teachers was evident, with some sharing best practices. After the second and third training sessions, the teachers started using the WhatsApp platform, as groups had been formed by then.

Individual and focus groups interview responses

Online tools used by Unisa to develop teachers' confidence in adopting a blended learning approach

The findings of this study indicated that Unisa provided training for teachers in the use of online tools, which helped the latter to supplement their traditional methods of teaching with online teaching. As Participant E remarked:

'The technological skills that Unisa equipped me with has built confidence in me, because I now know how to use online tools and platforms. I enjoyed the training on how to use a data projector and started developing [an] interest to use it at my school. I have realised that there are students who prefer this mode of teaching, even those who are problematic became so attentive.' (Participant E, 52 years old, 30 years teaching experience)

It appeared from this response that the long-standing partnership between schools and Unisa fostered collaboration, which led to the creation of a community of inquiry whereby Unisa shared knowledge and skills aimed at mitigating teachers' challenges in adopting a blended learning approach. The use of MS Teams as a platform for meetings and workshops encouraged most participants to buy laptops, so that they could participate in the meetings. Participant B attested to this:

'Throughout my 25 years of teaching, I did not bother to buy my own laptop because I lacked the skills to use it. When Unisa started engaging us through online meetings, I bought my personal laptop.' (Participant B, 47 years old, 25 years teaching experience)

Participant F added:

'During the lock down, Unisa staff helped us to activate the Teams tool and we used the platform to share strategies on how to complete the syllabi and teaching approaches of challenging topics.' (Participant F, 30 years old, 8 years teaching experience)

The findings also indicated that Unisa motivated teachers to create and maintain active e-mail accounts, thereby prompting them to become actively involved in online communication. In this regard, Participant F remarked:

'My email account was not active because I seldom used it, but when Unisa started sending us workshop presentations, other e-content material and messages via emails, I activated it and was fully engaged in using emails as an alternative means of communication.' (Participant F, 30 years old, 8 years teaching experience)

From the findings it became evident that Unisa provided teachers with electronic teaching material to supplement the hard copies they were using. Teachers preferred such

material because it was easy to save and share with their fellow teachers and learners. Participant C declared:

'The electronic materials I received were so handy and could be stored, unlike the hard copies which sometimes got lost. I visited the PowerPoint presentations by [the] Unisa team many times, to acquire the knowledge and content shared.' (Participant C, 40 years old, 18 years teaching experience)

Participant A added:

'I liked the YouTube videos which the Unisa staff sent us, they helped me to understand the topic more and even the learners enjoy these videos.' (Participant A, 44 years old, 22 years teaching experience)

The findings also indicated that teachers started to discover other ways of sharing important information via social media and online platforms such as WhatsApp. Participant D reported:

'Unisa team helped me to activate my WhatsApp which I used to send revision material such as previous question papers. The WhatsApp group developed by Unisa became an easy and fast communication line and a platform [for] shar[ing] ideas and suggestions.' (Participant D, 57 years old, 35 years teaching experience)

The role of Unisa's online training in enhancing the adoption of blended learning

The study findings indicated that the online training offered by the Unisa team, taught the participants computer skills which allowed them to use overhead projectors to teach.

Participant F remarked:

'The skill to use a data projector helped me to use it twice a month, I use data projector to teach the learners, and [the] learners become so excited when I changed from using my traditional way of teaching.' (Participant F, 30 years old, 8 years teaching experience)

Participant E added:

'The virtual engagement with Unisa has built confidence in me. I enjoy using a computer to supplement the usual chalkboard teaching. I use the YouTube videos to teach the learners, and they enjoy them.' (Participant E, 52 years old, 30 years teaching experience)

The findings also indicated that the electronic content material which the participants received helped them to develop question banks which they used in informal and formal assessments. Participant D had this to say:

'I have now created a folder with previous question papers and some revision material on my computer. Unlike the hard copies of teaching material which got lost, the electronic material saves me time, because when I set a test, I just copy and paste.' (Participant D, 57 years old, 35 years teaching experience)

It became evident from this study that forming WhatsApp groups with colleagues and learners fostered collaboration, which enhanced a spirit of teamwork. Teachers and learners

alike shared learning material and discussed issues related to the subject. As Participant E asserted:

