Faiq Waghid

Cultivating critical pedagogy using educational technologies in Life Sciences classrooms

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This article explores the use of educational technologies in Grades 10 to 12 Life Sciences classrooms at a local high school in the Western Cape. The application of educational technologies in science classrooms has the potential to engender critical teaching and learning, and to contribute to professional development. By reflecting on my own professional development as a science teacher, I show that the use of educational technologies cultivates moments of critical pedagogy which link strongly with reflective teaching, critical thinking and transformative learning. Educational technologies can enhance reflective teaching whereby teachers can take theories and expertise in their practice seriously, organise their classrooms to facilitate critical learning, and address broader institutional and social issues.

Kweek van kritiese pedagogiek deur onderwys-tegnologie in Lewenswetenskap-klaskamers

Hierdie artikel ondersoek die gebruik van onderwystegnologie in grade 10 tot 12 Lewenswetenskap-klaskamers by 'n plaaslike hoërskool in die Wes-Kaap. Die toepassing van onderwystegnologie in wetenskapklaskamers het die potensiaal om kritiese onderrig en leer teweeg te bring, en 'n bydrae tot professionele ontwikkeling te maak. Deur te reflekteer op my eie professionele ontwikkeling as 'n wetenskapsonderwyser dui ek aan dat die gebruik van onderwystegnologie kritiese pedagogiese oomblikke kultiveer wat sterk aanklank vind by reflektiewe onderrig, kritiese denke en transformatiewe leer. Onderwystegnologie kan reflektiewe onderrig bevorder deurdat onderwysers teorieë en kundighede ernstig opneem, klaskamers organiseer om kritiese leer te fasiliteer en breër institusionele en sosiale kwessies aanspreek.

Mr F Waghid, Dept of Curriculum Studies, Faculty of Education, Stellenbosch University, Private Bag X1, Matieland 7602; E-mail: 13809709@sun.ac.za.

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SUN MEDIA BLOEMFONTEIN

There is abundant literature on the professional development of science teachers in post-apartheid South Africa (Reddy 2004: 138). For instance, Johnson *et al* (2000: 1) argue that imposing Northern/Western ideas about teacher change and development on historically disadvantaged schools and teachers is inappropriate because practices in different physical, social and political contexts differ. I agree with this argument and shall thus examine the professional development of my position as a science teacher at the school where I happen to work. Similarly, Reddy (2004: 138) argues that professional teacher development at both pre- and in-service levels represents a major challenge for continuous teacher education. He asserts that professional teacher development needs to focus on assisting teachers "in the process of change" (Reddy 2004: 138).

In addition, it is widely recognised that the professional development of teachers is aimed at improving an education system and that teachers are "change agents" in these practices to improve education (Villegas-Reimers 2003: 12). One of the important tasks of teachers as change agents in post-apartheid (science) classrooms is to develop their "reflective capabilities" as part of their professional development (Reed *et al* 2002: 253). I thus consider my work in post-apartheid science classrooms as potentially contributing to my role as a change agent, particularly with respect to enhancing my reflective ability as a science teacher. It is hoped that I shall achieve this by using appropriate educational technologies in the teaching of science in a high school. According to Robinson (2003: 19), the professional development of teachers in South Africa should be linked to enhancing their levels of understanding and developing positive attitudes towards teaching. Taking my cue from Robinson, it is hoped that this article shall contribute towards extending my positive attitude towards science teaching by focusing on how the use of educational technologies can potentially simultaneously enhance teaching and learning in classrooms and my own professional development. I shall now discuss why the focus should be on educational technologies in relation to science teaching and learning.

In a globalised world the relationship between information and communication technologies (ICTs) has grown closer, with very high expectations of ICTs within the context of educational innovation (Smeyers & Depaepe 2007: 3). It appears that early educational practice was dominated by "chalk and talk", as well as "desks and texts", but with the development of ICTs, teaching and learning in schools have gained a new direction, in particular with respect to "the way in which knowledge and understanding (of teaching and learning) have undergone changes due to these recent developments in ICTs" (Smeyers & Depaepe 2007: 5). Consequently, education dispensations have the responsibility to ensure that learners are able to navigate through such technologically-oriented globalised educational demands (Jeremy 2000: 76).

The current educational dispensation in South Africa is preparing to promote the use of educational technologies in classrooms. An initiative of the Western Cape Education Department (WCED), a project called *Khanya*, was established in 2001 to determine the contribution that educational technologies could make to address the teacher shortage in schools. *Khanya* aims to determine how educational technologies can augment the professional development of teachers.[1] After graduating with a science degree from university, I joined the teaching profession a year later once I had completed a one-year teaching qualification. As a student in school and at university I had a particular interest in computer games and computer-based technologies. Like the majority of students at schools and universities worldwide, I also used social networking utilities, such as MXit and Facebook, to stay in contact with friends and family. Through my understanding of such computer-related technologies I could perceive how these technologies can be integrated into lessons and hence, possibly, enhance teaching and learning. In my first year of teaching I knew I had the content knowledge to teach reasonably well, but relied equally on my ICT competences and skills to improve my teaching at school by using educational technologies integrated into the teaching of Life Sciences. When one of the lessons I taught to a Grade 10 Life Sciences class was highly acclaimed

1 *Cf* http://www.khanya.co.za/news/

by an external evaluator from *Khanya* I realised how effective the use of technologies can possibly be for teaching and learning in public schools. This implies that learners can learn better and my teaching can also improve.

