

EMBRACING NEW TECHNOLOGY TO ENHANCE TEACHING AND LEARNING FOR SCHOOL LEARNERS

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ABSTRACT

Teaching is under the microscope in terms of delivering quality learning to students in the classroom. New technological tools, such as simulations that extend the understanding of physics concepts, laser discs, video tapes, CDs, computer analysis of digitised videos and presentation software have made their way into the school arena. The new technologies at a teacher's disposal add value to the teaching experience and improve the quality of the teaching service provided. From a basic marketing and public relations perspective, when a school looks to improve its quality of teaching, it should look at the learners' needs in terms of teaching and learning. Learners of today are technologically advanced, since they live in the digital age. Teachers can therefore embrace technology tools that can help facilitate the learning process in the classroom. Since learners enjoy interacting with their cell phones, computers and tablets, teachers today need to use these technology tools for teaching, where possible. New technologies should therefore enhance classroom teaching and learning. In this paper, a literary review of various theorists' views is explored. The research is qualitative in nature and is based on understanding the different approaches taken by different countries and theorists on the subject of adopting new technology in the classroom. By looking in the literature at the various studies undertaken, the pros and cons for embracing new classroom technologies for Africa are examined.

Keywords: *Technology, teaching, learners, students, schools*



INTRODUCTION

We live in the age of computers. Technology has bridged all areas of society, from government to large corporate entities, civil society and education. Technology has changed the classroom dynamics. Traditional instruction in a classroom takes place in a fixed space, while e-learning transcends boundaries and is designed and formatted in a more open and flexible manner. E-learning is remarkable in that the learner can access classroom material at work, at the gym, in the park or in his or her own bedroom. Change is part of teaching, whether it is teaching at school, within Africa or in the world at large. New technology is part of this change. As a teacher, one needs to come to terms with change and embrace it, as technological developments will no doubt play a crucial role in education in the future. Technology can change the teaching experience, introduce a wider variety of learning styles and ensure faster marking of scripts in certain instances. New technology is thus a valuable tool in classroom education that can be used by teachers in Africa. If it can enhance the quality of education, as many theorists advocate, then African teachers need to be trained to use these new technologies in their classrooms.

In the discussion that follows, various themes are put forward for discussion in terms of technology in education, with specific reference to schools. Technology in classrooms in Africa will also be looked at specifically.

LITERATURE REVIEW

Lim, Zhao, Tondeur, Chai and Tsai (2013) argue that schools are under pressure from the media, the public at large and government to ensure that technology is used for teaching and learning. These advocates of using technology in schools believe that students' learning outcomes are enhanced by the considerable magnitude of investment in technology. Bhattacharya and Richards (2001) are of the opinion that teachers need to transcend traditional approaches and become acquainted with new methods of teaching in order to get a clear understanding of the educational functionality of technological tools in their educational practices.

In the literature that was reviewed, various themes, theories and perceptions were explored. The researcher identified two important theories that formed the foundation of the use of new technologies in the classroom. These will be discussed in greater detail below. The discussion will begin with the theoretical framework that supports the use of technology and information and communication technologies (ICTs) in classroom teaching.

THEORETICAL FRAMEWORK

Although there are many theories that support the use of technology and ICTs in the classroom, the researcher focused on two theories: constructivist theory, and neurosciences and 21st-century learning paradigms. The discussion will start by focusing on the constructivist theory.

Constructivist theory

In 1934, Vygotsky set the framework for the constructivist theory. Bruner picked up on this and, in the 1960s, further added to the foundation of constructivist theory Olsen (2000). Olsen (2000) also suggests that there are “two main branches of constructivism”. One is based on the philosophical theories of learning and the other is based on psychological theories.

Pagan (2006) posits that a major theme in Bruner’s constructivist theory is that learning is an active process, whereby students learn best by constructing new ideas and building new schemas based on current and previous knowledge. Pagan (2006) adds that constructivist instruction theory addresses four important aspects of the learning process: students’ predisposition towards learning, how to structure knowledge so that it can be readily understood by the learner, the most effective sequence in which to present materials, and the nature and pacing of motivational rewards and punishments.