'I formed a WhatsApp group with learners. The electronic material I sent them helped us to be on par with [the] work schedule and prepared the Grade 12 learners for the mock exam.' (Participant E, 52 years old, 30 years teaching experience)

Participant B supported this view:

'Collaborating with fellow teachers via emails and WhatsApp also addressed some of the challenges we experienced as individuals, for instance, setting quality questions. Most of the questions we sent to learners were a group effort and of a good quality.' (Participant B, 47 years old, 25 years teaching experience)

It further became evident that learners without data visited Wi-Fi hotspots to download learning material. Learners without smartphones and tablets even joined their fellow learners at such hotspots to discuss the learning content. As Participant D commented:

'I stay next to my school; I was happy to see two to three learners at the Wi-Fi spot collaborating on the electronic content which I sent via WhatsApp from their cell phones during the weekends and holidays.' (Participant D, 57 years old, 35 years teaching experience)

Challenges teachers experienced in adopting a blended learning approach, and the mitigating strategies used

The findings of this study indicated that a lack of resources (computers, overhead projectors) presented a barrier to the adoption of a blended learning approach at schools. Participant F commented:

'At my school we have two computers used by our administrative staff. I had to use my personal computer to teach using an overhead projector.' (Participant F, 30 years old, 8 years teaching experience)

Participant A added:

'There are computers at my school, but we do not have a projector. My principal had to loan a projector from a neighbouring school.' (Participant A, 44 years old, 22 years teaching experience)

Since the study took place in one sub-district, the trained teachers shared their skills and e-learning materials with colleagues in neighbouring sub-districts. In this regard, Participant D said:

'My colleague from another sub-district asked me to send the content material through her school email, and I did. I also asked her to activate her WhatsApp, so that I [could] send her the videos and questions from previous question papers.' (Participant D, 57 years old, 35 years teaching experience)

Network availability was a significant challenge for teachers, caused by load-shedding. There were also complaints about data consumption when using a data projector. Participant B stated:

'I have been allocated four classes per day, the load-shedding affect[s] my teaching because sometimes when it is time to teach another class, there is no electricity supply. But what I did was to use an auditorium and combin[e] all the learners to teach, using a data projector.' (Participant B, 47 years old, 25 years teaching experience)

Participant E supported this view, noting:

'My principal is forever complaining about the high consumption of data when I use online teaching, I sometimes bring along my router to use my data.' (Participant E, 52 years old, 30 years teaching experience)

Participant I commented:

'Not all the learners had smartphones or tablets. For these learners I had to prepare hard copies which were not as handy as electronic material.' (Participant I, 32 years old, 10 years teaching experience)

Discussion

The study indicated the importance of the community of inquiry (Garrison et al. 2000) formed by Unisa staff and the Life Sciences teachers, in which they shared a vision of teacher empowerment in respect of online skills. The expertise with which the Unisa staff trained the teachers in technological skills, to enable them to adopt a blended learning approach, not only supported the teaching presences identified by Garrison et al. (2000), but also confirmed the notion that institutions of higher learning have long practised online teaching (Ersin et al. 2020; Fedynich 2013). The positive result of a collaborative partnership between Unisa and DoE attested to Truesdell and Birch (2019)'s study that universities direct community projects to enhance the implementation of technology in schools. Unisa 's coaching became one of the best collaborative relationships since it culminated with teachers adopting a new delivery mode of education that improved learner performance. Not only did the study indicate a lack of relevant professional development for teachers (with the DoE not filling that gap), but it also revealed the importance of inter-organisational collaboration in solving complex problems such as teacher development in online skills to improve scholastic performance as indicated by De Dreu and Van Vianen's (2001) study. It also became evident that the study also confirms the findings of Hofmeyr and Draper (2015), who assert that quality teaching is hampered by a lack of competence.

The outcome of the study is a continuation of the Padayachee (2017)' findings since both the young and older teachers became competent in using the technological tools as indicated in the observation tool above. From the researcher's observation, the acquisition of the technological skills did not happen at the same pace and that some of the teachers never reached the level of being competent at the end of the training. The reason could be that those who learned faster already had basic online skills or were younger teachers who are active in using online gadgets

and the struggling learners needed more time. In as far as time as a resource is concerned, the study attests to the infusion of practical technology education during teacher training as well as in schools something which is practised more in the western countries (Barbour et al. 2011; Chinengundu 2021) than in South Africa, to afford teachers and learners sufficient time to learn the technological skills. The findings of the study show the importance of forging partnerships with institutions of higher learning as a tentative measure to upskill and re-skill teachers towards ensuring that a blended learning approach to teaching and learning is adopted. The efficiency of Unisa's technological training and the ultimate adoption of a blended learning approach by teachers indicated a move to the Professional Development Framework for Digital Learning which aimed at teachers' competence in professional growth and knowledge (DBE 2018).

