



Multimodality and a diverse pedagogical mix: Insights into the 21st century South African secondary school learning environment

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Abstract

Over the years there have been repeated calls to reconceptualise schooling in the 21st century. Instead, the response has been to digitise traditional classroom practices thereby equating contemporary learning with technology adoption. In this paper, I report on the findings of a mixed methods study involving five secondary schools in Johannesburg that explored the characteristics of the 21st century secondary school learning environment. I examined teachers' appropriation of digital technologies as well as their pedagogical practices. While acknowledging the differences in classroom contexts, perspectives on the 21st century classroom were informed by teachers' best practices and the key literature that framed the research. I concluded that multimodality is an important feature of the 21st century learning environment and within which the appropriation of digital technologies is located. Another important characteristic is teachers' pedagogical mix that harnesses learners' epistemological diversity. The findings of this study would help to inform multimodal pedagogical change, particularly in secondary schools.

Keywords: digital technologies, diversity, epistemological diversity, multimodality, pedagogical mix, twenty-first century learning environment

Introduction and background

Rapid technological advancements have led to repeated calls to rethink industrial-era approaches to education (Bates 2022; Dede, 2011; Laurillard, 2008). Scholars such as Tarling and Ng'ambi (2016) and Sikhakhane et al. (2020) emphasised the need for transformative pedagogical changes, a perspective articulated by one of the participants in this study who stated, "Our whole system is still based on 1950s education." Instead, the focus has been largely on digitising classrooms with the assumption that this represents learning in the 21st century. Yet, new technologies alone do not represent transformed pedagogies. Educators are advised not to get distracted by the hype of new technologies (Bozalek & Ng'ambi, 2015)

since it is not the technology that makes the difference to teaching and learning but the pedagogy (Bates, 2022; Cope & Kalantzis, 2017; Sikhakhane et al., 2020; Tarling & Ng'ambi, 2016).

Given the emergence of digital technologies, children interact with a variety of multimodal texts (Serafini et al., 2020), a reality schools must accommodate (Pahl & Rowsell, 2005). Consequently, teachers should recognise and engage with “a species of *epistemological diversity* where students now bring to the classroom complex, multiple and blended background knowledges, identities and discourses” (Pahl & Rowsell, 2005, p. xiii, italics in original). Therefore, education in the twenty-first century must recognise and build on learners’ diverse knowledges (Odora Hoppers in National Education Collaboration Trust, 2017). The harnessing of learners’ epistemological diversity is of particular importance in the South African classroom that experiences autonomous approaches to teaching and learning (Newfield & Stein, in Cope & Kalantzis, 2000) and a legacy of epistemological silencing (Odora Hoppers in National Education Collaboration Trust, 2017) prior to the transition to democracy. Thus, one of the goals of the country’s new curriculum and subsequent iterations is the achievement of equity and access for all learners (Department of Basic Education, 2011).

South Africa’s democratic transition coincided with the proliferation of new technologies in society. Recognising their potential influence on the education sector, the Department of Education published an e-education policy to guide the integration of ICTs into teaching and learning and facilitate the transformation of the sector (Department of Education, 2004). Significant investments were therefore made to equip schools with various forms of digital technologies and create smart classrooms since an education without ICTs was viewed as incomplete (Department of Basic Education, 2015). However, despite these investments, similar efforts were not directed towards developing teachers’ ability to teach with digital technologies (La Fleur & Dlamini, 2022; Tarling & Ng'ambi, 2016). Research indicated that technology was used as an add-on (Tarling & Ng'ambi, 2016) and to deliver content (Padayachee, 2017). Tarling & Ng'ambi (2016) highlighted the low use of technology even in technology-resourced schools. Nevertheless, despite evidence from literature indicating a lack of technological pedagogical change (Padayachee, 2017; Sikhakhane et al., 2020; Tarling & Ng'ambi, 2016) there is a dearth of studies available to guide change in teachers’ practices. The government’s investments in expensive digital technologies were therefore made with minimal sound empirical evidence (Dlamini & Coleman, 2017).

The study on which I based this article was thus aimed at exploring teachers’ digital technology use and their pedagogical strategies. I sought to extend the body of knowledge on teaching and learning in the 21st century by suggesting key features of the 21st century secondary school learning environment. Further, one of the study’s key contributions was the creation of a conceptual model of a contemporary learning environment to guide teachers’ practices.¹ Consequently, it attempted to answer the following research questions:

¹ The model that was created is not included in this article.

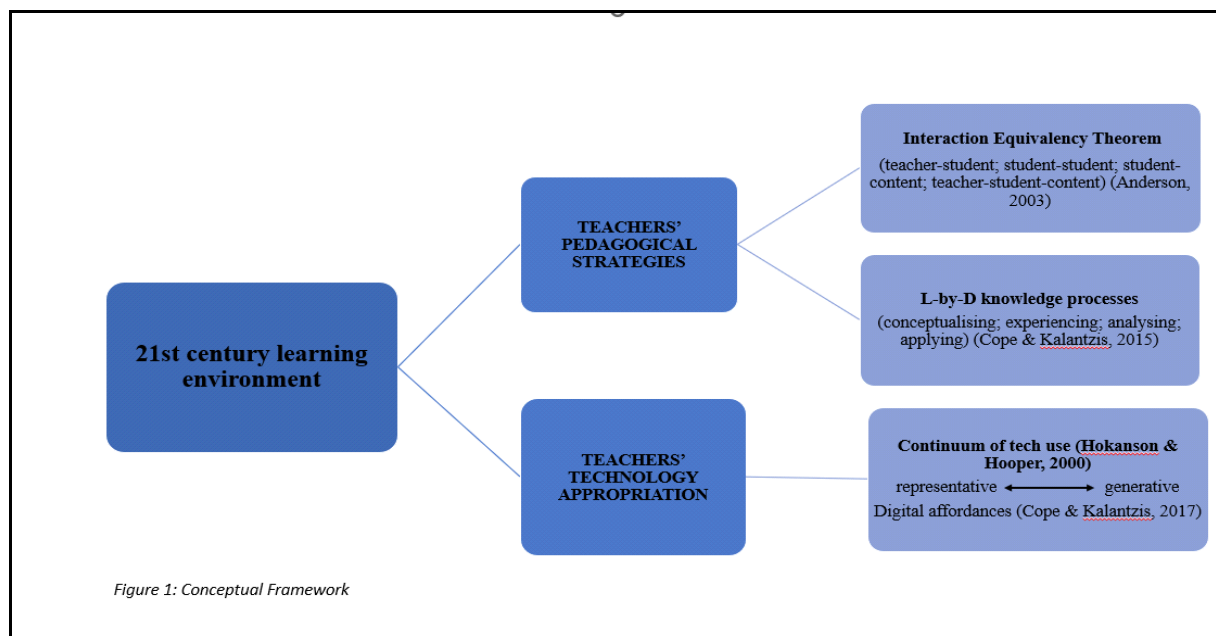
1. In which ways have digital technologies been appropriated in the classroom to transform teaching and learning?
- 2a. Which pedagogical strategies do teachers need to employ to produce rich learning experiences in the contemporary learning environment?
- 2b. How is the epistemological diversity of learners being privileged through teachers' pedagogical choices?