In the literature there appears to be some understanding that technologies stimulate the development of high-order skills such as critical thinking, reflective analysis and scientific (rational) enquiry (Jeremy 2000: 77). The majority of our current learners have access to mobile phones, even more so than to computers. Mobile devices are able to take photographs, videos, browse the internet, and have a built-in GPS that can guide you to within a metre of your destination. They can do what desktop computers can do but at a fraction of the cost – and they are more accessible. Although their mobile devices are banned from school, the learners still persist in bringing these devices to school. I am of the opinion that it would be challenging to prevent learners from bringing their mobile devices to schools. My contention is that teachers need to familiarise themselves with these devices and try to use the technologies (found in these devices) as tools for critically educating learners. My primary objective is to examine how the use of these technologies impacts on the professional development of teachers. I shall relate this and other instances of the use of technologies to my teaching practice, in which it is hoped I have developed professionally as a science teacher.

1. Teacher professional development, reflective practice and critical education

The seminal work by Schön (1983) entitled *The reflective practitioner: how professionals think in action* has undoubtedly been instrumental in shaping my understanding that a teacher's professional development should be centred on enhancing his/her ability for "reflection-action" – that is, learning by doing and developing the ability to sustain ongoing learning and problem-solving. My own teaching has to a large extent been influenced by an approach of "learning by doing" in the sense that my own professional development as a teacher has been guided by trying different

things and using different ways of connecting with my learners – an approach which inevitably inspired me to use educational technologies in making the content of Life Sciences known to learners. In this section I wish to focus on the professional development of teachers and how they could potentially become more open to critical education through reflection-in-action.

The work of Zeichner (2009: 121) has situated reflective teaching at the centre of teacher development. He argues that reflective teaching practice can be "seen as a reaction against a view of teachers as technicians who merely carry out what others, outside the classroom, want them to do" (Zeichner 2009: 122). Based on such a view of reflective teaching, which I consider as central to my own teaching practice in science classrooms, one can infer that reflection is ongoing and forms an integral part of a teacher's professional development. Like Zeichner (2009: 128), I am of the opinion that reflective teaching is a way of empowering teachers to "exercise their professional judgement about both the content of the curriculum and the means of instruction". Hence, one's professional development as a teacher hinges on the ways in which one embarks upon reflective teaching in classrooms.

In addition, Zeichner (2009: 127-8) claims that the importance of reflective teaching to the ongoing professional development of teachers is based on at least four aspects. First, teachers take theories and expertise embedded in their own and other teachers' practice seriously; secondly, reflection does not limit teachers' practice to technical questions of teaching techniques and internal classroom organisation; thirdly, reflective teaching allows teachers to take up broader institutional and social issues beyond their classroom practices and, fourthly, such teaching helps teachers to reflect on their practice individually. Reflective teaching to a certain extent helps teachers to acquire and develop professionally some of the key aspects associated with critical education. I shall now elaborate on how reflective teaching links teachers' professional development to critical education.

Critical education, or more appropriately referred to as critical pedagogy, has many meanings. Freire regards critical pedagogy as a

practice that gives voice to the oppressed within a framework of dialogue between people (Gur-Ze'ev 1998: 467), whereas Giroux's view of critical pedagogy "is indebted to the politicization of teachers and students and their empowerment as radical intellectuals who change their school as part of a general struggle over essential change" (Gur-Ze'ev 1998: 473). According to Freire (1993: 125), human activity consists of both action and reflection, that is, praxis which leads to transformation of the world. He relates action-reflection to theory and practice. Praxis thus implies taking a critical stance towards one's world of action and reflecting on it for transformative action (Freire 1993: 126). From this perspective, the most appropriate way to engage the learner's framework of relevance is to allow space for learners to engage critically with the issues, to bring their own insights, culture and different aspects of their multiple subjectivities to bear on the learning process. It appears that critical pedagogy, as articulated by Gur-Ze'ev (1998: 480), is appropriate to encourage reflective teaching in teachers' professional development. He argues that critical pedagogy is framed by the possibility of developing people's competence, reconstructing human cooperation and the realisation of people's dialogical essence; by the self-realisation of individuals as part of a collective partnership with other reflective politically-oriented human beings, and by striving for conditions under which everyone will become part of a dialogue (Gur-Ze'ev 1998: 481).

Similarly, Blake & Masschelein (2003: 47-9) provide three important ways of understanding critical pedagogy which relate to reflective teaching. First, it values critique as a support for personal autonomy and places critique at the centre of educational problems; secondly, it recognises reflective processes as important to the production of knowledge and, thirdly, it considers communicative interaction as central to human engagement. In the light of these explanations of critical pedagogy, I conclude that reflective teaching practice is important for the professional development of teachers for three reasons: it creates opportunities for teachers to think more deeply about their work and to ask questions about what they are doing; it offers opportunities for teachers and learners to engage

in dialogical praxis (action) about their work, that is, doing things together in a critical spirit, and it extends what people are doing to improving the lives of others in the broader society, that is, a matter of creating social conditions for the empowerment of individuals and groups. I will now focus on two aspects of critical pedagogy which offer possibilities for enhancing reflective teaching, on the one hand, and the application of educational technologies, on the other.