The participants in this study indicated that the training received from Unisa staff not only instilled confidence in them, in the use of technological skills, but also improved the teaching and learning encounter once they started adopting a blended approach. The newly adopted teaching and learning approach entailed the use a variety of teaching mechanisms to supplement traditional teaching methodologies (Rahman et al. 2015). Collaboration with Unisa led to the development of online skills in teachers, enabling them to start operating computers and cell phones, activating, and using emails for communication, and creating WhatsApp groups. The attained level of competency was inline with one of the proposed outcomes of the framework for digital learning namely, teachers to start implementing the ideas about new approaches to teaching and learning using digital tools and resources (DBE 2018:15).

The use of technology to enhance student participation appeared to be an alternative delivery mode as posited by Rahman et al. (2015) to address the principles of inclusion and diversity in the educational milieu because participants indicated how the new approach stimulated learner interest.

Findings from this study indicated that the participants valued the electronic material they received from the Unisa team, because unlike the hardcopies which they used to receive from their subject advisers, the electronic materials were handy and easy to save and access. The electronic material enabled teachers to use data projectors to teach, and as posited by Participant F, learners also showed an interest in the new approach to teaching (Fedynich 2013). The above finding informs the need for department of education to collaborate with universities for the provision of content knowledge that will bridge teachers' technological skills gaps (Butler et al. 2018). Findings from this study indicated that the supply of content knowledge in the form of YouTube videos enabled teachers send it to the learners via WhatsApp through the use of cell phones which according to the participants, was the fastest and efficient method of cascading

information, (Batumalai & Maat 2020). According to Participant D, the learners were so stimulated to learn using smartphones that they rushed to areas where there was a Wi-Fi signal, to download YouTube videos.

In adopting a blended learning approach, participants became the agents of change as supported by Fullan (2007)'s theory of change. Findings from this study indicated that collaboration amongst the teachers themselves, using online tools, empowered other teachers who were not part of the training; as Participant D indicated, training in technological literacy skills and the subsequent adoption of a blended approach was shared with other colleagues. This confirms Fullan's (2007) assertion, in terms of his theories of action, that it is imperative to change the larger context. The move to empower other teachers was an indication that teachers had no problem adopting a blended approach – they only needed mentoring and in-service training (Dhakal 2016; Ersin et al. 2020).

The findings of this study inform and support the need to be technological literate to practice the blended learning approach especially now that the COVID-19 pandemic has dictated a new normal where face-to face engagements could be a nightmare (Shava 2022; Winter et al. 2021). Findings supported a preponderance of literature that the acquisition of technological literacy enabled teachers and learners to engage in online modes of delivery which benefitted them by not being obliged to be in the same location, being cost-effective because no travelling is involved, and constituted faster ways of disseminating information (Batumalai & Maat 2020; Ersin et al. 2020; Fedynich 2013; Kastner 2019; Kim 2020). The teachers recognised the efficiency of using virtual engagement via the Teams platform, in that they were not expected to travel to attend workshops, as was the case during meetings with their superiors.

Although the study reported several positive outcomes from adopting a blended approach, the participants mentioned a number of challenges which they faced in the process. It became evident from the study that teachers' challenges in adopting a blended approach continued even after the problem of inadequate online skills was fully addressed by Unisa. The study participants identified a lack of resources as a stumbling block in the use of online tools: the shortage of computers and other gadgets such as data projectors impeded the use of online mechanisms as posited by (Hlatshwayo 2022; Nkadimeng 2022). In addition, it was revealed from this study that the availability of internet was another challenge. Schools' lack of funds influenced principals to develop a negative attitude towards the adoption of this strategy, because of the high usage of data. (a finding supported by Abrahams & Burke 2022; Boeren, Roumell & Roessger 2020). The study thus values the recent initiative by the government to spend money on technological gadgets which counteracts the existing negative literature that governments do not want

to finance technology-oriented initiatives (Barbour et al. 2011; Boeren et al. 2020). While the step of compliance taken by the South African government is commendable, findings from this study indicated that the teachers' incapacity to implement technology poses a threat to the implementation of the above initiative and it became evident from the results of this study that inter- institutional partnership are key to mitigate the above challenge (Brinkerhoff 2002; Bovaird 2004; De Dreu & Van Vianen 2001; Mitchell 2014).