Conceptual framework and theoretical foundation

I used a pragmatic philosophical lens to frame this study since it privileges a pluralistic approach to inquiry (Creswell & Plano Clark, 2018; Johnson & Onwuegbuzie, 2004). It allows equally for the application of seemingly conflicting theoretical perspectives to inquiry (Johnson & Onwuegbuzie, 2004). Hence, this study conceptualised the twenty-first century classroom as a learning environment to reflect the dynamic and ubiquitous nature of learning in the digital age.

The three frameworks that guided the interpretation and analysis of the research were Hokanson and Hooper's (2000) orientation of computer use, Cope and Kalantzis's (2015) learning by design (L-by-D) knowledge processes, and Anderson's (2003) interaction equivalency theorem as represented in Figure 1 below.

Figure 1
Conceptual framework



Hokanson and Hooper's (2000) framework guided the analysis of teachers' appropriation of digital technologies. This approach maps technology use along a continuum from representative to generative use. Additionally, Cope and Kalantzis's (2017) digital affordances, and, to a lesser extent, Conole and Dyke's (2004) technology affordances guided

the analysis of teachers' technology use since their awareness of such affordances is a strong predictor of use (Ng'ambi, 2013).

Anderson's (2003) interaction equivalency theorem provided a model for examining patterns of interaction involving learners, teachers, and content. In this study, I applied the following modes: teacher-student; student-student; student-content and contributed teacher-student-content interaction as another mode of interaction which is distinct from teacher-student interaction. Such a distinction was deemed necessary in a face-to-face environment.

L-by-D knowledge processes reframed the pedagogical orientations of the Pedagogy of Multiliteracies as knowledge processes (Cope & Kalantzis, 2015). The four knowledge processes: experiencing; conceptualising; analysing and applying are described as epistemic actions which represent "the things you do to know" (Cope & Kalantzis, 2015, p.15). It is within the knowledge process of experiencing that the concept of harnessing learners' epistemological diversity is located.

Theoretical foundations

While Hokanson and Hooper (2000) and Anderson (2003) used a constructivist perspective to frame their theories, Cope and Kalantzis's (2015) proposed a reflexive pedagogy which draws on constructivist theory as well as broader socio-cultural perspectives on learning particularly, the work of Lev Vygotsky (1978). Kalantzis and Cope (2020) argued that these theories alone were insufficient to explain learning in the digital age. They also posited that Vygotsky did not use the concept to describe his psychology, hence did not apply the concept of social constructivism to their work.

Constructivism advances the view that learning is iterative (Selwyn, 2017) and that learners are intellectually generative (Yilmaz, 2008). It is through interaction with their peers and teachers that learners construct knowledge based on their developmental level, prior experiences, and sociocultural background (Selwyn, 2017). The two most popular strands of constructivism are cognitive constructivism which is associated with the works of Jean Piaget, and social constructivism which is said to have its roots in the works of Vygotsky (Moll, 2002; Selwyn, 2017; Yilmaz, 2008). For Piaget, learning and development are internal, biological processes while for Vygotsky (1978) learning is first a social process even when the individual is acting alone. Vygotsky's social theory emphasised the dialogical nature of learning which occurs within the zone of proximal development. A learner can achieve a higher level of mental functioning through interaction with a more knowledgeable person in their environment. Sociocultural theories extend constructivism (Moll, 2002) and highlight the situated and participatory nature of learning where knowledge is constructed in authentic situations through joint social activity (Crook, 2001). Authentic learning experiences reflect learning contexts that are realistic, personally significant, and transferable (Mystakidis et al., 2021).

Cope and Kalantzis's (2015) knowledge process of conceptualising draws on Piaget's cognitive constructivism and Vygotsky's social learning theory in the development of new

concepts through the backward and forward movement between social everyday knowledge and concrete and abstract thinking. The knowledge process of experiencing is based on situated practice during which learners engage in new experiences in the zone of proximal development (Cope & Kalantzis, 2015).

Reflexive pedagogy frames the teachers' role as both facilitative and explicit as well as an intentional designer and manager of the learning process (Kalantzis & Cope, 2010). Their explicit role is particularly observed during the conceptualizing process. Garrison and Anderson (2003) acknowledged the complexity of the teachers' role in creating and shaping the evolving learning environment. In some instances, the teacher's role may involve direct instruction while in other cases, the role could be more facilitative.

In this study on the 21st century learning environment, I applied socio-cultural and, by extension, constructivist principles to guide the analysis of my findings. Thus, learning is viewed as an active, social, and situated process.