As mentioned earlier, critical pedagogy encourages individuals to reflect on their work in relation to others. Bailin & Siegel (2003: 181) claim that individuals who reflect deeply about what they are doing are "appropriately moved by reasons" – they are critical thinkers. To think critically is to have a deep concern for "the probative strength of reasons" (Bailin & Siegel 2003: 181). In a different way, critical thinking involves "higher-order thinking", which involves enabling learners to "judge [...] matters for themselves" (Bailin & Siegel 2003: 189). In addition, critical thinking involves preparing learners for "self-sufficiency and self-direction", which would enable learners to do "careful analysis, good thinking, and reasoned deliberation in democratic life" (Bailin & Siegel 2003: 189). In essence, critical thinking as an instance of critical pedagogy is "an attempt to engage in questioning, criticism, and inquiry (that) proposes the force of reasons" (Bailin & Siegel 2003: 192). Thus, when teachers are concerned with their professional development, they embark on a kind of reflective practice which harnesses critical thinking. They do so by encouraging themselves and learners to question meanings and to give recognition to the strength of reasons, enabling learners to do careful analyses in an atmosphere of reasoned deliberation. In this instance, critical pedagogy becomes the order of the day. Similarly, critical pedagogy aims to cultivate a deliberative and reflective spirit in learners whereby they collectively listen and respond to ideas presented to them, as well as responding critically by talking back to one another and their teachers. Giroux (1988: 27) proposes that teachers can avoid turning into mere technicians by becoming

> ... transformative intellectuals who develop counter-hegemonic pedagogies that not only empower students (learners) by giving them the knowledge and social skills they will need to be able to

> function in the larger society as critical agents, but also educate them for transformative action.

This implies that they will be educated to take risks, to struggle for institutional change, and to fight for democracy outside schools in other public spaces. I wish to explore this idea of transformative action in relation to teaching with the support of educational technologies in schools.

Does the use of educational technologies in teaching create opportunities for transformative action? Currently the professional development of teachers is mainly concerned with innovatively integrating the use of educational technologies into teaching and learning (King 2002: 285). One of the effects of such integration has been the potential for transformational learning, which

> ... serves as a comprehensive way to understand the process whereby adult learners critically examine their beliefs, assumptions, and values in the light of acquiring new knowledge and correspondingly shift their worldviews to incorporate new ideas, values and expectations (King 2002: 293).

In a different way adult learners embark on a reflective practice. According to Wenger, the use of educational technologies in classroom practices and the continuing professional development of teachers can create opportunities for teachers to cultivate reflective practice and to encourage the development of learning communities that may lead to (transformative) communities of practice (King 2002: 296). In addition, Foreman (2003: 22) is of the opinion that educational technologies such as instructional videogames offer the prospect of learning experiences which can be transformative in the sense of simultaneously inducing delight and enabling instruction. He argues that transformative action is attained on the grounds that learning requires active discovery, analysis, problem-solving, memory and physical activity, which game-based educational technologies provide (Foreman 2003: 12). Likewise, Pearson & Somekh (2006: 520) are of the opinion that transformative learning involves the following: learning creatively: contributing, experimenting, solving problems; learning as active citizens: acting autonomously, taking responsibility for their

own learning; engaging intellectually with powerful ideas: using thinking skills, grappling with ideas/concepts, and reflecting on their own learning: evaluating their own learning through metacognition.

The above views on transformative learning can be achieved by applying educational technologies such as the search engine Google, directories of Yahoo, and video-recordings which were fully incorporated into group work (Pearson & Somekh 2006: 524).

2. Theoretical account of educational technologies

The promises and pitfalls of information and communications technologies are linked to two present-day motifs: globalisation and the learning society (Lelliot *et al* 2000: 45). On the one hand, globalisation can be considered a process whereby societies are connected through rapid, large-scale networks of political, social and economic interaction whereas, on the other hand, the learning society comprises well-educated communities and individuals through the application of ICTs (Lelliot *et al* 2000: 46). Without access to ICTs societies in Africa are in danger of being excluded from global development, although not immune to the effects of globalisation (Lelliot *et al* 2000: 47). Of all African countries, South Africa is the most technologically advanced, and there is a very high possibility that schools in the country can promote ICTs (Lelliot *et al* 2000: 50). In addition, the growth of a democratic public sphere can also be linked to the implementation of ICTs. According to Bohman (1998: 213),

> ... we can expect that under proper conditions and with the support of democratic institutions, a vibrant public sphere will expand and become open to and connected with other public spheres. Members will develop the capacities of public reason to cross and negotiate boundaries and differences between groups, persons and cultures. Certainly the global media may help foster this process.

Considering that schools also make up the public sphere, ICTs have the potential to impact on schooling, in particular teaching, learning and professional development – the subject of my investigation.