The findings also indicated that amidst the challenges created by the absence of resources in schools, some teachers used their personal resources to teach learners using technology. In this study, the participants indicated how effective and efficient the adoption of the new teaching methodology was, but also shared their experiences of the difficulties associated with the use thereof.

Conclusion

The study focused on a relatively underexplored area, namely the role of institutions of higher learning in partnering with schools to foster the adoption of a blended approach to teaching and learning encounters. The mentoring of teachers by experts from higher education institutions was used to empower teachers on content and technological skills. The study reported on here, indicated the effectiveness of such a partnership and the professional development which Unisa staff offered in ensuring that teachers use online teaching tools to supplement existing or traditional methodologies. Unisa's use of online platforms such as MS Teams, e-mails and WhatsApp has developed teacher confidence in the use of technology. Evidence was provided to suggest that there are indeed benefits for schools in using a blended pedagogical approach. Few studies have, to date, investigated the strategies institutions of higher learning use to mitigate the online challenges confronting teachers. This study could contribute to the body of knowledge on possible strategies to use within a changing work environment. The limitations of the study relate to the fact that it was based on one sub-district in one province, thus the Life Sciences project members who were interviewed were not fully representative of this cohort of teachers nationwide. For that reason, the findings cannot be generalised. If the study were to be conducted to include a wider area, it would improve the credibility and trustworthiness of the findings.

Emanating from the above findings, the following recommendations can be made:

- Schools and district offices should start working on the Action Plan for the Achievement of the Framework Outcomes to enhance teachers' technological literacy.
- There is a need for the DoE to form partnerships with institutions of higher learning, to empower teachers with technological literacy skills and knowledge for 21st century teaching.

- The initiative to form alliances must be a mutual enterprise; institutions of higher learning should not be the ones to take the lead.
- Teachers must engage in lifelong learning in institutions of higher learning, to equip themselves with the necessary technological skills and strategies to deal with the changing work environment and a new cohort of learners.
- A bottom-up rather than a top-down strategy must be followed, so that teachers' challenges inform the intervention needed.
- Institutions of higher learning must tailor their interventions or outreach programmes to address societal needs through research, and suitable new ways of teaching must be found.
- Technological literacy training for teachers must be a top priority, and schools must be provided with resources to facilitate the implementation thereof.
- The professional development of teachers must also involve computer skills training.

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The authors have declared that no competing interest exists.

Author's contributions

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Data availability

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References

- Abrahams, L. & Burke, M., 2022, *Report on the South African experience in Open Digital Governance, SA-EU Strategic Partnership Dialogue Facility*, University of Witwatersrand, Johannesburg.
- Adov, L. & Mäeots, M., 2021, 'What can we learn about science teachers' technology use during the COVID-19 pandemic?', *Education Sciences* 11(6), 255. <https://doi.org/10.3390/educsci11060255>
- Akyol, Z., Garrison, D.R. & Ozden, M.Y., 2009, 'Development of a community of inquiry in online and blended learning contexts', *Procedia-Social and Behavioral Sciences* 1(1), 1834–1838. <https://doi.org/10.1016/j.sbspro.2009.01.324>
- Ankiewicz, P., 2020, 'Technology education in South Africa since the new dispensation in 1994: An analysis of curriculum documents and a meta-synthesis of scholarly work', *International Journal of Technology and Design Education* 31, 939–963. <https://doi.org/10.1007/s10798-020-09589-8>
- Barbour, M., Brown, R., Waters, L.H., Hoey, R., Hunt, J.L., Kennedy, K. et al., 2011, *Online and blended learning: A survey of policy and practice from K-12 schools around the world*, International Association for K-12 Online Learning, viewed n.d., from http://www.aurora-institute.org/wp-content/uploads/iNACOL_a-survey-of-policy-and-practice.pdf.

