TOWARDS THE DEMOCRATISATION OF SENIOR PHASE SCHOOL SCIENCE THROUGH THE APPLICATION OF EDUCATIONAL TECHNOLOGY

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DECLARATION

By submitting this dissertation electronically, I declare that the entirety of the work contained therein is my own, original work, that I am the sole author thereof (unless to the extent explicitly otherwise stated), that production and publication thereof by Stellenbosch University will not infringe any third party rights and that I have not previously in its entirety or in part submitted it for obtaining any qualification.

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ABSTRACT

In this dissertation I report on an action research study in relation to the democratisation of science education in a Grade 10 life sciences classroom at a local high school through the application of educational technology, more specifically social network media such as Facebook. I argue that action research for social justice with the support of educational technology can contribute towards cultivating critical teaching and learning in the science classroom, thus contributing to the democratisation of science education in schools.

In the main, this study shows that educational technology can contribute to the democratisation of science education in classrooms in relation to teaching contentious issues in the current life sciences school curriculum on three levels: firstly, learners and educators can experience enhanced levels of participation, collaboration and deliberation through Facebook; secondly, learners can construct personal learning contexts as a testament to the sense of autonomy they have (and can acquire) in learning about life sciences, particularly as they endeavour to nurture their critical and problem-solving skills, construct and apply life sciences knowledge, and integrate understandings of life sciences into the context of societal change; and thirdly, learners and educators can cultivate equal partnerships in the sense that equality refers to their insistence to ‘rupture’ and ‘disrupt’ pedagogical activities in the life sciences classroom.

Finally, this study also reveals that critical teaching and learning in the life sciences classroom cannot be oblivious to poststructuralist thought on learning to think and act

rhizomatically as opposed to hierarchically and linearly, and that exercising one's individual autonomy through a claim to intellectual equality can simply be pedagogical ingredients that can further enhance democratic science education in schools.

OPSOMMING

In hierdie proefskrif doen ek verslag oor 'n aksienavorsingstudie in verband met die demokratisering van wetenskaponderwys in 'n Graad 10 lewenswetenskappe-klaskamer in 'n plaaslike skool deur die toepassing van onderwystegnologie, meer spesifiek sosiale netwerkmedia soos Facebook. Ek argumenteer dat aksienavorsing vir sosiale geregtigheid met die ondersteuning van onderwystegnologie kan bydra tot die kultivering van kritiese onderrig en leer in die wetenskapklaskamer, wat dus bydra tot die demokratisering van wetenskaponderwys in skole.

Hierdie studie bewys hoofsaaklik dat onderwystegnologie op drie vlakke kan bydra tot die demokratisering van wetenskaponderwys in klaskamers met verwysing na omstrede vraagstukke in die huidige lewenswetenskappe-skoolkurrikulum: eerstens kan leerders en opvoeders hoë vlakke van deelname, samewerking en beraadslaging deur Facebook ervaar; tweedens kan leerders persoonlike leerkontekste konstrueer as bevestiging van hulle sin van outonomiteit wat hulle bekom (en kan aanleer) deur leer oor die lewenswetenskappe, veral soos hulle poog om kritiese en probleemoplossingsvaardighede uit te bou, wetenskapskennis te konstrueer en toe te pas, en betekenisse van lewenswetenskappe in die konteks van sosiale verandering kan integreer; en derdens kan leerders en opvoeders gelyke verhoudings kweek in soverre gelykheid verwys na hulle aandrang daarop om pedagogiese aktiwiteite in die lewenswetenskappe-klaskamer te 'verbreek' en te 'ontwrig'.

Ten slotte wys hierdie studie dat kritiese onderrig en leer in die lewenswetenskappe-klaskamer nie onbewus kan wees van poststrukturalistiese denke oor die aanleer van risomatiese eerder as hiërargiese en liniêre denke en optrede nie, en dat die uitleef van individuele outonomie deur aanspraak te maak op intellektuele gelykheid die pedagogiese inspuiting kan wees wat benodig word om demokratiese wetenskaponderwys verder in skole te bevorder.