Literature review

Digital technologies

Digital technologies constitute just one facet of a learning environment yet afford great potential to enhance teaching and learning (Dlamini & Nkambule, 2019). Selwyn (2017) categorised the range of technologies used in education as: computerised and electronic devices; additive technologies; artificial intelligence tools and systems; systems software; and the applications software used with the operating systems. Nevertheless, regardless of their classification, Hokanson and Hooper (2000) advocated for the use of media in education including computers, as learning tools, thus emphasising the value of learning *with* technology as opposed to learning *from* it (Hokanson & Hooper, 2004, italics in original). The latter describes the use of technology to replicate a task or as "representations of experience" (p. 538). Learning *with* indicates generative use to create new ideas and knowledge (Hokanson & Hooper, 2000). A representative activity like note taking could have a generative aspect if it is transformed using hyperlinks or mind maps. South Africa's e-education policy associates learning *with* technology with the use of ICTs to supplement normal processes (Department of Education, 2004) that is, for representative purposes. The policy also refers to, learning *through* the use of ICTs, which supports active, exploratory, and collaborative learning and promotes a learner-centred approach.

Uneven technology access or a lack of access to adequate ICT resources as well as ICT skills, were cited as barriers to teachers' transformative use of digital technologies (Chigona, 2018; Dlamini, 2022; Padayachee, 2017). Teachers' transformative use of technology is often linked to high self-efficacy. This represents an openness to new ideas, new teaching methods and pedagogies, and a willingness to experiment (Neugebauer et al., 2019; Sang et al., 2010). Teachers with high self-efficacy are thus more likely to appropriate digital technologies generatively. High technological self-efficacy could be linked to an awareness of the affordances of such technologies.

Digital technology affordances

McGrenere and Ho (2000, p.1) described an affordance as “an action possibility (that is) available in the environment to an individual (but is) independent of the individual’s ability to perceive this possibility.” Teachers must perceive the various digital affordances to optimise their use (Hammond, 2010).

Cope and Kalantzis (2017) proposed seven digital or e-learning affordances to represent the transformative use of emerging technologies. These affordances are ubiquitous learning, active knowledge making, multimodal meaning-making, recursive feedback, collaborative intelligence, metacognition, and differentiated learning. *Ubiquitous learning* speaks to anytime, anywhere learning made possible by the accessibility of the internet and mobile technologies. Conole and Dyke (2004) used the term *accessibility*, instead, as part of their taxonomy of affordances. *Active knowledge making* frames the learner as an active participant in the learning process as well as a co-producer of knowledge (Cope & Kalantzis, 2017). *Multimodal meaning making* (Cope & Kalantzis, 2017) or *multimodal and nonlinear* (Conole & Dyke, 2004) affords learning using many different modes to make meaning. Multimodality is also central to Learning by Design and describes social and cultural meaning-making resources such as linguistic, visual, spatial, gestural, audio, and layout (Cope & Kalantzis, 2015; Kress, 2000), and more recently data and codes. In the African context, Stein and Newfield (2006) included African representational forms such as live performance, music, the aesthetics of the body, and multilingualism as important features of multimodality. *Recursive feedback* involving prospective and constructive feedback and also using analytics, is another digital affordance proposed by Cope and Kalantzis (2017). The affordance of *metacognition* relates to critical self-reflection. *Differentiated learning* represents a departure from the conventional one-size-fits-all curriculum (Cope & Kalantzis, 2017). It allows for a flexible, adaptive approach that addresses each learner according to their interests, self-identity, and needs. The ubiquity or accessibility of multimodal content on the internet offers numerous possibilities for teachers to differentiate their learning.

Pedagogical frameworks

The interaction equivalency theorem

The interaction equivalency theorem advocates for different modes of interaction in distance education to get the mix right between independent study and interactive learning strategies (Anderson, 2003). The main thesis that focuses on the quality of the interaction argues for one of the three forms of interaction—student-teacher; student-student; student-content—to be at a high level for deep and meaningful learning to occur. The secondary thesis focuses on the quantity of modes and suggests that high levels of more than one mode could result in satisfactory learning experiences.

According to Anderson (2003) and Garrison and Anderson (2003), *teacher-student interaction* pertains to the engagement between the teacher and learners involving some aspect of direct instruction, where the teacher provides diverse sources of information, offering explanatory feedback and summarising discussions. Perspectives on the social

construction of knowledge as well as on situated learning (Lave & Wenger, 1991) contributed to the knowledge on *student-student interaction* (Anderson, 2003). Possibilities for such interaction are extensive when synchronous and asynchronous multimodal communication is used (Anderson, 2004). Learners can collaborate with their peers, extending learning beyond the four walls of the classroom. However, for learners without ubiquitous digital access as is the case in many South African schools, student-student interaction may be limited to face-to-face settings. *Teacher-student-content interaction* was added to represent joint meaning-making between the teacher and learners. It exemplifies the analysis and application of knowledge typical of transformative pedagogies. In this way, the teacher and learners co-construct knowledge using a variety of knowledge sources.

Learning by design knowledge processes

Learning by Design frames pedagogy as “a deliberate and purposeful shunting backwards and forwards between different acts of knowing” (Kalantzis & Cope, 2014, p. 113). The Knowledge Processes of *conceptualising*, *experiencing*, *analysing*, and *applying* are pedagogical orientations which differ from the traditional discourse structures typical of didactic pedagogy represented by initiation-response-evaluation (I-R-E) (Cazden, 2001 cited in Cope & Kalantzis, 2015).

Experiencing occurs in two different ways—experiencing the known and experiencing the new. Experiencing the known draws on learners’ lifeworld experiences, their prior knowledge and perspectives. With experiencing the new, learners are immersed in novel experiences which could be multimodal texts, real events, places, or situations (Cope & Kalantzis, 2015; Kalantzis & Cope, 2010). The harnessing of learners’ participative agency is also central to Learning by design (Kalantzis & Cope, 2010). The privileging of learners’ epistemological diversity is thus made visible when teachers harness learners’ knowledge resources such as their prior knowledge, experiences, and local context to facilitate learning.