In South Africa knowledge advancement is considered the primary means for resolving societal problems. Education should therefore inculcate this understanding of knowledge and its intent to solve societal problems in the minds of the youth. Certain forms of knowledge transmission are limited in their scope to achieve the goal of acquiring knowledge for the sake of resolving societal problems (Scardamalia 2006: 15). If institutions such as schools want to effectively serve the needs of the twenty-first century, they will have to be reconciled to the use of ICTs. In the words of Peters & Araya (2007: 33), ICTs seem

> ... to offer strong methodological and epistemological promise across the social sciences, with an apparently easy application to education. This is particularly true with regard to learning networks in the context of *innovation* and a *knowledge economy*.

As Castells (2004: 224) notes, technological networks, including ICTs, are fundamental to both the challenges we face and the solutions to those challenges:

> Networks matter because they are the underlying structure of our lives. And without understanding their logic we cannot change their programmes to harness their flexibility to our hopes, instead of relentlessly adapting ourselves to the instructions received from their unseen codes. Networks are the Matrix.

There is abundant literature on the use of educational technologies in classroom practices (Cuban 1986: 8). Since the 1920s American schools have gradually implemented educational technologies in the classrooms with varying support and success (Cuban 1986: 8). Kent & McNergney (1998: 5) offer an account of how, on the one hand, technologies will, it is hoped, improve the way educators teach and learners learn. Consequently, there appears to have been a demand to integrate computer and related technologies into the classroom (Kent & McNergney 1998: 6). On the other hand, there is a growing dissent that questions the efficacy of computers and their related technologies in classrooms, in particular questioning the ability of technologies to deliver quality and affordable education (Kent & McNergney 1998: 6). Raizen *et al* (1995: 7-8) argue more in favour of the use of technologies education which,

according to them, would significantly alter the way in which science, mathematics and other subjects are taught. I share and support the latter view. More recently, Ashburn & Floden (2006: 8) contend that, despite the evolutionary status of technologies, children need to incorporate its use in classrooms along with reading, writing and the acquisition of subject knowledge. I wish to echo the view of Burbules & Callister (2000: 10-5) who argue that educational technologies neither embrace a utopian vision of computers as likely to revolutionise schools nor join the chorus of those who consider the movement of computers into schools as wasteful and a threat to educational values and processes. According to them, educational technologies offer ways to rethink teaching and learning along the lines of critical thinking. I support and shall argue later for the latter view.

Emerging educational technologies hold the key to improving knowledge transmission and teacher quality (Gimbert & Cristol 2004: 207). Jeremy (2002: 80) suggests that, besides improving learning, technologies may also improve critical thinking, analysis and scientific enquiry. Evidence suggests that the use of educational technologies in the transmission and construction of knowledge makes a measurable difference between learner achievement and teacher quality (Jeremy 2002: 81).

Gimbert & Cristol (2004: 207) suggest five propositions for the integration of technologies into pedagogical practices. First, the use of technologies in the classroom affords learners the opportunity for socialisation and language development, dependent on the set-up of the learning environment. For example, at the school where I teach there are classrooms of up to 40 learners and approximately only 30 computers. Depending on the lesson, learners are required to work in pairs. This encourages social sharing and cognition (Gimbert & Cristol 2004: 208). Learners working with technologies in groups would be encouraged to become decision-makers, creators and solvers of new problems.

Secondly, Gimbert & Cristol (2004: 208) propose that by using the appropriate technologies, learners are encouraged to use their imagination and to explore at their own pace, given the nature of the

technologies used. This would be useful for learners with learning disabilities, enable them to control the pace at which they learn. The software characteristics that are required to assist this type of learner would include software design consisting of open-ended learning tasks with animated routines and directions that may be paused and resumed in order to nurture students' learning (Gimbert & Cristol 2004: 209).

Thirdly, what I consider to be considerably important for learners is that the use of technologies enhances learners' attention span. In my own experience, learners respond better and pay more attention when technologies are incorporated into lessons. Guthrie & Richardson (1995: 14) suggest that learners are intrinsically more motivated and learn better when technologies are infused into learning in the classroom. However, they (1995: 15) stress that this only occurs when the appropriate technologies are used, as the technologies may in fact often impede the learning process; in other words, certain technologies may counteract learning (Gimbert & Cristol 2004: 210). Okolo & Hayes (1996: 12) found that learners spend four times more time reading with technologies infused with animation. Yet their research indicates that learners are able to recall knowledge learnt better.

Fourthly, learners (with special needs) benefit from the use of technologies (Behramann & Lahm 1994: 105) such as touch pads; special keyboards magnify the content, affording learners the opportunity to learn effectively despite their physical and language disabilities, and autism (Johanson 1997: 12).

Finally, Gimbert & Cristol (2004: 211) suggest the professional development of teachers. Teachers should learn not only about technologies, but also how to teach with technologies. In doing so, their own professional development is taken into consideration. The technologies used should be viable and meaningful (Gimbert & Cristol 2004: 212). Gimbert & Cristol (2004: 212) claim that there is a need to integrate technologies into teaching as well as job-embedded professional development at tertiary institutions. Technologies can enhance teaching and learning effectively, and critically, as many teachers who have been in the teaching profession for many years

have no experience in the integration of technology into their lessons. They are not able to take advantage of the five propositions of technology-supported education as stated Gimbert & Cristol (2004: 214).