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CHAPTER 1

DEMOCRATISATION OF FURTHER EDUCATION SCHOOL SCIENCE THROUGH THE APPLICATION OF EDUCATIONAL TECHNOLOGY: ORIENTATION OF STUDY

1.1 Setting the Scene

The public understanding of science is becoming increasingly important in the contemporary era because people are confronted with contentious scientific issues. These issues may pertain to genetically modified food, evolution, global warming and other scientific phenomena that have a direct bearing on citizens. In turn, these issues require critical citizens to deal with them. From this it follows that science education should play a prominent role in developing a critical citizenry. According to Jenkins (1999, p. 703), science education, citizenship and public understanding are inextricably linked. He further points out that school science curricula have often been associated with stimulating an economic impetus rather than promoting democratic understanding (Jenkins, 1999, p. 703). A democratic understanding implies that citizens become involved in decision-making processes regarding scientific phenomena, whether they are personal or political (Jenkins, 1999, p. 703). In short, a democratic society requires critical citizens.

However, traditional classroom practices, like 'chalk and talk', might place constraints on developing critical citizens through science education. In today's digital age, many learners are still largely confronted by the traditional 'chalk and talk' method, although they might want to be taught through other, more stimulating ways so as to ensure more active participation in their classrooms (Wankle, 2011, p. 3). As an educator in a local high school I am quite adept in the use of information and communication technologies (ICTs), and this adeptness is a necessary requirement for the promotion of social interaction by those using these technologies (Wankle, 2011, p. 4). Educational technology has the potential to promote social learning, as it allows space for learners to make their voices heard – voices that otherwise might have been stifled by a traditional learning environment (Wankle, 2011, p. 7). The use of technology could stimulate technical literacy, social interaction and critical reflection (Wankle, 2011, p. 6). This emancipatory perspective on pedagogy, whereby learners are afforded opportunities to engage in classroom activities through educational technology, led me to pursue this research in order to understand, and perhaps even extend, theories of how technology can assist inclusive, democratic teaching and learning. Consequently, I was motivated to undertake this research on whether the use of technology could contribute to democratising my practices and those of learners. My instructional communication, like that of others in the field of education, has undergone a metamorphosis due to the influence of technology-mediated communication. According to Wankle (2011, p. 7), the use of technology could serve as a catalyst for cultivating excitement in and interaction and sharing by learners.

Democratisation may be described as assisting those who are not part of a democratic sphere to become part of a sphere of inclusion (Biesta, 1999, p. 8). Inclusion is one of the core values of a democracy, as the whole point of democracy is ultimately to achieve the inclusion of everyone (Biesta, 1999, p. 1). Biesta makes a distinction between two assumptions with regard to inclusion, namely internal inclusion, which refers to how we can make our practices even more inclusive, and external inclusion, which looks at bringing more people into a democratic deliberative sphere (Biesta, 1999, p. 5). There seems to be an educational potential for this notion of inclusion, in terms of which pedagogical practices in the classroom can become even more inclusive (internal inclusion), and links can be formed between organisations and other schools, which would be an example of external exclusion.