There are two ways of *conceptualising*—conceptualising by naming and conceptualising with theory. While conceptualising by naming involves drawing distinctions, identifying similarities and differences, and categorising with labels, conceptualising with theory includes making generalisations, associating key concepts with theories while co-opting the experiential to make sense of new concepts (Cope & Kalantzis, 2015). The teacher plays an explicit role in assisting learners to develop abstract and generalising concepts through scaffolding (Cope & Kalantzis, 2009) and within their zone of proximal development (Cope & Kalantzis, 2017).

Analysing takes two forms—analysing functionally and analysing critically. This encompasses examining functional and structural elements, drawing inferences, and interpreting the rationale for an action. It also includes the critical evaluation of texts from different viewpoints as well as interrogating biases and intentions (Cope & Kalantzis, 2009: 2015).

There are two distinct ways of *applying* knowledge. Applying appropriately reflects the application of understandings gained from the other knowledge processes. While knowledge may be applied in predictable ways, it should not be a mere replication of content. In applying creatively, learners apply the new knowledge back to real-world environments and transfer their learning to other contexts (Kalantzis & Cope, 2010).

Methodology

In keeping with the pragmatic philosophical stance around which this research was framed, I used a mixed methods design, a key feature being its methodological pluralism (Johnson & Onwuegbuzie, 2004). This resonates with my own pluralistic approach to pedagogy as an educator and a former secondary school teacher.

Creswell and Plano Clark's (2018) convergent design influenced the planning, implementation, and analysis of the study. Emphasis was placed on the qualitative strand with the notation Qual + quan (Creswell & Plano Clark, 2018). With this design, qualitative and quantitative data were collected concurrently then analysed and the results merged.

Sampling

This study relied on two types of non-probability sampling—convenience sampling and purposive sampling. Participating schools in the Johannesburg area were selected because of expediency and accessibility to me. The general criterion for the selection of research sites was access to and use of digital technologies since the underlying assumption of the 21st century classroom is that digital technologies are an integral aspect. Hence, purposive sampling was also applied.

Research sites and participants

Twenty-one teachers from five secondary schools participated in this study. Three were well-resourced private schools, referred to as colleges, and two were well-resourced public schools, referred to as high schools. Teachers and schools were referred to by pseudonyms as indicated in Table 1 below.

Table 1
Participants

Participants	Queenstown College	Duke's College	Hampton High School	Southridge High School	Baker College
English Teacher	Liselle	Marie	Palesa	Mariette	Lauren
History Teacher	Cathy	Alice	Stacey	Natasha	William
Principal	Lynne	Rupert	George	Anton	Ilana
Person responsible for technology	Tracey	Liam	Paul	Megan	Yvette

Data collection

The qualitative phase of the study included observations of 10 History and 10 English Grade 8 & 9 classrooms (n=20) to gain insights into teachers' practices. Semi-structured interviews were also conducted with the subject teachers, school principals, heads of Information Technology/innovation of each school, and the Head of the Growth Curriculum at Queenstown College.

For quantitative data collection, survey questionnaires were sent to the teaching staff in the participating schools. Questionnaires were designed using a 5-point Likert-scale with 12 statements containing the options *never*, *rarely*, *often*, *sometimes*, and *all the time*. The rationale for extending the scope of the study to include the entire academic staff was to obtain a wider cross-section of perspectives since it was not possible to interview nor observe every teacher in their classroom setting. Three hundred and one (n=301) teachers were surveyed with 176 completing the questionnaires, thereby reflecting a 58% response rate.

Data analysis

Qualitative data analysis involved an iterative process of moving between inductive and deductive approaches. Deductive thematic analysis included the use of pre-determined themes drawn from the conceptual framework. For the inductive process, open coding was applied to identify themes from the interview transcripts and observation fieldnotes that were not identified in the pre-determined codes. These themes were then used to categorise the research findings. Quantitative analysis of the survey responses involved the use of descriptive statistics to organise, summarise, and interpret the data. The statistical results from the survey responses were summarised and organised into text, tables and figures in preparation for interpretation. Qualitative and quantitative data were analysed separately, and the findings subsequently integrated to identify areas of convergence and divergence. The results of the integration findings were then applied to the conclusions to answer the research questions. This process of triangulation of the three data sources contributed to the credibility of the findings thereby strengthening its conclusions. The combination of qualitative and quantitative methods allowed for the inclusion of many different perspectives and, hence, increased the validity and reliability of the findings.

Limitations of the study

A key limitation of the study is its lack of replicability of some of its findings particularly to very under-resourced contexts with very large classrooms. Additionally, the length of time (3–4 weeks) and the timing of classroom observations meant some completed assessments were not observed. A longer period of observations may have revealed slightly different results. Regarding the quantitative aspect of the study, there were weaknesses in the survey design. Since students did not actively participate in the study, survey questions about the use of digital technologies should have included questions that required teachers to be more specific about the types of activities for which learners used digital technologies in their classrooms. This could have provided richer data.

Findings and discussion

Appropriation of digital technologies

Access to digital technologies

Survey and observation data revealed that most classrooms were equipped with data projectors and had Wi-Fi access, while those at Baker College (BC) were fitted with new, state-of-the-art interactive white boards. The teachers observed received either iPads or laptops for pedagogical purposes, although the history and English teachers at Queenstown College (QC) received both. QC and BC were the most technologically equipped schools since teachers and learners had access to a wide range of smart technologies. QC used both Apple and Microsoft platforms, with iPads being compulsory for learners. BC, a Microsoft Showcase School, used Microsoft applications and opted instead for laptops for learners. Computer literacy classes were also compulsory for learners in Grades 8 and 9 from both colleges. In addition, ongoing professional development in the use of digital technologies was mandatory for teachers. Most BC teachers were Microsoft Certified Educators while most at QC were Microsoft and Apple Certified Educators. Nevertheless, professional development at BC involved one-size-fits-all so-called ignite sessions focused on technology trends, while those at QC were varied, allowing for individual as well as group learning. As the principal of QC emphasised, “Using technology in the classroom (was) a standard pedagogical approach.” Yet, there was a level of learner flexibility as she stressed, “Those that want to use it, do; those that don’t, don’t.”