In the discussion that follows, the core pillars of constructivist theory will be identified and practical examples will be put forward to expand on how this theory supports the use of technology and ICTs in the classroom.

Taber (2006) identifies the following core pillars that underpin constructivist theory:

- Knowledge should be actively constructed by the learner, not passively received from an external source. Learning is therefore something done by the learner and is not an activity that is imposed on the learner. Information that is required by schoolchildren is readily available on the internet via Google. As a result, learners today like to obtain information online that they can use to understand and complete class assessments, for example. They therefore no longer depend on only what is in the textbook and what they learn in the classroom.
- Learners come to the learning situation (in science, etc.) with existing ideas about many phenomena. Some of these ideas are random and unsubstantiated;



others are more deeply rooted and well developed. The digital age has resulted in learners already being exposed to ideas on the subjects taught in class. In science, learners today understand more concepts than they did in the past as some of them have already seen them on television or on YouTube.

- Learners have their own individual ideas about the world, but there are many similarities and common patterns in their ideas. Some of these ideas are socially and culturally accepted and shared, and are often part of the language, supported by metaphors, etc. They could also often function well as tools to assist understanding of many phenomena. By using technology in the classroom, teachers could play a video in the classroom to show young students how culture affects people's views on eating habits, for example.
- These ideas are often at odds with accepted scientific ideas, and some may be persistent and hard to change. The Big Bang Theory, for example, is often difficult for a school learner with a religious background to understand and process as he or she has already been taught by their priests and family members that God created the world.
- Knowledge is represented in the brain as conceptual structures, and it is possible to model and describe these in some detail. The brain stores information, and through memory, this information can later be recalled. The teacher needs to build constructs in children's minds in a manner that they can later recall and understand information. With the aid of technology, like tools with game simulations, a child can enjoy the learning method and remember what has been taught in the classroom.
- Teachers have to take the learner's existing ideas seriously if they want to change or challenge these ideas. Students have very enquiring minds that should be challenged by the teacher so that new ideas can be learned and processed. The teacher also has to understand the student's views. By positively encouraging a young mind in the classroom, ideas can be shared, which further adds to learning.
- Although knowledge is personal and individual, in one sense, learners construct knowledge through their interaction with the physical world, collaboratively in social settings and in a cultural and linguistic environment. (The relative stress on such factors accounts for the different "versions" of constructivism alluded to earlier.) The world can shape the mind of a student in the classroom. By using technology during classroom sessions, a student can actively engage with other learners by using online platforms to discuss pertinent issues about the world today. A teacher can create chatrooms for students in an ICT class, for example, and ask students to explore how the internet has changed people's lives.

Mos (2003) indicates that, in constructivist theory, learning is not simply about being exposed to new information, but is an active process in which learners should examine, code, decode and interpret new concepts and ideas. Mos (2003) adds that educational models that utilise constructivist theory consider these influences and attempt to match education systems and curricula to each socio-culturally distinct group of students. They also build programmes and train instructors to encourage students to discover principles on their own, using the knowledge they already have to embrace and internalise information. Scientific reasoning is another learning technique that students can employ in constructivist education. As mentioned above, students must formulate and test hypotheses, build and adjust mental models, and form conclusions based on the course material and their own research (Echevarria, 2003). The views explored by the constructivist theorists are indicative of how important ICTs and technology can be in improving teaching in a classroom setting.

Another theory that supports the use of ICTs in the classroom is the neurosciences and 21st-century learning paradigms. The discussion that follows will highlight these learning paradigms in detail.

Neurosciences and 21st-century learning paradigms

Teachers need to understand the learner's brain and how the learner learns and processes information in the classroom. This is not easy. Neurologists, physiologists and educationists are researching this area. The theory below can help us understand how technology affects a child's brain, for example. Jean Piaget, a well-known theorist, made an enduring contribution to psychology and education. Throughout his career, Piaget strongly grounded his work in biology and tied it to education as phenotypic adaptation (Piaget, 1980). According to Smith (2000), Piaget's research famously identified four stages of cognitive development: the sensory-motor stage, the pre-operational period, the concrete operational stage and the formal operational stage. Piaget also proposed adapting these to specific educational settings, along with a biological explanation for how they were instantiated. Multi-sensory teaching skills in the classroom are important. According to Wilmes, Harrington, Kohler-Evans and Sumpter (2008), scientists believe that over 80% of all information that the brain absorbs is visual, making lighting and colour particularly important factors in the learning environment. Additionally, medical research has found that the ear has more extensive brain connections than any other nerves in the body. Therefore, factors such as sound and music have been identified as possible significant contributors to learning in the classroom.