- Bardach, E., 1999, *Getting agencies to work together: The practice and theory of managerial craftsmanship*, Brookings Institution Press, Washington, DC.
- Bastian, K.C. & Marks, J.T., 2017, 'Connecting teacher preparation to teacher induction: Outcomes for beginning teachers in a university-based support program in low-performing schools', *American Educational Research Journal* 54(2), 360–394. <https://doi.org/10.3102/0002831217690517>
- Batmalai, Y. & Maat, S.M., 2020, 'Understanding students' learning of Mathematics through the integration of ICT: A systematic survey', *International Journal of Novel Research in Education and Learning* 7(2), 8–16.
- Bausmith, J.M. & Barry, C., 2011, 'Revisiting professional learning communities to increase college readiness: The importance of pedagogical content knowledge', *Educational Researcher* 40(4), 175–178. <https://doi.org/10.3102/0013189X11409927>
- Bektashi, L., 2018, 'Community of inquiry framework in online learning: Use of technology', in *Technology and the curriculum: Summer 2018*, viewed n.d., from <https://techandcurriculum.pressbooks.com/chapter/coi-and-online-learning>.
- Bereiter, C. & Scardamalia, M., 2005, 'Technology and literacies: From print literacy to dialogic literacy', in N. Bascia, A. Cumming, A. Datnow & K. Leithwood (eds.), *International handbook of educational policy*, pp. 749–761, Springer, Dordrecht.
- Bertram, C., 2011, 'What does research say about teacher learning and teacher knowledge? Implications for professional development in South Africa', *Journal of Education* 52(5), 26.
- Blau, I. & Shamir-Inbal, T., 2017, 'Digital competences and long-term ICT integration in school culture: The perspective of elementary school leaders', *Education and Information Technologies* 22, 769–787. <https://doi.org/10.1007/s10639-015-9456-7>
- Blau, I., Shamir-Inbal, T. & Avdiel, O., 2020, 'How does the pedagogical design of a technology-enhanced collaborative academic course promote digital literacies, self-regulation, and perceived learning of students?', *The Internet and Higher Education* 45, 100722.
- Boeren, E., Roumell, E.A. & Roessger, K.M., 2020, 'COVID-19 and the future of adult education: An editorial', *Adult Education Quarterly* 70(3), 201–204.
- Bovardt, T., 2004, 'Public-private partnerships: From contested concepts to prevalent practice', *International Review of Administrative Sciences* 70(2), 199–215. <https://doi.org/10.1177/0020852304044250>
- Bozeman, B. & Boardman, C., 2014, *Research collaboration and team science: A state-of-the-art review and agenda*, Springer, Arizona.
- Brinkerhoff, J.M., 2002, 'Global public policy, partnership, and the case of the World Commission on Dams', *Public Administration Review* 62(3), 324–336. <https://doi.org/10.1111/1540-6210.00182>
- Butler, D., Hallissy, M. & Hurley, J., 2018, 'The digital learning framework: What digital learning can look like in practice, an Irish perspective', in E. Langran & J. Borup (Eds.), *Proceedings of Society for Information Technology & Teacher Education International Conference*, pp. 1339–1346, Association for the Advancement of Computing in Education (AACE), Washington, DC, viewed 02 February 2020, from <https://www.learntechlib.org/p/182702>.
- Chang, F.C., Chiu, C.H., Chen, P.H., Chiang, J.T., Miao, N.F., Chuang, H.Y. et al., 2019, 'Children's use of mobile devices, smartphone addiction and parental mediation in Taiwan', *Computers in Human Behavior* 93, 25–32. <https://doi.org/10.1016/j.chb.2018.11.048>
- Chinengundu, T., 2021, 'Four strategies for blended learning in TVET: A South African post-pandemic perspective', in *New models for technical and vocational education and training*, pp. 74–90, IGI Global. <https://doi.org/10.4018/978-1-7998-2607-9%201.ch005>
- Collins, A. & Halverson, R., 2018, *Rethinking education in the age of technology: The digital revolution and schooling in America*, Teachers College Press, New York.