This brings me to a discussion of the role of democratisation in relation to school making processes concerning socio-scientific and socio-technical controversies (Roth & Desautels, 2004, p. 150). These controversies include topics such as climate change, evolution and genetically modified organisms (Roth & Desautels, 2004, p. 150), which are subjects that relate particularly to the life sciences curriculum. Science has generally been regarded as an exclusive domain of disciplined experts (Roth & Desautels, 2004, p. 166). But, as science increasingly becomes part of our economy, politics and ethics, there is a shift from the view that sees science as an exclusive entity to one that views it as an inclusive practice involving all individuals having a stake (Roth & Desautels, 2004, p. 167). These economic, political and ethical issues are prominent in the science content covered in classrooms. A shift seems to be required to transform school science from the elite, exclusive entity into a more inclusive, democratic practice (Roth & Desautels, 2004, p. 166). And, in this regard, democratisation aims to make science and science education an inclusive practice. Notions of citizenship and inclusive democracy are strong preparatory themes for theorising about science education (Roth & Desautels, 2004, p. 165). For example, when educators cover the topic of genetically modified organisms in relation to safety for human consumption, learners need to be able to voice their concerns through inclusive deliberation, as it is their value judgments that will contribute to their understanding of the topic. Through the democratisation of science education, learners will hopefully be able to clarify various controversies (Roth & Desautels, 2004, p. 161). Science education, specifically school science, may also have an impact on the context in which learners find themselves. For example, a water-testing project that I conducted with learners in a local wetland, in which they articulated their value judgments and decisions, not only contributed to their understanding, but also to the authenticity of their learning. The learners questioned the rationale for some of the conservation strategies implemented in the wetland by conservationists based on their (the conservationists') scientific knowledge. In this case the learners felt that their conversations were more deliberative, as they had knowledge of the area in which they live. This project was quite successful because it was authentic, that is, the project had a direct bearing on the learners and the community in which they live. When individuals participate in an activity and have a stake in the activity, it considerably shapes the activity, thus making it authentic (Roth & Desautels, 2004, p. 167). It is this authenticity that is related to the notion of legitimate peripheral participation (Lave & Wenger, 1991, p. 14). Authenticity is achieved when people participate in an ongoing activity that is driven by the motive of achieving an inclusive democracy (Roth & Desautels, 2004, p. 168). If this project were just another classroom-related activity it could be regarded as inauthentic. However, if learners engage in projects like these, they may contribute to the community and simultaneously contribute to their democratic development as citizens (Roth & Desautels, 2004, p. 168). Through the democratisation of science education, the development of authentic activities such as these may be seen as a stepping stone to participation in democratic activities outside of the classroom (Roth & Desautels, 2004, p. 169).

Studies done on deliberation and the Internet indicate that users of the latter (the Internet) are more tolerant of non-conforming views than non-users (Robinson, Neustadtl & Kestnbaum, 2002, p. 285). This indicates that technology could enhance inclusivity and equality if all have access to these information and communication technologies. Specific types of audiences may be targeted, and these individuals can be brought together through a single medium (O'Hara, 2002, p. 288). The use of this single medium contributes to communicative rationality (Warren, 1996, p. 9). It is my contention that the use of technology can enhance democratic civic practices and, in turn, that these civic practices could contribute to the democratisation of education, more specifically, science education in classrooms – my focus in this dissertation.

1.2 Statement of the Problem

I intend to use social media networks such as Facebook, YouTube and the Internet to teach learning outcome[1] 1 (showing problem solving and critical thinking skills), learning outcome 2 (constructing and applying life sciences knowledge) and learning outcome 3 (understanding the interrelationship between science, technology, indigenous knowledge, the environment and society) of the grade 10 life sciences curriculum. My main objective is to use educational technology (in particular Facebook) to teach the learning outcomes. I shall use educational technology to teach these outcomes in relation to key curriculum issues in life sciences for grade 10, such as evolution, pollution and biotechnologies, which include cloning and transgenic organisms, and global warming. In addition, I intend to problematise the impact of educational technology on the democratisation of teaching and learning, more specifically science education in classrooms.

[1] Although the revised curriculum in South Africa no longer refers to learning outcomes, I shall retain its use in this dissertation as a means to offer a cryptic understanding of the intended goals of the curriculum.

This brings me to my research question: Does the use of educational technology contribute to the democratisation of teaching and learning? In ascertaining whether the application of educational technology has an impact on the democratisation of science teaching and learning, subsidiary questions that need to be taken into account include the following:

(1) Does the use of educational technology promote collaboration and engagement in science classrooms?
(2) Do learners encounter critical thinking on being taught through educational technology in further education school science classrooms?
(3) What opportunities for and challenges to societal awareness/justice can be engendered in science classrooms when using educational technology? and
(4) How can my own professional development as a science educator be enhanced through the teaching of life sciences using educational technology?