In multi-sensory teaching, the teacher can use hearing and sight to teach learners new concepts in the classroom. For example, if a video is shown during a classroom lesson on poverty showing Justin Bieber talking about poverty in Africa, learners will watch and listen to the video. Secondly, since many classroom students love Justin Bieber, they are more likely to take the lesson on poverty seriously, as a celebrity is commenting on the subject. School learners are very taken in by celebrity role models. Technology can therefore be used in a positive way to stimulate the minds of young, impressionable learners.

The views put forward by the theorists below add to the value and importance of using ICTs as tools to facilitate learning in school learners. Galimberti, Bednare, Donato and Caroni (2006) argue that adolescents experience extensive brain transformation as they move towards cognitive, emotional and social adulthood. As a result, they are particularly susceptible to the outside forces found in the environments of the school, home and recreation. Each new experience interacts with and sculpts the brain, and they will take these experiences with them into adulthood. Of the many external sources interfacing with the teenage brain, technology is prevalent and potent. Anderson (2004) adds that the evidence from neuroscience is indisputable: the teenage brain is a brain in transition. Clearly, these changes are heavily dependent on experiences, and technology plays an integral part in facilitating learning. However, as we learn more about technology and the brain, it is important for educators to keep in mind that instructional technology is dependent on good teaching pedagogy and content knowledge, which are the cornerstones of academic achievement.

Studies conducted by Le Be and Markram (2006) and Paus, Keshavan and Giedd (2008), indicate that there is a relationship between learning and the number of neural connections in a learner's brain. The educational implication is that students who learn a great deal in a subject area grow more neural connections in response to the stimuli they receive. Conversely, neglect of an area inhibits neural connections from forming. For instance, students who dedicate themselves to playing the piano have more neural connections in that part of the brain than those who are not musically inclined. It appears that the introduction of neuroscience into an Initial Teacher Education programme can support and facilitate the transfer of neuroscientific knowledge into best practices in the classroom. It was found that of 95 new teachers who had taken a course on the adolescent brain, over 90% stated that their knowledge of neuroscience research had impacted significantly on their classroom practice (McBride & Todd, 2008; McBride & Pomeroy, 2009).

In light of this, in Africa, teacher training should also include such courses. Since the brain is central to a child's development, teachers in Africa need to understand its workings and the physiology that affects children's learning abilities. Pittler, Hubbell, Kuhn and Malenoski (2007) argue that technology is shaping the world we live in, and, as a result, our students' brains are rewiring and restructuring themselves. Burgeoning findings on the impact of e-learning on the teenage brain has helped inform instruction. Tutorials, gaming and graphic organisers are all compatible with the teenage brain. While computer-based instruction provides the medium, it is important for educators to recognise that the instructional design ultimately determines the effectiveness of the means of instruction.

According to Tokuhama-Espinosa (2011), there has been an increasing call for bidirectional collaboration between educational psychology and neuroscience. The early 1990s saw more international and interdisciplinary cooperation in this arena. Tokuhama-Espinosa (2011) adds that new neuroscientifically based reading curricula, like RAVE-O (retrieval, automaticity, vocabulary, engagement with language, orthography) and Fast ForWord, were developed and are being successfully applied in the classroom. From the above discussion, it is clear that new technologies are important tools that can add value to the teacher's lessons and can assist positively in classroom teaching.

The discussion that follows will focus on the typology of new technological tools used in the classroom.