Although there are many advantages concerning the integration of technologies into lessons, Gimbert & Cristol (2004: 214) suggest that care needs to be taken when considering integrating technologies into (science) lessons. Teachers should investigate the effectiveness of the technologies used in order to improve and not impede the teaching and learning process. This may be done by seeking assistance from other teachers who have successfully implemented technologies into their teaching practices.

As far as the professional development of teachers is concerned, I am of the opinion that there needs to be a support structure in place to assist teachers in their attempts to use technologies to support their classroom practice. I note that the government is investing money in the implementation of technologies into classroom. However, I contend that the education authorities also need to consider the professional development of teachers to enable them to use the appropriate technologies in which the government has invested effectively, and that computer rooms do not become "white elephants" because of teachers are unaware of, or apprehensive about using the various computer-based technologies in their pedagogical practices.

In addition, as far as the successful implementation of technologies in the classroom is concerned, Gimbert & Cristol (2004: 214) argue that teachers ought to maintain his/her professional development with the aid of professional and collegial support from colleagues, so that they can develop themselves to use technologies in their pedagogical practices. In some Western Cape schools commitments are made by organisations such as *Khanya* that send individuals to schools to train teachers to use technologies as a means to ensure the teachers' professional development. When learners are using technologies a technologically competent teacher has been shown to stimulate their thinking (Gimbert & Cristol 2004: 214).

Jeremy (2000: 76) also researched the use of technologies in pedagogical practices and identified four fundamental characteristics, which can be related to the work of Gimbert & Cristol (2004). The first characteristic described by Jeremy (2000: 77) is learning through active engagement. Active engagement involves experience, interpretation and structured interaction with peers and teachers to improve the learning process. However, when learners are passive, they are not able to apply what they have learned to situations outside the classroom (Jeremy 2000: 77). Although active learning can be achieved without the use of technologies, the basis for the use of technologies is that it is guided by active engagement. Thus incorporating technologies into classroom practices congruently can promote the active engagement of learners. Should active engagement fail to materialise, it follows that the use of technologies might not have been appropriately implemented. Simply put, the effective application of educational technologies gives rise to active engagement in learning.

Gimbert & Cristol (2004: 214) assert that programmes or workshops addressing the professional development of teachers tend to use a "one-size-fits-all" approach. Teachers' technological competences are not at the same level. I have encountered this situation in workshops regarding the use of technologies to enhance teaching and learning. As a new teacher I hope to be competent in the use of technologies and to cope well in the workshops, but more experienced teachers tend not to cope in these workshops as a result of the application of this blanket "one-size-fits-all" approach. As such, professional development opportunities need to be designed rather to allow teachers to determine what best suits their technological needs, to prevent their falling into a void where they are unable to grasp the real-life implications of the use of technologies for teaching and learning that these workshops should be addressing. These workshops should afford teachers the space and time to observe the applications for critical teaching and learning when implementing a curriculum (Scardamalia 2006: 14). Therefore, there needs to be a collaborative effort among teachers and organisations to drive a

professional development process that will result in the meaningful infusion of technologies into teaching in science classrooms.

Jeremy (2000: 79) identified another characteristic: the use of technologies in teaching encourages participation of learners in groups. He suggests that social contexts afford learners the opportunity to carry out complex skills which they would otherwise not be able to carry out alone (Jeremy 2000: 81). If technologies encourage the active participation of learners, the learning process can only be improved by creating a social context in which technologies promote learning in groups. A related characteristic which I would like to discuss at this point is providing frequent interaction and feedback. I was fortunate to study at a tertiary institution that has embraced the use of educational technologies. This institution has an interactive online classroom programme called WebCT. This allowed me to obtain all my Power Point notes presented in lectures, supported me in doing many tutorial exercises designed by the lecturer and to do tests. These online tests enabled me to gauge my knowledge of the subject area. The tutorial component of WebCT was particularly relevant to the notion of frequent interaction and feedback. It allowed me to do tutorial questions, after which a detailed memorandum was instantly provided. This is an example of frequent interaction and feedback. If this educational technology had not been used, the opportunities for feedback and questions would have been relatively infrequent and this would have impeded the learning process.

The final characteristic identified by Jeremy (2000: 82) is related to the way learners learn through connections to real-world contexts. Many learners in classrooms perceive little relevance in the work they cover in class, or they often cannot identify the real-life applications of the work they do in the classroom. To enable learners to apply knowledge acquired to real-life applications does not require the memorisation of content, but rather that learners grasp and understand concepts. Jeremy (2000: 82) suggests that traditional exercises do not allow learners to apply their knowledge effectively because of varying contexts. He claims that by using educational technologies learners can effectively apply their knowledge to varying contexts. For example, students have access to many tools that scientists use,

such as Google Earth. For example, recently scientists discovered a new mammalian fossil specimen that is presumed to be the missing link in the evolution of Homo *Sapiens*. This discovery was brought about by the use of Google Earth. In teaching evolution to Grade 12 learners I must discuss fossil formation with them. By using Google Earth learners can view the discovery site and therefore not consider this section of Grade 12 Life Sciences as arbitrary. A real-life connection is made between what is learnt in class and the latest scientific developments. Research indicates that learner performance has improved as a result of the use of educational technologies which link classroom practices and real-life situations (Jeremy 2000: 82).