In investigating my main research question, two dimensions are taken into account: Firstly, my own professional practice as a life sciences educator for grade 10 learners will be under investigation; and secondly, how learners have attained the learning outcomes of the grade 10 life sciences curriculum – that is, their learning. These two dimensions in the pedagogical process are intertwined. However, my reason for doing this inquiry is to ascertain how educational technology can be used by learners to achieve the learning outcomes 1, 2 and 3. This would then require that I improve on my own practice as I endeavour to apply educational technology in my teaching of aspects of the grade 10 life sciences curriculum. Moreover, my research also links up with the notion of critical thinking, which can be referred to as the ability of learners to offer justifications or defensible reasons for their points of view (Bailin & Siegel, 2003, p. 182). And, considering that learners' points of view on issues in the curriculum might differ, one requires a process of deliberative engagement to ensure that reasons are played up against each other. This means that learners offer their critical points of view and other learners take their views into consideration through agreement and disagreement with and modification of those reasons – that is, democratically engaging with one another's views. Therefore, if learners are taught to think critically they hopefully can offer more credible reasons for their points of view in relation to other learners' reasons and, in a way, they will foster democratic engagement because their reasons are considered through mutual engagement and deliberation. Thus, when I investigate how technology can be used in the classroom to improve democratic engagement that can effect critical thinking and vice versa, I am situated in the study together with the learners I teach. In investigating my primary research question I therefore am obliged to look at my own practices as well as at the learning of the grade 10 learners, otherwise I would not know whether they have achieved the learning outcomes. Moreover, considering the aforementioned research questions my aims and objectives for this study are as follows: To determine whether the use of educational technology contributes to the democratisation of teaching and learning?; to determine whether the use of educational technology promotes collaboration and engagement in science classrooms?; to determine whether learners encounter critical thinking on being taught through educational technology in further education school science?; to determine what opportunities for, and challenges to, societal awareness/justice can be engendered in science classrooms when using educational technology?; and to determine how can my own professional development as a science educator be enhanced through the teaching of life sciences using educational technology? This brings me to a discussion of my tentative research design.

1.3 A Tentative Research Design

A research design in qualitative research offers one an opportunity to investigate new territory (Denscombe, 1999, p. 92). I shall select a design most appropriate to an investigation of the democratisation of science education through the use of educational technology in schools. Since this research is focused on the democratisation of education, which inherently involves the interaction of individuals and critical reflection on my own practice, qualitative research will be conducted through the use of an action research design.

I find action research appropriate for two reasons: Firstly, I want to evaluate whether what I am doing is influencing my teaching and the way learners connect with my teaching; and secondly, I want to find out whether using educational technology in a grade 10 life sciences classroom comprising twenty-six learners makes teaching and learning more democratic. My motivation for choosing action research is supported by McNiff and Whitehead (2006, p. 12), for whom 'action research has always been understood as people taking action to improve their personal and social situations'. Moreover, as a life sciences educator I can perhaps show how the use of educational technology potentially contributes to democratising classroom practices, and how these practices of teaching and learning can transform into new theory – an idea that gives action research its 'self-transforming capacity' (McNiff & Whitehead, 2006, p. 13). In addition, action researchers always consider themselves in relation to other people, practices and the environment. In other words, action researchers undertake 'enquiries with others, recognizing that people are always in company' – a matter of developing 'inclusional methodologies that nurture respectful relationships' (McNiff & Whitehead, 2006, p. 14).

In the main the theoretical underpinning that informs my study are threefold: Firstly, I am interested in the quest for meaning through interpretation and analysis particularly in relation to the work of democratic theorists (Chapter 3) who contends that interpretation and understanding are acts of collaboration and engagement; secondly, I am guided by the seminal thoughts of critical action research aimed at improving classroom practices in relation to an education for social justice (Chapter 3); and thirdly, I am open to what is still to become, the unexpected and incalculable; hence my attraction to poststructuralist inquiry as expounded on in Chapter 4. In addition, action research has often been associated with small-scale research projects conducted by social scientists using a very 'hands on approach' (Denscombe, 1999, p. 122). What attracts me to action research is the fact that it is a process of continuous application and evaluation of findings (Denscombe, 1999, p. 123). The advantage of this is that the subjects in the study would be actively involved, and not just passive participants, in relation to the research findings and evaluation (Denscombe, 1999, p. 123). Furthermore, action research is practical and applied, with a driving force pointing towards resolving practical, real-world problems (Denscombe, 1999, p. 123). Given the nature of action research, in which research and action are integrated, the researcher is afforded the identity of a 'practitioner'. In my practices I therefore can be viewed as a 'practitioner', as