THE TYPOLOGY OF NEW TECHNOLOGICAL TOOLS FOR TEACHING AND LEARNING

Classroom instruction has evolved beyond the use of textbooks and the blackboard. Since technology has evolved and taken root in many of society's hallways, the classroom too has needed to change, and it has done so by including new technologies as teaching tools. These technologies can be used to assist teachers to enhance their teaching in the classroom. In this century, teachers have an array of new technological tools at their disposal. Some of these technologies are listed below:

- Simulations to extend understanding of physics concepts
- Laser discs, video tapes, CDs
- Real-time data collection and graphic analysis tools associated with computer-interfaced probes and sensors



- Computer analysis of digitised video
- Presentation software
- Interactive student assessment software (Flick & Bell, 2000)

If taken a step further, schools in Africa can use a combination of classroom and e-learning modes of delivery. In e-learning, the Joint Information Systems Committee (2004) indicated the following technology that is being used in e-learning environments:

- Desktop and laptop computers
- Software, including assistive software
- Interactive whiteboards
- Digital cameras
- Mobile and wireless tools, including mobile phones
- Electronic communication tools, including email for discussion
- Virtual learning environments
- Learning activity management systems

Examples and studies will be outlined that indicate how some of the technological tools mentioned above can be used by teachers in the classroom.

Throughout the world, movies are seen as an integral part of society's popular culture. Movies can also be used effectively in classroom teaching as it gives the learner an enjoyable way of learning outside the traditional classroom environment. According to O'Babbon and Golddenberg (2008), movies are an effective teaching tool. A prepared educator can use a movie to stimulate a discussion session in the classroom. A teacher can also use movies to facilitate learning on a topic such as poverty, AIDS or wealth creation. Furthermore, the teacher can use movies to re-emphasise material that is being presented through textbooks or classroom presentations, which students might consider to be boring. By showing a movie in the classroom, a teacher can pair it with interesting methods of framing and debriefing. This provides a form of active learning that can be very useful to learners. A reason for the success of this teaching tool is that the teacher can reach diverse students in the classroom through movies (Robinson, 2000). Another benefit of using movies as a teaching tool is that they help humanise the teacher and encourage learners to engage with them (Wilson, 2004).

Some teachers use technology to stimulate learning in very young learners. O'Babbon and Golddenberg (2008) argue that pre-schoolers are learning to use

technology at a very early age. Tweens (9-12 year olds) and screenagers (tweens and young adults) have become accustomed to using digital devices and media input (Rushkoff, 1996). Screenagers opt to use Google or Wikipedia to do their homework, instead of working through piles of books in a library. This change is attributed to today's learners having become habituated to getting information quickly and easily. This is what makes technology so appealing to them. The view of Younge (2002) is that traditional means of teaching and learning do not always hold the attention of young people, who live in a technology-based, popular culture-worshipping society. O'Babbon and Golddenberg (2008) suggest that educators must be aware of what motivates learners. If they have to teach teenagers and screenagers, for example, their learning needs are often met when a movie is incorporated into their formal education. Watching a movie is very stimulating to a teenage learner, just as discussion during the debriefing can be. Teachers need to understand that movies provide an excellent opportunity to address different types of learning in the classroom. For example, a visual learner takes in a movie visually, whereas an auditory learner learns by listening to the movie and then to the discussion that follows. When teachers address learning styles through popular culture, learners' capacity to learn, understand and retain information is increased. This can be seen in the visual learner's appreciation of moving images and the auditory learner's interest in dialogue and music.

Another tool that is used on the education frontier is e-learning. Khan (2005) suggests that the design and format of e-learning is more open and flexible than traditional learning. It is also not as space-bound as traditional classroom instruction. Kearsley (2002) indicates that traditional instruction is a closed system within the confines of the classroom, school, textbook and field trip. This can often limit the learner. Employing e-learning can allow the teacher access to the learner beyond the traditional space boundary.

Another new technology that is being used increasingly in the education arena is mobile learning. Sharples, Taylor and Vavoula (2005) posit that, given that social interaction is central to effective learning, as indicated by theories on new learning, mobile phones would also impact on educational outcomes by facilitating communication. Mobile phones permit collaborative learning and continued conversation, despite the physical location of students. Mobile learning can also stimulate students from different cultures and backgrounds to talk to each other. This type of learning allows learners to engage in conversations to resolve their differences, understand the experiences of others, and create common interpretations and an understanding



of the world around them. In his study, Ramos (2008) used an English module that contained an audio CD containing the workbook exercises in audio form to help learners with proper pronunciation and dictation. The modules were designed in such a way that SMS quizzes and tests had to be passed in order to complete the modules. In this study, Ramos (2008) indicated that learners expressed excitement regarding the use of mobile phones for learning. One learner mentioned that the learning process was akin to answering trivia questions, with feedback provided immediately on whether the answers were right or wrong; this feedback ensured that the learner did not repeat any errors.