The IT Director characterised Duke’s College (DC) as having “a mixed environment” with teachers having the option to use their preferred learning platforms and applications. The school had a dedicated Moodle platform which he described as “old-fashioned and clunky.” Despite DC being well-resourced, the technologies available were outdated and hence, scheduled for replacement the week following the conclusion of observations. Wi-Fi was erratic thereby limiting accessibility to certain areas of the college. Unlike DC, Wi-Fi at Hampton High School (HHS) was pervasive, and Microsoft Office 365 and Teams were the preferred applications. While both schools employed a Bring Your Own Device, BYOD, policy for learners, this was compulsory at DC with learners using either an iPad and/or a smartphone or a laptop. Conversely, “not all of the kids (had) smartphones or access to that stuff”, at HHS as Stacey, the History teacher explained. This was the reality for one learner at DC who did not participate in some classroom activities as he did not have a smart device. Computer literacy training was not offered to learners at both schools. Additionally, teacher professional development in the use of digital technologies was rare and could be described as episodic, one-size-fits-all events.

At Southridge High School (SHS), Wi-Fi was accessible for all teachers and Computer Application and Information Technology learners, but it was restricted for other learners who were permitted access only in the resource centre and computer labs. As the Head of Computers explained, “We just don’t have the capabilities to connect 1500 children to our Wi-Fi because then nobody would get internet. It would slow us down.” Besides, the

principal questioned, “Why would everybody need to be online at the same time?” suggesting that leadership did not support ubiquitous internet access for all learners.

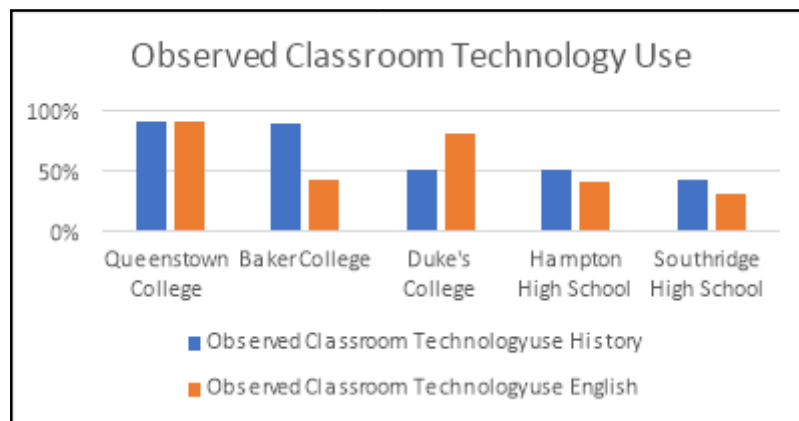
The picture painted above illustrates uneven digital access as well as differences in attitudes towards the use of digital technologies for pedagogical use.

Technology use

As indicated in the literature (Chigona, 2018; Dlamini, 2022), a lack of digital access and computer literacy skills are impediments to technology appropriation. This could have impeded digital technology use in the classrooms at SHS and HHS, as illustrated in Figure 1 below. Stacey, the history teacher at HHS, explained that she resisted using digital technologies frequently “because (she felt) that it puts the kids that don’t have access to the internet at a disadvantage.”

Figure 2

Technology use in history and English classrooms



A similar view was articulated by the teachers from SHS. Figure 2 reveals that overall technology use in the history classrooms (64%) was higher than in the English classrooms (56%). Observed technology usage by both teachers at QC and the history teacher at BC was consistently high at 90%. Teacher and learner digital skills as well as widespread digital access may explain the high frequency of technology use.

Table 2

Purpose of Technology Use

	Queenstown College	Duke's College	Hampton High School	Southridge High School	Baker College	Mean	Standard deviation
Search the internet for information and resources to prepare lessons	97%	95%	83%	86%	90%	90%	0.06
Use apps to prepare lessons	62%	67%	56%	45%	71%	60%	0,10

	Queenstown College	Duke's College	Hampton High School	Southridge High School	Baker College	Mean	Standard deviation
Use tech apps to present lessons	44%	29%	31%	38%	69%		0,16
Create your own learning resources	69%	67%	64%	49%	94%	69%	0,16
Post homework and assignments	62%	76%	19%	6%	74%	47%	0,33
Provide feedback and access student learning	49%	33%	31%	14%	36%	33%	0,13
Provide opportunities for blended learning	51%	20%	28%	20%	68%	37%	0,21
Download/upload/browse material from learning platform	77%	62%	50%	20%	87%	59%	0,26

Table 2 that depicts survey responses regarding the purpose of digital technology use underscores predominant use to prepare lessons, including conducting internet research for information and resources. This response received a mean score of 90%, the lowest standard deviation of 0.06. The Apple Platform used by QC as well as BC's and HHS's access to Microsoft Teams and DC's Moodle, afforded greater interaction between teachers and learners and the opportunity for recursive feedback on learners' work. Survey data showed that while at least 50% of respondents from these institutions used the platforms, the colleges with widespread teacher and learner access, Baker College (87%) and Queenstown College (77%), exhibited the highest scores. Nevertheless, the effective harnessing of the affordances of these platforms was scarcely observed in teachers' practices. Instead, they served as repositories for curated course materials and for administrative and monitoring purposes. This suggests that digital access and being digitally literate are necessary yet insufficient for generative technology use. Nevertheless, the curation of content from many sources positions teachers as designers of knowledge, an important trait of a 21st century teacher (Kalantzis & Cope, 2010). Evidence of teachers being designers of knowledge is also seen in Table 1 with an average of 69% of teachers indicating that they created their own resources, the highest score being BC at 94%. Additionally, despite the opportunity for blended learning afforded by the digital learning platforms, particularly at the schools with out-of-school learner access, only 51% of teachers from QC and 68% of teachers from BC reflected that they exploited this potential. This figure was less than 30% for the remaining schools since blended learning activities necessitate out-of-school technology access for learners.