I want to look at my own pedagogical practices so as to improve them in a beneficial way, both for my own professional development and for the learners' learning. Practitioner research can only be viewed as action research if it is carried out by professionals researching their own practices (Denscombe, 1999, p. 123). As far as the method is concerned, the following cyclical technique was used for this study:

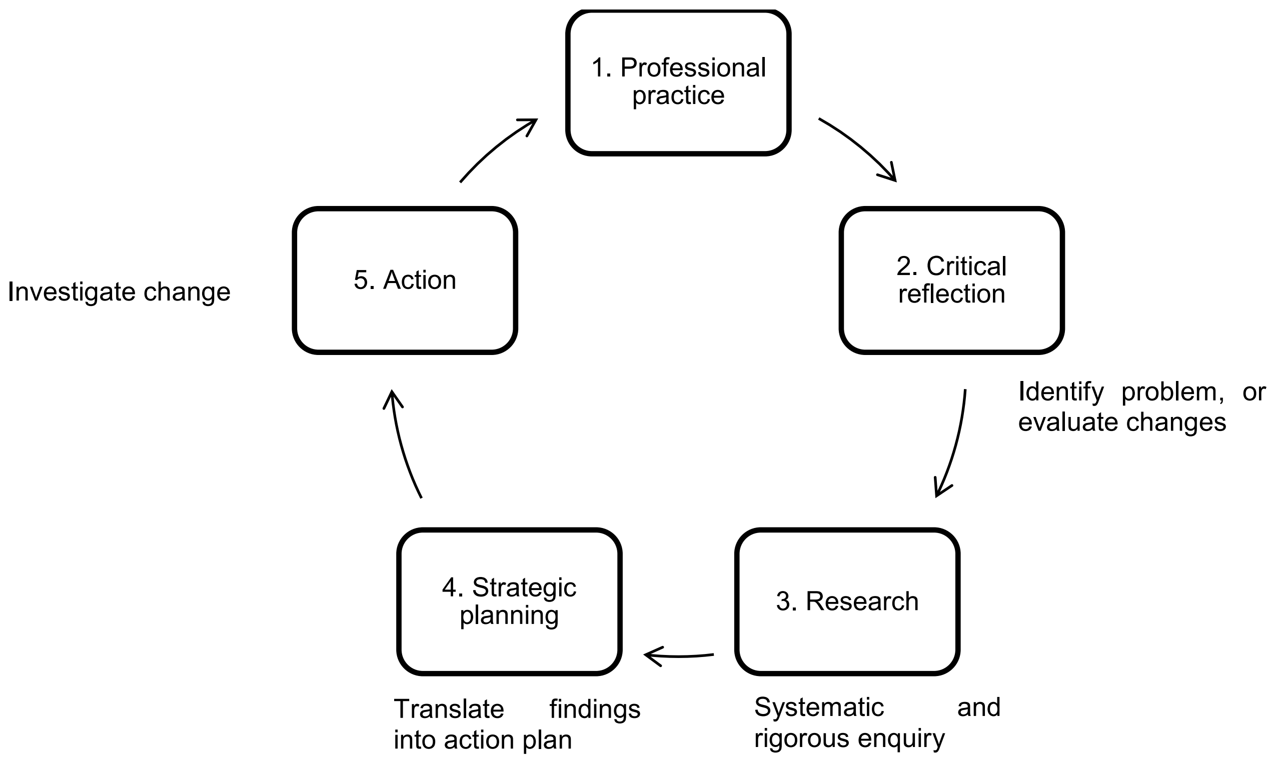

Figure 1: A cyclical method of action research as suggested by Denscombe (1999, p. 126).

Considering that a research study is characterised by continual interaction between reading, thinking, perusing materials and data, and analysing (Hardiker, 1989, p. 16), I would like to supplement the cyclical method with the following activities:

(1) performing a literature review, which forms the basis of any research (Denscombe, 1999, p. 41). Prior to performing the action research cycles of inquiry discussed in the next chapter, I embarked on a preliminary literature review to guide my decisions and activities in this research. By reading and reflecting in a critical way, I ensured that my research is informed by theory;

(2) becoming a participant observer in this research. With action research as a framework I have observed the activities, and peer and group comportment of learners, on the Facebook group site I established about three years ago. It should be stressed that, when using action research, a key pillar is that the research actively involves all the participants, which means that observations

that are reported and reflected upon will be fed back to the stakeholders of the research for criticism and scrutiny;