A study by Valk, Rashid and Elder (2010) investigated a project led by the Molave Development Foundation Inc. (MDFI) and funded by the International Development Research Centre (IDRC). It explored the study of Kam, Kumar, Shirley, Mathur and Canny (2009) on improving literacy in rural India using cell phone games in an after-school programme. The children who participated in this programme were from rural, low-income families. With the assistance of an Indian English Second Language (ESL) teacher, Kam et al. (2009) devised a curriculum that was aligned with local ESL learning needs and which represented the equivalent of the material that a qualified teacher could cover in 18 hours in a classroom setting with rural children. The cell phone games targeted listening comprehension, word recognition, sentence construction and spelling, and were constructed at various levels. The programme consisted of two-hour sessions that spanned 38 days from December 2007 to April 2008. The results of the study indicated that the children enjoyed the gaming and that it stimulated their learning.

A study performed by Anderson and Barnett (2013) in the USA examined how a digital game used by learners aged 12 to 13 years increased their understanding of electromagnetic concepts, compared to learners who had conducted a more traditional inquiry-based investigation of the same concepts.

In the discussion that follows, the benefits of using new technology will be explored, with specific reference to the African continent.

BENEFITS OF USING NEW TECHNOLOGICAL TOOLS FOR TEACHING AND LEARNING IN AFRICA

Brush, Glazewski and Hew (2008) have stated that ICT can be used as a tool for students to discover learning topics, solve problems and provide solutions to problems in the learning process. ICT makes knowledge acquisition more

accessible, and concepts in learning areas are understood while engaging students in the application of ICT. In Africa, school learners can use ICT tools in the classroom to discover new learning topics, e.g. doing a Google search on Google Earth. The speed at which the internet provides information makes it a very desirable tool to young teenagers.

In a study conducted by Jewitt, Clark and Hadjithoma-Garstka (2011), the following conclusions were put forward on the benefits to school learners of using ICT in the classroom:

- Using digital resources provided school learners with more time for active learning in the classroom.
- Digital tools and resources provided more opportunity for active learning outside the classroom, as well as self-directed spaces, such as blogs and forums, and access to games with a learning benefit.
- Digital resources provided learners with opportunities to choose the learning resources.
- The resources provided safer spaces for formative assessment and feedback.
- African students can also enjoy these benefits by using ICTs in the classroom, as research has shown this to be the case elsewhere in the world.

Teachers in Africa could videotape their lessons and podcast these to learners who live in remote locations and cannot travel during the rainy seasons. Learners could also use a computer in a local library in their village to access the lessons.

Interesting debates by educational experts suggest that new technology is the way to go. Jochems, Van Merrienboer and Koper (2004:166) suggest that "learning is integrated with other activities such as knowledge, skills, attitudes and competencies, and quality is judged by the impact on the organisation involved". Opting to use new technology in the classroom will change the focus of learning and recreate the role of the teacher.

In Africa, using technology in the classroom would force the learner to become more focused. The learner could develop skills as he or she uses the new classroom technology. This type of classroom learning forces the learner to become more engaged in the learning process. The learners are no longer only concentrating on mastering the academic subject matter, but are also learning a skill. The role of the



teacher is then transformed from merely being the subject expert, the transmission medium or examiner, to being the subject guide, knowledge intermediary and assessor. The teacher becomes the coach in this instance. This adds value to the teacher's everyday duties. Learners see the teacher in a new light: that of motivator and guide. Transforming the teacher into a coach opens up the mode of learning on both sides.

In the discussion that follows, reservations about the educational use of new technologies will be debated.