Regarding the use of technology applications for teaching, the mean was 42% with a standard deviation of 0,16. This figure was again highest for BC (69%) and QC (44%). Classroom observations revealed teachers' intentional use of the YouTube application to create authentic learning experiences. The importance of authentic learning activities, a feature of situated

learning, was emphasised by Crook (2001) and Mystakidis et al. (2021) This was demonstrated in the history classrooms through the showing of World War 1 and 2 YouTube documentaries at DC, BC, SHS, and HHS as well as videos depicting events immediately preceding the 1994 elections in South Africa. In these instances, teachers harnessed the multimodality, accessibility, and ubiquity affordances of the media (Conole & Dyke, 2004; Cope & Kalantzis, 2017), to help learners experience events that were unknown to them and to generate class debate. William, history teacher at BC stated, “I use a fair amount of video, particularly to convey emotion. . . So, I think it can be very effective in drawing pupils in particularly on that emotional level.” So, although technology was used as a representation of experience (Hokanson & Hooper, 2000), subsequent class debates resulted in the generation of ideas through active knowledge making.

The streaming of some of the chapters of the audiobook, *The Hobbit* was another example of the use of the YouTube app by the English teacher at SHS, to supplement and enhance the traditional reading of the novel, thereby creating a multimodal English lesson.

While the previous example saw technology being used in the representative sense, the protest poetry lessons at DC combined both representative and generative use of technology. Learners first watched YouTube videos of protest songs from different geographical regions before selecting one for in-depth study. They then conducted online research on their chosen song using the internet as a valid source of information. The teacher facilitated the learning process providing clarifications when needed. Learners subsequently collaborated in groups, one person per poem per group, to share what they had learnt about the poems. Marie, the teacher, then administered an online quiz which she uploaded to Google Classroom and projected onto the white board to evaluate students’ learning. For their assessment, learners conducted research to create their own piece of protest art or writing about something they believed was a current societal problem. They could choose to write a song, create a spoken word poem, a poster, or a piece of graffiti using either PowerPoint or Slides and submit on Google Classroom. This poetry lesson harnessed many digital affordances such as multimodality, ubiquity and accessibility, active knowledge-making, diversity. and recursive feedback (Cope & Kalantzis, 2017). It also shows an awareness of the various affordances confirming Ng’ambi’s (2013) view that this is a strong predictor of use. However, during our interview, Marie advised, “I’ve experimented with a lot of apps and technologies, and some I’ve retained and some I’ve discarded, and most of it I’ve kind of figured out for myself”, despite attending few professional development sessions on how to appropriate technology into her practice. This illustrates high technological self-efficacy (Neugebauer et al., 2019; Sang et al., 2010). As Figure 2 illustrates, Marie used digital technologies during 80% of her lessons, yet she also stated that she was not “a massive fan of excessive technology use in the classroom at all”, demonstrating that she was perhaps not an enthusiastic adopter.

Quantitative and qualitative data illustrate that learners and teachers were technology consumers and producers or designers of knowledge (Kalantzis & Cope, 2010) although there was less evidence of the latter. This, to some extent confirms Ng’ambi’s (2013) statement that in many classrooms, technology was an add-on. There was greater evidence of the

representative use of technologies but, in many instances, this was for generative knowledge-making. Additionally, many of the digital affordances were not harnessed, even in technology-rich colleges. This could suggest a possible lack of awareness of their affordances and inadequate teacher learning activities (La Fleur & Dlamini, 2022). Yet, insights from teacher interviews point to the generative use of digital technologies for special projects, particularly in the colleges. Notably, at BC, I observed a student-led animation project dealing with gender-based violence and created as part of students' out-of-the-box activity. Additionally, the integration of, and interest in, robotics and coding and the introduction of VR goggles as stated in interviews with the principals and heads of Information Technology at DC, SHS, and HHS, shows a growing interest in newer forms of technologies to enhance learning. Furthermore, as suggested in the literature, a lack of digital access is a barrier to technology adoption. Apart from Stacey at HHS, Mariette lamented the lack of digital access at SHS stating that she is "limited by what resources can provide" since there was not "enough resources to make technology available at the fingertips of every student." She added that access to technology at the school should not be "something that only IT students get to have in a classroom."

Teachers' pedagogical choices

Data reveals that the pedagogical strategies that contributed to rich learning experiences reflected a blend of modes of interaction and knowledge processes (KPs). While high teacher-student interaction was most valued in online interactions (see Anderson, 2003), the dominance of teacher-student interaction in this study indicated a didactic pedagogical strategy (Cazden, 2001 in Cope and Kalantzis, 2015). This was observed repeatedly in the history classroom of SHC, characterised by high levels of teacher-telling. Teacher-student interaction represented the teaching of concepts or content delivery but without teacher scaffolding and with minimal learner input. For example, after the viewing of a short video on the dropping of the atom bomb on Hiroshima and Nagasaki during WW2, a learner asked, "What happens if an atom bomb lands in water?" Another learner responded, "Tsunami" while the teacher stated, "I don't know. I am not sure" and then continued to read the lesson notes from the handout.