(3) conducting focus groups with learners and educators – with the latter only to gain insights about their practices that could improve my own practice. Using pre-selected discussion topics I conducted semi-structured interviews with ten of the twenty-six learners. Semi-structured interviews capitalise on group dynamics (Morgan, 1988, p. 10). Group interaction was used to generate data and insights. Given the nature of participatory democratic interaction, interviews and observations of the Facebook discussion postings helped me to obtain data that I eventually used to address the primary research question, which relates to the democratisation of science education through the application of educational technology; and

(4) using field notes[2] in order to ensure an 'on-going record' and an 'aide memoire' for this research study (Elliot, 1991, p. 12).

Considering my primary research question, which relates to how teaching and learning in life sciences classrooms can be improved through the use of educational technology, I chose the following sample: although I teach two grade 12 and two grade 11 classes, I selected my grade 10 class of twenty-six learners for logistical reasons. I taught them during the last period of the day for three days of the week, which meant that they could always remain after school without disrupting the school timetable and other educators' lessons in the event that the period ended before the day's objectives had been achieved. The learners then had sufficient time to document their experiences of being exposed to the teaching of life sciences through educational technology. Through an initial enquiry (afterwards I conducted a survey, as indicated in Appendix IV) I determined that all the learners had a cell phone and that at least 80% of them had computers at home. In order to support the 20% of learners who did not have a computer at home, I arranged with the school for them to be permitted to do some of their tasks in the school's computer laboratory. Using a cyclical method, I first reflected on my use of technology in teaching a specific learning outcome in relation to how the

[2] The field notes are the comments of learners on the Facebook group site. Unlike the procedure of taking notes, I have taken screen shots of the comments as they were posted on the site. Refer to Appendix vii for a list of all the screen shots I used during the study. An analysis of the comments on the screen shots was by far the most labour-intensive activity of the action research study that will be reported on.

learners responded. I then encouraged the learners to use the technology in order to facilitate their achievement of the outcomes. Where the learners and I used the technology we identified weaknesses in our teaching and learning in order to improve on the use of technology. Further, and secondly, our collective use of technology was aimed at enhancing our democratic engagement, in terms of which the learners and I offered our understandings and explanations of curriculum issues. Our democratic practices have hopefully improved in terms of revisions in our understanding of curriculum matters. Once we had used technology in the attainment of learning outcomes in a particular way, we collectively reflected on our practices with the aim to use technology in an improved way.

In addition, I benefitted tremendously from the practices of other educators through my collaboration with five educators from neighbouring schools on the 'Teaching Biology' project. This collaboration (although not specifically reported on in this dissertation, as the other educators did not actually encounter the learners in the study) enabled us to meet frequently to share and document our experiences of teaching through educational technology in life sciences classrooms. We shared our experiences of using innovative technology, and this information would be useful for my ensuing practice. Throughout this study, the grade 10 learners showed an eagerness to participate in the life sciences action research project in which educational technology, specifically Facebook, was used. In oral conversations, the five educators informally shared ideas on how they had used technology in achieving the three learning outcomes that I could use for the improvement of my practice. They also reflected on how they taught some contentious issues in the life sciences grade 10 curriculum using social media networks. Also, during 2009 my school was awarded fifty computers by Khanya[3], and two educators (I was one) were trained in the use of the software and the technical equipment. One of the conditions of the Khanya offer was that I become involved in the training of educators – which made me a participant 'insider' in this research endeavour. I shall now give an outline of the action research study.

[3] Khanya is an initiative established by the Western Cape Education Department to implement the use of technology in schools.

1.4 Outline of the Study

In Chapter 1 I provide a justification for pursuing educational research in relation to science education in the further education phase at school level in South Africa (more specifically in a high school in the Western Cape), and for the use of educational technology. I argued that research in and about school science in relation to the use of educational technology has the potential to contribute towards the democratisation of classroom practices.