RESERVATIONS ABOUT THE EDUCATIONAL USE OF NEW TECHNOLOGIES

Today's children are "digital natives". They live in a world where computer technology is on every corner. However, their teachers are much older and had a totally different experience growing up, as they were not exposed to digital technology at every turn. These teachers are the "digital immigrants", who are now tasked with addressing the needs of school learners who are technologically advanced and computer savvy. The role of the teacher has increased tenfold, as teachers have to grapple with these new technologies and make sense of them in order to employ them in their classrooms.

Some educationists argue that new technology can only be used in first-world countries as they have a well-built infrastructure for school programmes that make use of such technologies. Africa has unique problems that include war, famine, poverty, AIDS/HIV and other diseases, and does not have the money to provide expensive technologies in the school system. Spector and Davidsen (2000) suggested that one single and typically simple approach to using technology to support learning would not succeed.

The African continent is not like the rest of the world when it comes to school education systems. In Africa, the school systems are in a state of constant transformation. This has resulted in many problems. An interesting view put forward by Jochems et al. (2004) is that organisational, pedagogical and technological aspects have to be managed in a harmonious manner in order to adequately solve the current educational problems. Learning technologies can play a pivotal bridging role in African schools. They can be the catalyst that can assist ministries of education

within African governments to formalise pedagogical and organisational thinking in such a way that they can be implemented as a workable, technical solution in the long term. African school systems can survive in the global landscape if governments are willing to set aside large amounts of money to benefit the continent as a whole.

In a study conducted in Indonesia, Marwan (2008) suggested the following barriers to integrating technology into teaching:

- **Lack of knowledge and skills.** Despite their active use of technology into pedagogy, most teachers felt that they lacked adequate knowledge and skills for optimally integrating the facility into teaching. One respondent, for example, admitted: "I frequently use technology to support my teaching, but, honestly, I am only able to use basic computer programs such as email programs and PowerPoint. I never use other programs such as those that enable computer-mediated communication (CMC) or desktop teleconferencing. Knowing how to operate other advanced programs would be very useful, I think."
- **Lack of technical support.** For another respondent, "technical staff should be available before, during and after the class sessions". Yet another respondent added: "Once I was about to start my teaching and I had difficulty in turning on the LCD projector ... I tried to seek help, but no technical staff was available at the time, so I finally decided not to use the computer in my teaching."
- **Lack of incentives.** Throughout the interviews, lack of incentives was repeatedly mentioned by several teachers. They admitted that no additional incentive was provided by the institution to use the innovations that are available. According to one respondent: "The main reason I use technology for teaching is because I like learning new things and I like technology ... If I didn't, I would be less likely to use it, unless there were incentives for that."

Since e-learning is part of the new technological advancement that is taking place in teaching, the next section will touch on this area.

The above barriers cited by Marwan (2008) are also barriers that African teachers face when using technology in the classroom.

Lack of funding to build infrastructure makes it difficult for teachers in Africa to use e-learning. Since the infrastructure for e-learning is not in place in many parts of Africa, it is often difficult for e-learning systems to be implemented.



Secondly, in certain parts of Africa, the reality is that rural communities are dealing with AIDS/HIV and other diseases, as well as dire poverty, which means that dispatching computers to these communities is not the highest on government's agenda, since food, clean running water and medication is considered to be of greater importance. Another shortfall to e-learning is having a great system, but not having sufficient technical support.

Power outages on the African continent are also a major obstacle that slows down the use of ICT in the classroom. Another serious problem associated with new technology in teaching is that African children can become addicted to gaming. This can have an adverse effect on their personalities. They can go home and not be very communicative with their parents, for example, as they become so engrossed in gaming that they cease to distinguish reality from fantasy.

The need to train teachers to understand and use new technologies in the classroom will be discussed in detail below.

THE NEED TO TRAIN TEACHERS TO USE NEW TECHNOLOGY

Research suggests that the successful implementation of technological innovations in the classroom is more likely to take place when teachers are highly reflective about their own teaching practice and goals, in the sense that they consciously use technology in a manner that is consistent with their pedagogical beliefs. In Africa, teachers have to be trained to implement technological tools that could enhance their teaching and learning. Since change is often hard to deal with from a personal perspective, workshops on change should first be introduced, before formal training sessions occur.