3. Life Sciences, educators, learners and educational technologies

I am one of three Life Sciences teachers at a local high school in the Western Cape. Life Sciences is taught to learners from Grades 10 to 12. The Life Sciences department has a rich history of successful results, obtaining a 100% pass rate in Grade 12 in 2009. Content taught in Life Sciences varies according to year and complexity in various fields of the natural sciences, such as biodiversity, genetics and evolution, to mention but a few. On average approximately 400 learners do Life Sciences at the school every year. I am responsible for teaching Life Sciences from grades 10 to 12. The teachers in the Life Sciences department have a wealth of experience spanning over 20 years. As a relatively new teacher, I have been mentored by these teachers and have learned a great deal from them. Despite their wealth of experience, these teachers are not competent in the use of educational technologies to enhance their pedagogical practices. The relationships between my colleagues and myself are two-directional, with the result that I can share my expertise concerning educational technologies with them.

Since the school has received a wealth of resources in the form of ICTs, I have taken it upon myself to advise my senior colleagues on how the use of various educational technologies can be implemented

in their existing teaching practices. For example, these teachers have been teaching certain aspects of the human heart for many years using an overhead projector to project a static picture of the human heart. From this diagram the teacher would demonstrate to learners through which areas of the heart the blood will pass in sequence. I have suggested that they use a flash animation on a computer and project an animation that is able to better convey to the learners the pathway of blood through the human heart. Using YouTube to show the learners actual open-heart surgery has added a new dimension to teaching and learning in comparison to the more traditional approach of teaching. These colleagues have shown a willingness to learn about how their existing teaching practices can be enhanced with the use of technologies. They have now also taken it upon themselves to improve their own teaching and learning by applying the technologies. In matric, for example, there is a relatively short window period within which to cover the contents of a curriculum. The Life Sciences teachers at the school have realised that by using technologies they can cover a larger amount of work in a shorter period of time. This is another reason why they appear to have embraced the use of educational technologies in their teaching practice. By working with these teachers I have observed that they tend to use only certain technologies. They therefore will only use a technology if it will improve their teaching. My colleagues often resent using technologies which are difficult to set up prior to lessons.

Planning is essential when implementing educational technologies in the classroom and using these to support learners' learning. Certain technologies such as Google can be used instantly to reach a desired outcome. For example, learners often ask questions related to the work I am teaching, but I am unable to provide an immediate answer. I use Google instantly to search for an answer to the learners' questions or search for images by simply using my own mobile device or allowing learners to use their mobile devices to access Google – this is a matter of establishing conditions for greater learner participation and empowerment. For instance, YouTube is a technology that can provide instant videos to learners' enquiries. Using such technologies means that there is no break in a chain of thought. This

implies that if I did not use this technology (YouTube, for instance) and told learners I would do some research for them and return to them at a later time, there would be a break in the learners' chain of thought and even level of interest. I have found that by using these technologies learners' responses were really positive as they were not spectators with regard to the learning process, but were in fact participants and had a joint interest in learning Life Sciences.

As mentioned earlier, I have always had an interest in ICTs. Whether it was for entertainment activities such as playing games and watching movies, surfing the internet to reading up on interesting activities happening around the world, or social networking such as YouTube and Facebook, I was always stimulated by the application of ICTs. At first glance it might appear as if technologies are confined only to fun and play, and that their use might be unrelated to learning. However, because of my interest and understanding of these technologies, I often wondered and realised how these technologies could be used to enhance teaching and learning, specifically impacting on critical teaching and learning in Life Sciences. The majority of these technologies do not require extensive learning and are easy to use. Hence, my affinity to their practical application in science classrooms with learners has been enhanced.

I teach Grades 10, 11 and 12, and use a similar approach to teaching them. I use technologies as a resource or tool as much as possible. Not only has the use of technologies improved the effectiveness of how I am able to share content with learners, but it has also saved me time in preparation work whether for lessons or for the completion of examination papers. The first time I used technologies in my teaching was when I was asked to prepare a Life Sciences examination paper. A colleague recommended that I use an interactive CD called *Focus Exambank*. This programme allows a user to set up an examination paper using questions from an existing data base. All I needed to do was to simply tick off out of how many and which questions I would like to have included in the question paper using the database. In a nutshell, the examination paper would be completed with a corresponding memorandum. This technological innovation helped me as an inexperienced teacher and gave me a framework for

setting up examination question papers. This brings me to a discussion of my encounter with learners in using educational technologies to engender critical teaching and learning.