In Chapter 2 I offer explanations for my choice of an action research design. Emanating from action research theory, I show how using a cyclical method can help in constructing data that I eventually derived mostly from my pedagogical engagement with learners, from informal conversations with educators and from the literature on the use of educational technology and the democratisation of education, more specifically science in school classrooms. Although I started off with interpretive inquiry and remain devoted to it, I have at times, especially during and after my analysis of the learners' comments on the Facebook group site, flirted with poststructuralist inquiry in reference to the thoughts of Jacques Rancière and Gilles Deleuze (as will be reported later on, in Chapters 3 and 4 respectively).

In Chapter 3 I examine the democratisation of education on three levels: firstly, the link between democracy and education; secondly, the connection between science education and democracy; and thirdly, the relationship between democracy, science education in schools and the use of educational technology. Here, my main argument revolves around how a Rancièrean notion of democracy (drawing on Biesta) possibly guides science education in school classrooms through the use of technology.

In Chapter 4 I examine theories of and debates on educational technology in relation to senior phase school science teaching and learning. I focus particularly on technology, educational technology and their links to critical teaching and learning. Thereafter, I explicate the use of educational technology in a Deleuzian way, focussing on how 'assemblages' of learning unfold as a corollary of a rhizomatic form of critical thinking.

In Chapter 5 I give an account of various educational technologies. Without having been ignorant of the challenges that educators and learners might encounter in implementing educational technology in science classrooms with the intent to democratise teaching and learning, I have shown how Facebook and instant messaging in particular can stimulate critical thinking and collaborative learning. Thus, my bias has been towards Facebook for both technical (and logistical) and social or human reasons.

In Chapter 6 I report on three senior phase school science action research cycles of inquiry with the grade 10 life sciences class (including instances of teaching and learning) and offer an analysis of teaching and learning in relation to theories of democratic education, and school science in the senior phase through the use of educational technology. I show my attraction to a Habermasian notion of democratic education (by focussing mostly on participatory engagement and deliberation), before moving on to becoming mildly Rancièrian and at times Deleuzian.

In Chapter 7 I provide my main findings and possibilities or recommendations for ongoing and future educational research on the democratisation of school science through the use of educational technology, particularly how this can have an impact on teaching and learning.

1.5 Ethical Considerations and Issues of Validity, Reliability, Credibility and Trustworthiness

Research ethics is concerned with how participants in a research endeavour are treated, taking into consideration values of caring, objectivity and truth (Mathison, Ross & Cornett, 1993, p. 1). Although action research focuses primarily on the practitioner, there inevitably are ethical implications, as the actions of the practitioner as well as of his/her colleagues and learners will come under scrutiny (Denscombe, 1999, p. 128). The forms of action taken often have direct consequences for colleagues, and consequently it is necessary to adhere to standards of research ethics when the information collected is of a source other than that relating to personal information relating to the practitioner (Denscombe, 1999, p. 129). These ethical standards include obtaining permission, ensuring confidentiality and protecting identities. In the development of work there also needs to be visibility, and dialogue and deliberation with the individuals participating in the research, taking into consideration their suggestions (Denscombe, 1999, p. 129). Therefore I would like to make the following distinction, namely that I intended to do research 'with' participants rather than 'on' participants.

Because I did my research 'with' participants, who mostly were learners, I not only gave them copies of the screen shots of their comments (although they could not have denied that they had actually made the comments) for confirmation. Also, to validate the comments of the learners during the interviews, I returned the ten transcripts to the learners for their perusal and approval. In order to retain high ethical standards I formally applied to the Western Cape Education Department (WCED) to do my research, the school principal, members of staff and the parents and learners. Ethical screening of my application was done by a Departmental Ethics Screening Committee (DESC) and since they deemed the study not to be of high risk, permission to perform this study was granted by the DESC of the Department of Curriculum Studies. I also obtained permission to use the school's name in the research, and the learners also consented to having their first names used. With regard to the participants, namely the learners, I continuously reinforced the importance and worth of their inputs with regard to the research, and also ensured that our engagement was one of integrity and respect for one another. This brings me to a more detailed account of the action research design I used throughout this study.