Figure 3

Patterns of classroom interaction

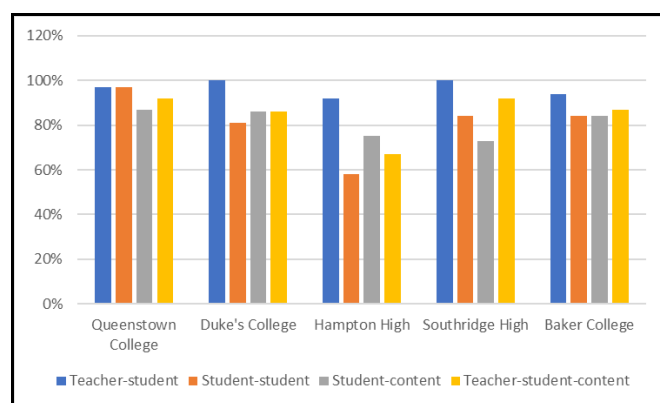
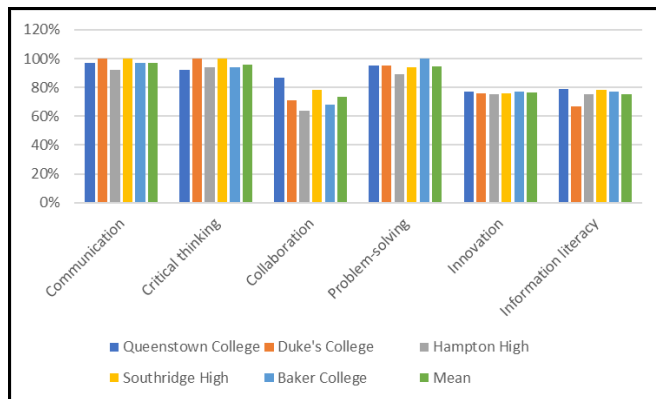


Figure 4
Teachers' perception of 21st century skills



Student-student interaction offering opportunities for learners to work collaboratively were less frequent in most of the classrooms observed. Except for QC (87%), quantitative data as shown in Figure 4, illustrates that teachers regarded collaboration as the least important skill. Data from Figure 4 along with qualitative data, corroborated Figure 3, in which 97% of teachers indicated that student-student interaction occurs with high frequency. During our interview, the principal stated that collaboration was an important “soft skill”, a perspective which was echoed by the history and English teachers, indicating a shared vision among the principal and staff. Student-student interaction during the history, module on revolutions at QC involved different group configurations and team teaching by the four teachers and occurred in different spaces. One such activity represented a blend of experiencing the known and applying creativity as learners drew on their prior knowledge to plan their revolution to protest an aspect of school life. Student-student interaction was also observed in English lessons where students collaborated to create short stories. Again, this mode of interaction was linked to the creative application of knowledge. Students were given the choice of collaborating in pairs or in a larger group while a few opted to work alone, thereby reflecting student-content interaction.

However, qualitative and quantitative data from BC regarding collaboration were in conflict. While 84% of teachers responded that student-student interaction occurred with high frequency (*Figure 3*), only 68% viewed collaboration as an important 21st century skill. This perspective was articulated by the English teacher who stated that “the world was becoming less insular and global”, hence collaboration was unimportant. She added that there were challenges which required teachers to find creative ways to make group work successful and assess collaborative tasks. Likewise at DC, 81% of teachers indicated that student-student interactions occurred with high frequency yet only 71% of them indicated that collaboration was important. In our interview, the English teacher remarked that “with the sort of the move towards a more technological environment, collaboration seems to be less of an important skill.” She then expressed her frustration that teachers themselves did not collaborate, then asked, “If teacher collaboration is not happening, then how is learner collaboration even going to happen?” Natasha, from SHC, also showed scepticism around collaborative classroom activities in stating, “I’m not big on group work. Practically, it’s difficult.” Data

therefore suggests a possible lack of understanding between what constitutes group work and collaboration and effective assessment strategies.

Medium to high teacher-student interaction combined with conceptualising and experiencing the known also contributed to rich learning experiences. In one of the English lessons at QC, the teacher drew on learners' lived experiences and prior knowledge to help them grasp the concept of setting in relation to short stories. Instead of providing a definition, she asked, "What is setting?" She continued, "How would you describe the top of Table Mountain?" followed by, "What do you smell?", "Have you been to Cape Town when it's wet and windy?", "How does it feel?" Learners responded by sharing their experiences. The teacher then asked, "How does it feel in Johannesburg as opposed to Durban?", to which one learner responded, "It's dry here" while another said, "It's humid in Durban." The teacher then commented, "Do you see how we're describing the setting?"

Rich learning experiences were equally evident in the combination of two or more knowledge processes and two or more modes of interaction. Student-content and teacher-student-content interaction were observed in a multimodal World War 11 History lesson at HHS. The lesson began with low teacher-student interaction as the teacher spoke briefly about the dropping of the atom bombs on Japan. Low student-student interaction followed, as learners watched a YouTube documentary of interviews with the survivors of the bombing to experience what it was like for the survivors. Experiencing the new was thus followed by analysing critically as medium teacher-student-interaction occurred during a debate on the question, "Was America justified in dropping the bombs?" The teacher and learners drew on information from their textbook and the video content to discuss the issue. The debate ended with one learner stating, "America wasn't aware. The bomb had never been used before, so they weren't aware of the damage that they were going to cause and mostly civilians were affected and generations afterwards." Most learners responded by clapping in agreement.

Medium teacher-student and teacher-student-content interactions representing the knowledge processes of conceptualising with theory, experiencing the known and the new, and analysing functionally occurred in Palesa's English lesson at HHS. The lesson focused on two African poems, one, a South African praise poem and the other, a Ghanaian poem. The initial discussion elicited minimum learner interaction in response to Palesa's questions. After briefly describing the structure of a praise poem, one learner remarked, "I can't relate to this poem. I can't even recognise this as a poem" to which the teacher responded, "Let me challenge you. Is music poetry?" What followed was medium teacher-student-content interaction as she co-opted learners' known lived experience of rap poetry to make sense of the new. Learners became more engaged when she asked, "Is rap music poetry?" One learner replied, "Yes" while another said, "Poetry is a formal way of expressing yourself" and yet another added, "Rhythm is what makes music poetry, which makes music in the lyrical form, but some music has no rhythm to it." Palesa then read the lyrics of a rap song that was at the back of the book. Some of the student became animated. She then posed the question again, "Is music poetry?" to which most learners agreed that it is. The teacher concluded that to an extent music is poetry, like Praise Poetry. This example shows the teachers' attempt at critical

and functional analysis as she drew on learners' appreciation of the rap genre to create an appreciation for Praise Poetry as a legitimate form of poetry. This lesson could have been enhanced by the streaming of a YouTube video showing a Praise Poetry performance since there was ubiquitous Wi-Fi access, and the technology available for a richer lesson.