- De Dreu, C.K. & Van Vianen, A.E., 2001, 'Managing relationship conflict and the effectiveness of organizational teams', *Journal of Organizational Behavior* 22(3), 309–328. <https://doi.org/10.1002/job.71>
- Department of Basic Education (DBE), 2018, *Professional development framework for digital learning*, Department of Basic Education, Pretoria.
- Desimone, L.M., 2011, 'A primer on effective professional development', *Phi Delta Kappan* 92(6), 68–71. <https://doi.org/10.1177/003172171109200616>
- Dhakal, S., 2016, 'Appositeness of teacher training for in-service EFL teachers in real teaching context', *Journal of NELTA* 21(1–2), 121–127. <https://doi.org/10.3126/nelta.v21i1-2.20208>
- Ehsanipour, T. & Zaccarelli, F.G., 2017, *Exploring coaching for powerful technology use in education*, Center to Support Excellence in Teaching – Stanford University, Digital Promise, viewed 01 September 2017, from <http://digitalpromise.org/wp-content/uploads/2017/07/Dynamic-Learning-Project-Paper-Final.pdf>.
- Elmore, R.F., 2004, *School reform from the inside out: Policy, practice, and performance*, Harvard Education Press, Cambridge, MA.
- Ersin, P., Atay, D. & Mede, E., 2020, 'Boosting preservice teachers' competence and online teaching readiness through e-practicum during the COVID-19 outbreak', *International Journal of TESOL Studies* 2(2), 112–124.
- Fedynich, L.V., 2013, 'Teaching beyond the classroom walls: The pros and cons of cyber learning', *Journal of Instructional Pedagogies* 13, 1.
- Fullan, M., 2007, 'Change theory as a force for school improvement', in A. Hooper & J. Potter (eds.), *Intelligent leadership*, pp. 27–39, Random House, London.
- Garrison, D.R., 2018a, *Assessment of CoI Revisions*, Community of Inquiry, viewed n.d., from <http://www.thecommunityofinquiry.org/editorial12>.
- Garrison, D.R., Anderson, T. & Archer, W., 2000, 'Critical inquiry in a text-based environment: Computer conferencing in higher education', *The Internet and Higher Education* 2(2–3), 87–105. [https://doi.org/10.1016/S1096-7516\(00\)00016-6](https://doi.org/10.1016/S1096-7516(00)00016-6)
- Glazer, E., Hannafin, M.J. & Song, L., 2005, 'Promoting technology integration through collaborative apprenticeship', *Educational Technology Research and Development* 53(4), 57–67. <https://doi.org/10.1007/BF02504685>
- Goodwin-Jones, B., 2000, 'Emerging technologies: Literacies and technology tools/trends', *Language Learning and Technology* 4(2), 11–18.
- Grant, M.M., Tamim, S., Brown, D.B., Sweeney, J.P., Ferguson, F.K. & Jones, L.B., 2015, 'Teaching and learning with mobile computing devices: Case study in K-12 classrooms', *TechTrends* 59(4), 32–45. <https://doi.org/10.1007/s11528-015-0869-3>
- Hlatshwayo, M., 2022, 'Online learning during the South African COVID-19 lockdown: University students left to their own devices', *Education as Change* 26, 23–pages. <https://doi.org/10.25159/1947-9417/11155>
- Hofmeyr, J. & Draper, K., 2015, *Teachers in South Africa: Supply and demand 2013 – 2025*, The Centre for Development and Enterprise, Johannesburg, viewed 24 February 2016, from <http://www.cde.org.za/teacher-supply-and-demand-2013-2025>.
- Hoic-Bozic, N., Mornar, V. & Boticki, I., 2008, 'A blended learning approach to course design and implementation', *IEEE Transactions on Education* 52(1), 19–30. <https://doi.org/10.1109/TE.2007.914945>
- Hrastinski, S., 2019, 'What do we mean by blended learning?', *TechTrends* 63(5), 564–569. <https://doi.org/10.1007/s11528-019-00375-5>
- Isaacs, S., 2020, 'South Africa's (unequal) digital learning journey: A critical review', in C.K. Looi, H. Zhang, Y. Gao & L. Wu (eds.), *ICT in education and implications for the belt and road initiative*, pp. 187–211, Springer Nature, Dordrecht.
- Kastner, J.A., 2019, 'Blended learning: Moving beyond the thread quality of blended learning and instructor experiences', Doctoral dissertation, Centenary University.
- Kim, J., 2020, 'Learning and teaching online during COVID-19: Experiences of student teachers in an early childhood education practicum', *International Journal of Early Childhood* 52(2), 145–158. <https://doi.org/10.1007/s13158-020-00272-6>