One aspect of my school being involved with *Khanya* entails that teachers are required to attend workshops on the use of educational technologies and how these technologies can be used to support teaching and learning. This is done to ensure that the technological investments made in the school are used to the benefit of both teachers and learners. *Khanya* has encouraged the use of technologies to nurture the professional development of teachers. In my first year of teaching a *Khanya* science training coordinator presented a workshop on the various capabilities of Smart Boards for teaching, as well as its basic application. The Smart Board is essentially an interactive whiteboard that makes use of touch inputs, much like a touch-screen monitor. Smart Boards provide input in much the same way as a mouse or keyboard would be used connected to a desktop computer. The picture that appears on a Smart Board is projected with a data projector. This technology functions as a result of the combination and interaction of the following: a data projector, an interactive board and a desktop computer or laptop. Simplified, a Smart Board can be likened to a laptop, where the touchpad of the laptop and the screen are combined into one unit, allowing users to control all the functions of a computer or laptop using a single peripheral known as a Smart Board. Not only does a Smart Board provide touch input, but it is in fact a board for writing on in the traditional sense. The Smart Board comes with digital pens and an eraser. Teachers would use these pens to write on this interactive board and the desktop PC would process the touch inputs of the pens on the interactive board as writing, which is then projected via a data projector. Desktop computers attached to Smart Boards can be linked via a network. The rationale for this is that if one were to have several classrooms each containing a Smart Board, and a teacher writes on one Smart Board, the writing would appear on all the other Smart Boards. After this workshop I was asked by the *Khanya* science training coordinator who presented this workshop if he could sit in on one of my classes to observe how I would integrate the Smart Board into one of my

Life Sciences lessons. I agreed to allow him to observe my teaching. The lesson was for a Grade 10 Life Sciences class and it focused on the digestive system. In preparation for the lesson I used Google to search for flash animations which I felt worked innovatively with the interactive nature of Smart Boards. I then presented my interactive lesson with the aid of the Smart Board to learners. Learners were required to indicate orally what I had to select on the animation using the touch inputs of the Smart Board. After my initial demonstration of the flash animation with the learners, they took a keen interest in the use of the Smart Board, controlling the flash animation using the touch input of the Smart Board. Learners were thus actively involved and were not merely spectators. For me, this was a poignant moment in stimulating more learner interest in the Life Sciences lesson as well as having encouraged active learner participation by the use of the Smart Board technology. Besides actively participating, learners articulated their assessment of the ways they understood the content they encountered.

A review article was posted on *Khanya's* website and Science blog after the lesson had been presented and observations made by the *Khanya* science teaching coordinator. The article focused primarily on the success of the lesson as a result of the use of educational technology and the positive responses of the learners as assessed by the training coordinator. The training coordinator was very impressed with how ICTs were used to teach a section of the curriculum in an innovative way. The lesson review suggests that science learning and teaching can be imaginative as is evident from the assessment of the independent *Khanya* coordinator. It appears that what can be inferred from this experience is in line with the theoretical view that emerging educational technologies hold the key for improving knowledge transmission and teacher quality (Gimbert & Cristol 2004: 207). The active engagement of learners using the Smart Board (on the basis of individual manipulation and control) is theoretically linked to gaining experience, interpreting ideas and encouraging interaction among learners, as aptly stated by Jeremy (2000: 77). The learners were not passive either about what they learned in the classroom or how what they have connects with situations outside

the classroom. This observation by both the *Khanya* coordinator and myself echoes the thoughts of Jeremy (2000: 77), who claims that by using an appropriate technology one can ensure that learners are not merely passive participants, but are actively involved in an interactive technologically-aided lesson. The *Khanya* science teaching training coordinator observed that active engagement can occur among learners and teachers by using the appropriate technology. The teaching coordinator also noted learners' responses to the lesson as engaged and participatory – supporting the view in the literature that using educational technologies competently can enhance active learner participation. It can therefore be argued that the use of educational technologies not only excites learners, but also promotes active learning. When active learning occurs, learning can be said to be critical.

I have indicated that Gimbert & Cristol (2004: 207) suggest that the use of technology in the classroom affords learners the opportunity for socialisation and language development. This was achieved in the interactive lesson. Learners were actively communicating to other learners who were in front of the classroom what they wanted the learners to select. Using the Smart Board technology simultaneously served as a medium for socialisation, that is, learners were not only initiated into the content with the aim to make them think on a higher cognitive level, but also offered responses to their peers that reflect how they link what has been learned to the social issues with which they are confronted. In a different way, as noted by Gimbert & Cristol (2004: 208), by using educational technology learners have been encouraged to use their imagination and to explore at their own pace. The flash animation used in this interactive lesson is dependent on the user's inputs. Therefore the user can control the pace of learning – a practice associated with the development of critical learning.

As noted by Gimbert & Cristol (2004: 208), learners' concentration span was increased. This was also noted by the *Khanya* science teaching coordinator, who observed that "the learners paid more attention as it was them who were driving lesson". This indicates that the attention span of learners is enhanced and more time is given to

learners to offer their reasonable interpretation of the subject matter This goal is in line with what Gimbert & Cristol (2004: 208) propose. In addition, the use of the flash animation in the interactive lesson gave learners the opportunity for frequent interaction and feedback. Through their inputs learners received instant descriptive feedback from the animation. For example, when learners selected the mouth in the diagram of the flash animation, it gave them feedback in the form of a description of the function of the mouth. Learners used this animation to test themselves and subsequently received instantaneous feedback enabling them to judge matters for themselves, thus developing their critical thinking skills, as advocated by Bailin & Siegel (2003).

In essence, what this narrative foregrounds about critical learning is that learners not only actively participated when educational technologies were used, but also took responsibility for their own learning. They also engaged powerfully with new ideas and creatively experimented as they embarked on problem-solving and critical thinking. They acted as autonomous beings who reflected on their learning at their own pace. As such they became active critical learners – this idea finds support in the work of Pearson & Somekh (2006).