It is often good to learn from our counterparts in the West how they managed to conduct training in their countries, and to adapt these techniques, where possible, to the African classroom context. According to the National Staff Development Councils (NSDC) in the United Kingdom (2001), technology purchases had increased dramatically in many school districts in the United Kingdom during the past decade, often with little attention given to the development of teachers' ability to use technology. The NSDC advocated that at least 30% of the technology budget be devoted to teacher development in this area. African ministries of education should also put teacher development programmes in place to upskill teachers on the new technologies. By doing this, teachers can plan and practise what they have learned. The investment made in rolling out new technologies in classrooms would not fail if government explored such initiatives.

African educationalists can learn from the proposals set forth by educationalists abroad in the science field. Flick and Bell (2000) proposed the following guidelines for using technology in the preparation of science teachers:

- Technology should be introduced in the context of science content.
- Technology should address worthwhile science with appropriate pedagogy.
- Technology instruction in science should take advantage of the unique features of technology.
- Technology should make scientific views more accessible.
- Technology instruction should develop students' understanding of the relationship between technology and science.

Flick and Bell (2000) argued that, despite Western society's heavy dependence on technology, few teachers actually understood how technology was used in science, for example. Using technologies in learning science provides opportunities for demonstrating to new teachers the reciprocal relationship between science and technology. New teachers could develop an appreciation of how advances in science drive technology. In Africa, the same is true: teachers need to be trained to apply the new technology to their specific field of teaching. For example, in Africa, a teacher can show a physical science video on solids, liquids and gases during the lesson. They could then take it a step further and stimulate the young minds by showing them YouTube science fair inventions.

Harwell (2003), from the Centre for Occupational Research and Development (CORD) in the USA, recommends that, in preparing teachers on how best to teach content, and then equipping them with knowledge and skills, there should be programmes in place to support professional teacher development. These programmes should not only empower teachers to succeed in the present, but should also enable them to improve their skill over time. This is especially true with respect to technology, which has become an essential tool in teaching and learning, and will continue to play a significant role in education far into the future.

In the science discipline, new technology can be actively integrated into the curriculum to stimulate student learning. Flick and Bell (2000) argued that the impact of digital technologies on science teacher education is more pervasive than curriculum or instructional innovations in the past. Digital technologies are changing the way teachers interact with students in the classroom in a good way. Ahburn and Floden (2006) drew insights from the studies done by Becker (1999),



Zhao and Frank (2003) and Zhao, Pugh, Sheldon and Byers (2002), arguing that studies of teaching and teachers' beliefs have shown that teachers who are more reflective and aware of their own pedagogical beliefs are generally more adaptive and flexible teachers. They can also adopt new technologies more easily.

Technology can also assist teachers in marking their assessments. Teachers in Africa have very large classes and multiple-choice questions can be used as a class assessment. These assessments can then be marked electronically. This can make a teacher's life far less stressful.

Teachers in Africa can use e-learning. The benefit of having an e-learning system is that learners from all age groups could work and study in their own time. This flexibility can benefit many who are illiterate or semi-literate by enabling them to work and study. NGOs can now develop programmes to accommodate such rural people in Africa. In Africa, teachers do not have the training they need to use the new technologies. A way forward is that government can work with the NGOs in rural communities to train teachers in using new technologies to enhance their classroom teaching practice.

Teachers also need technical support staff at hand to assist them when they encounter difficulties in the classroom. School administrators should budget for this and motivate for such support.

The above discussion clearly outlines the need for the training of teachers and technicians. Technicians have to be present to assist teachers if they experience challenges.

CONCLUDING REMARKS

In Africa, we have to look at the new technologies being used elsewhere in the world. Since the explosion of the internet, the world is a global village. Teachers have to respond to these challenges. Using new technologies in teaching can lead to better teaching styles, assessment times and feedback. This would, in turn, improve the overall quality of teaching. In Africa, teachers need proper training to understand the new technologies. The bottom line is, whether we like it or not, change is here in the form of new technologies in the classroom. African teachers must embrace technology as a teaching tool. At the end of the day, technology can never replace the human aspect that only a teacher can bring to the classroom.

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