Lauren's English lesson at BC during which learners were tasked with listing the similarities and differences between Elizabethan and contemporary women as part of their study of Shakespeare's *Twelfth Night*, combined high student-student, medium teacher-student and medium to high teacher-student-content interactions. In presenting the findings from their collaborative internet research, learners not only listed the similarities and differences but drew on their prior knowledge and lived experiences to connect local and global issues and interrogate topics such as patriarchy and power. The debate also touched on the issue of the marriage transaction, particularly the dowry system, as learners drew comparisons with the lobola system in South Africa. In exploring the issue of gender identities in the play, learners referred to the recent spate of femicide in the country. Although the literature text seemed alien to the learners' lived experiences, Lauren related it to the learners' interests, and in this way, harnessed their known experience to make sense of the new while incorporating aspects of critical and functional analysis. In our interview, she emphasised her explicit focus on critical literacy in stating, "We have to be able to equip our learners with the ability to be able to think and analyse and interrogate and question."

In another example of teacher-student and teacher-student-content interaction, Alice from DC combined different knowledge processes to help learners make sense of the term propaganda and its link with conscription in World War 1. She started the interaction by asking, "What is propaganda?" Learners' responses included references to utterances of former US President Trump and the use of propaganda in advertisements. Alice then asked learners if they thought propaganda was used during their Grade 8 camp to persuade them to think that the school was great. She then used this to facilitate understanding of the concept of enlistment in the military. One learner then questioned, "Doesn't education somehow count as propaganda? They teach you what they want you to believe." A discussion ensued about the apartheid state's use of propaganda to control education. This lesson illustrated learner questioning, a key indication of critical analysis. Additionally, the learner question about education being propaganda showed the transfer of knowledge from their English protest poetry lesson during which they explored the issue in their analysis of the song, "Another Brick in the Wall." Knowledge transfer in this instance introduces the knowledge process of applying appropriately. Learners also drew on their knowledge of current events featured in the news while the teacher wove between conceptualising and analysing while harnessing learners' experiences to create a deep understanding of the concept of propaganda.

William from BC used a similar mix of knowledge processes and modes of interaction in the history lessons on Zimbabwe. There was evidence of the four modes of interaction with teacher-student-content being the highest, combined with the knowledge processes of conceptualising by naming, experiencing the known, and analysing critically. Learners drew on their knowledge of recent xenophobic incidences in the country to discuss the issue of

xenophobia and Pan-Africanism. In our interview, William explained, “We’ve changed a lot of curricula based on what pupils have said. Pupils have said we want to learn more about African countries. So, we’ve introduced something on Zimbabwe that we would never have taught in Grade 9 before.” By doing this, learners’ participative agency was privileged since the topic was based on learners’ interests and recommendations.

Conclusion

Drawing on teachers’ best practices, from this study I conclude that the overarching thread is the importance of diversity in the 21st century secondary school learning environment. Diversity is reflected in teachers’ application of different semiotic modes for making meaning. Consequently, a key characteristic of the contemporary learning environment is multimodality. This was observed in the way some teachers harnessed visual, audio-visual, gestural, and other modes while moving between representative and generative application of digital technologies. Representational forms like performance are important manifestations of multimodality in South Africa (Stein & Newfield, 2006). Digital technologies afford the incorporation of other knowledge sources thereby adding to the diversity of texts used in the classroom. hence, it is but one aspect of a multimodal approach.

Another significant feature of the 21st century learning environment, is a diverse pedagogical mix incorporating various modes of interaction and knowledge processes. Such diversity would effectively counter the limitations of teacher-centred, one-size-fits-all didactic approaches that have been criticised in the literature. The harnessing of learners’ epistemological diversity is a crucial aspect of a diverse pedagogical strategy which could facilitate the achievement of equity, an issue that is central to the CAPS curriculum. Rich learning experiences were observed when teachers co-opted learners’ diverse knowledge resources including their lived experiences and background knowledges while acknowledging their participative agency. This was particularly noticeable in classrooms in which learners were given the freedom to select the poem they wanted to analyse, whether they wanted to work alone or collaboratively, and also the composition of the groups. Learner input into the topics to be studied for history also demonstrated the harnessing of their participative agency.

The 21st century learning environment needs to be equally flexible. Flexibility is directly linked to freedom of choice and the harnessing of learners’ epistemological diversity. Such examples of flexibility were also observed in the flexibility of learning spaces. The inclusion of the Zimbabwe as one of the history topics at Baker College reflected curricular flexibility. However, I acknowledge that curricular flexibility may be difficult for schools that follow the CAPS curriculum. As one high school principal remarked, “We are limited in terms of the extensive CAPS curriculum... (so) we’re also hamstrung by what the DoE wants us to do.”

In conclusion, the effective use of digital technologies, a multimodal approach to learning, and a rich pedagogical mix all require high teacher self-efficacy (Neugebauer et al., 2019; Sang et al., 2010) and continual professional development.

Recommendation

As technologies become more advanced, teachers and learners require digital literacy skills to be able to harness their multimodal potential. Hence, teachers need ongoing, situated professional development (La Fleur & Dlamini, 2022). It is equally vital that learners have opportunities to learn about technology in a contextualised way (Jonassen, 1996) since this fosters the development of their digital fluency. This is of particular importance for those learners with no out-of-school digital access. While acknowledging that many South African schools face resource constraints, it is important for school leaders to re-think the issue of access, especially for disadvantaged learners, and strive to find innovative ways of optimising the technologies available in learning centres and computer laboratories. As Mariette from SHS pointed out, digital technologies should not be exclusively accessible to IT students.

Statement of ethics

Ethics approval was received from the University of the Witwatersrand to conduct this study. The participating schools and educators, whose identities remain anonymous, also granted permission for the conduct of the research and the use of its data for academic articles. There are no known conflicts of interests, and the data is not available for open access.

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