- Marpa, E.P., 2021, 'Technology in the teaching of mathematics: An analysis of teachers' attitudes during the COVID-19 pandemic', *International Journal on Studies in Education (IJSE)* 3(2), 92–102.
- Mitchell, D., Keese, J., Banerjee, M., Huston, D. & Kwok, A., 2021, 'Induction experiences of novice teachers and their coaches', *Teacher Development* 25(4), 411–431. <https://doi.org/10.1080/13664530.2021.1944903>
- Mitchell, G.E., 2014, 'Collaborative propensities among transnational NGOs registered in the United States', *The American Review of Public Administration* 44(5), 575–599. <https://doi.org/10.1177/0275074012474337>
- Nkadimeng, M.P., 2022, 'Implementation of blended learning in Sekhukhune District schools in Limpopo Province, South Africa', Doctoral dissertation, University of Limpopo.
- Padayachee, K., 2017, 'The myths and realities of generational cohort theory on ICT integration in education: A South African perspective', *The African Journal of Information Systems* 10(1), 4, viewed n.d., from <https://digitalcommons.kennesaw.edu/ajis/vol10/iss1/4>.
- Rahman, N.A.A., Hussein, N. & Aluwai, A.H., 2015, 'Satisfaction on blended learning in a public higher education institution: What factors matter?', *Procedia-Social and Behavioral Sciences* 211, 768–775. <https://doi.org/10.1016/j.sbspro.2015.11.107>
- Ramaphosa, C., 2019, *State of Nation Address*, South African Government, viewed n.d., from <https://www.gov.za/speeches/president-cyril-ramaphosa-2019-state-nation-address-7-feb-2019-0000>.
- Saldaña, J., 2016, *The coding manual for qualitative researchers*, Ashford Colour Press Ltd, Gosport.
- Shava, E., 2022, 'Reinforcing the role of ICT in enhancing teaching and learning post-COVID-19 in tertiary institutions in South Africa', *Journal of Culture and Values in Education* 5(1), 78–91. <https://doi.org/10.46303/jcve.2022.7>
- Silva, C.M.D., Kavai, P. & De Villiers, R., 2023, 'Natural sciences teachers' experiences using blended teaching in township smart schools: Perceived benefits and challenges', *African Journal of Research in Mathematics, Science and Technology Education* 27(2), 1–12. <https://doi.org/10.1080/18117295.2023.2202021>
- Staples, A., Pugh, M.C. & Himes, D.J., 2005, 'Rethinking the technology integration challenge: Cases from three urban elementary schools', *Journal of research on Technology in Education* 37(3), 285–311. <https://doi.org/10.1080/15391523.2005.10782438>
- Towe, V.L., Leviton, L., Chandra, A., Sloan, J.C., Tait, M. & Orleans, T., 2016, 'Cross-sector collaborations and partnerships: essential ingredients to help shape health and well-being', *Health Affairs* 35(11), 1964–1969. <https://doi.org/10.1377/hlthaff.2016.0604>
- Truesdell, E. & Birch, R., 2019, 'Developing digital literacy through community engagement', in J. Theo Bastiaens (ed.), *Proceedings of EdMedia + Innovate learning*, pp. 1251–1254, Association for the Advancement of Computing in Education (AACE), Amsterdam, viewed 03 January 2024, from <https://www.learntechlib.org/p/210134>.
- UNESCO, 2011, *UNESCO ICT competency framework for teachers* UNESCO, Paris, viewed n.d., from <http://www.unesco.org/new/en/communication-and-information/resources/publications-and-communication-materials/publications/fulllist/unesco-ict-competency-framework-for-teachers>.
- Usher, J., 2020, 'Is geography lost? Curriculum policy analysis: Finding a place for geography within a changing primary school curriculum in the Republic of Ireland', *Irish Educational Studies* 39(4), 411–437. <https://doi.org/10.1080/03323315.2019.1697945>
- Winter, E., Costello, A., O'Brien, M. & Hickey, G., 2021, 'Teachers' use of technology and the impact of COVID-19', *Irish Educational Studies* 40(2), 235–246. <https://doi.org/10.1080/03323315.2021.1916559>
- World Bank, 2020, *Fixed broadband subscriptions per 100 People, 1998 to 2017*, World Bank, viewed 21 September 2020, from <https://data.worldbank.org/indicator/IT.NET.BBND.P2>.