The question arises: What have I learnt from using the Smart Board and how was my own professional development enhanced? I have learnt to become pedagogically tactful. As a novice teacher I could perceive what goes on with learners, understand their experiences, that is, I began to sense what Van Manen (1995: 46) refers to as "the pedagogical significance of the situation, to know how and what to do, and to actually do something right". I instantaneously sensed that learners enjoyed using the mouse and bringing about changes through their manipulations which they witnessed on the Smart Board. In Van Manen's (1995: 46) words:

> ... a teacher who is tactful has the sensitive ability to interpret inner thoughts, understandings, feelings, and desires of children from indirect clues such as gestures, demeanor, expression, and body language [...] (and) the ability to immediately see through mo-

> tives or cause and effect relations. A good teacher is able to read, as it were, the inner life of the young person.

There were certainly moments when I knew how to interpret, for example, "the deeper significance of shyness, frustration, interest, difficulty, tenderness, humor, discipline" with the learners as they worked with the Smart Board. In addition, I could spontaneously bridge the link between theory and practice, for instance, applying theoretical knowledge to solve a practical problem such as illustrating to learners how excess acidity in the stomach can be neutralised. In essence, I have learnt that practical knowledge of teaching resides in our environment: the physical dimensions of the classroom, the learners and the educational technologies which we used so efficiently in relation to science education. I realised that my practical knowledge is constituted by

> ... my felt sense of the classroom, my feeling who I am as teacher, my felt understanding of my students (learners), my felt grasp of the things that I teach, the mood that belongs to my world at school, the hallways, the staffroom, and of course this (my) classroom.

5. Cultivating critical teaching and learning in a science classroom

I have already presented Zeichner's (2009: 121) argument for reflective teaching being linked to the on-going professional development of teachers. First, the view that reflective teachers take into consideration theories embedded in their own and other teachers' practice is of relevance to my own professional development. For instance, as the narratives presented in this article indicate, I considered various theories such as the use of technologies and their implications for critical, transformative learning. This suggests that I also gained professionally in terms of connecting my practice with practices that can bring about changes in learners' attitudes, commitment to learn, motivation to find out on their own, and to effect societal change. Likewise, I have been inspired to create conditions for both the learners and myself to think more critically, trying to get more

persuasive answers for pertinent issues in the real world, and to be deliberative and attentive to learners' opinions. The fact that I consulted with my two science colleagues and collaborated on what teaching works "best" in particular lessons indicates that I have also been moved by reason – a matter of having become more critical. Secondly, following Zeichner, technologies were not used simply as technical instruments, but rather as pedagogical tools that can engender in me a critical spirit to ask why and to search for better ways of teaching science. Thirdly, as a reflective teacher I am even more aware of wanting to address issues in society which can enhance improved living conditions for humanity. The collaboration with learners made me more environmentally aware of my own surrounding as a resident in Zeekoevlei, as well as having been encouraged through this project to link up with community organisations that care about the environment and society. I am even more aware of the negative effects of drug abuse, for instance, considering that on occasion I witnessed with concern how people walk around in the area without jobs and perhaps even without food. I am also deeply concerned about why some people (vagrants) sleep in the wetland areas – perhaps they do not have any housing. These are societal issues with which I am seriously beginning to grapple. And I reflect individually about teaching and learning and begin to wonder whether educational technologies do not have other functions such as alleviating the crisis of social injustices in our communities. I became an empowered teacher deeply guided by a critical and transformative agenda which I hope to pursue in my science classrooms and beyond.

This brings me to a discussion about my own professional development. Drawing on the ideas of Guskey (2002), in particular his five levels of evaluating teachers' professional development, I shall once again reflect on my own practice in relation to the following aspects: learners' reactions to my teaching; learners' learning (on which I have reflected extensively so far); organisational support and change; learners' application of new knowledge and skills acquired, and learners' learning outcomes. I must mention that my

own professional development was enhanced by my attendance of workshops where other teachers and I reflected together on our practice by means of educational technologies in Life Sciences. First, learners' reactions relate to the initial satisfaction they felt with my professional development (Guskey 2002) – that is, my use of educational technologies to support my teaching practice. I am reasonably satisfied with my own performance by using educational technologies in Life Sciences. I am also at ease regarding my research on how educational technologies can be used and how these technologies supported my teaching in science classrooms. Secondly, following Guskey (2002), learners' levels of knowledge and skills of Life Sciences in relation to the application of technologies expanded in an autonomous way. Thirdly, as indicated by Guskey (2002), with the support from *Khanya* and my two Life Sciences colleagues, my own problem-solving capabilities improved, especially with the help of troubleshooting guides and mentorship discussions with colleagues. Fourthly, and as noted by Guskey (2002) there exists sufficient evidence from photographs taken and evaluative reports of *Khanya* that I used technologies competently and efficiently. Fifthly, learners' attitudes towards the Life Sciences improved through their active participation in classes and in the research project.

I have argued that the use of educational technologies in and beyond the practice of my science classroom makes room for critical teaching and learning to occur. And as learners' critical thinking gained momentum, they (like me) became more consciously aware of the societal issues which affect our daily lives. In this way, our pedagogy (teaching and learning) has been critical, transformative and reflective.

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