CHAPTER 2

ACTION RESEARCH AS DESIGN: TOWARDS A PARADIGM OF ACTION

2.1 Introduction

In this chapter I offer an account of action research as a qualitative approach to educational research. Firstly, I offer some justification for why action research is apposite to my investigation on democratising science education through educational technology. Secondly, I provide a more detailed account of a cyclical method that assisted in constructing data that I derived from both my pedagogical engagement with the learners and from the literature on the use of educational technology in relation to science in school classrooms. Thirdly, I elucidate why my action research on classroom practices in a high school can be considered as 'educational research for social justice' (Griffiths, 2008, p. 3).

2.2 Justification for Using Action Research

Altrichter, Feldman, Posch and Somekh (1998) suggest that all one needs to qualify as a practitioner engaging in an action research study is curiosity, creativity and the willingness to engage. Schön (1983) devised a metaphorical elucidation that is still regarded today as an enduring theme in the social sciences and practitioner research. This metaphorical elucidation involves describing educational hierarchies at different topological levels in a metaphorical landscape. On the highest topological level are university academics, and on lower topological levels one finds practitioners such as educators (Altrichter et al., 1998, p. 19). This topological landscape is often used to substantiate the validity of educational research. Professional elites see research conducted by practitioners and the consequent theories that are proposed as invalid in relation to research that is carried out by university academics, which is considered as the only legitimate source of theory propositioning (Altrichter et al., 1998, p. 19). This view is seen as ironic, as the practitioners who find themselves on the lower topological level often produce knowledge most beneficial for everyday life, whereas knowledge produced by those on the higher topological level is far removed from the practicalities of everyday life (Altrichter et al., 1998, p. 19). Schön (1983) suggests that practitioners should create their own knowledge through investigations of their own practice. The knowledge produced here should then be subjected to rigorous testing and scrutinising, as is often performed by university academics producing highly grounded theory (Altrichter et al., 1998, p. 20). This could help ensure the validity of the claims made in the practitioners' research (Altrichter et al., 1998, p. 20). With the advent of action research, practitioners have levelled the topological high ground, as proposed by Schön (1983). The advent of action research has legitimised the practices of practitioners, and academics themselves have embraced the use of action research in their own practices (Altrichter et al., 1998, p. 20). This changing topology has underlined the need for all individuals to regard themselves as practitioners and to pursue research in a scholarly, collaborative and disciplined way through the use of action research (Altrichter et al., 1998, p. 20). Through action research, practitioners such as educators thus can embark meaningfully on action that can improve their pedagogical practices.

Sagor (2000, p. 2) describes action research as 'a disciplined process of inquiry conducted by and for those taking action. The primary reason for engaging in action research is to assist the actor in improving or refining his or her action'. There are many stakeholders in education, such as parents, learners and educators. At times, these stakeholders are perhaps not as committed to the success of learners as they ought to be (Sagor, 2005, p. 1). Learner success is not always obtained and many educators leave their classrooms unfulfilled on a daily basis, wondering how they might have approached their teaching differently in order to attain learner success. Ultimately, every educator who has entered the teaching profession cannot deny the importance of learner success (Sagor, 2005, p. 1). The inability of some educators to contribute to learner success often results in them feeling discouraged (Hargreaves, 1991). However, if educators are more motivated to care about learners the possibility might arise that learners will be inspired to do well. I want to suggest that action research can assist educators in stimulating learners to do well, because this form of research also involves learner participation. This might encourage the learners to improve their performance through jointly participating in action with their educators.

The question that arises is: What does action research involve and how can it assist in improving learning? Action research involves clarifying visions and targets, articulating theory, implementing action, collecting (or constructing) data, reflecting on data and planning informed action – all processes that can help educators achieve their goal of learner success (Sagor, 2005, p. 4). In all the aforementioned processes, learners would not be treated as separate from teaching in science classrooms, for example. Learners are expected to participate actively in the pedagogical activity. For this reason it is claimed that action research has the power to radically transform classroom conditions (Sagor, 2005, p. 4). Where action research has been institutionalised a marked increase in learner success can be observed, and educators find their work to be more satisfying than before (Little, 1982, p. 326).

Elliott (1991, p. 6) considers action research as 'the study of a social situation with a view to improving the quality of the action within it'. The goals of action research thus may be defined as aiming to enhance practical judgments and validity to allow an action researcher to act more intelligently and skilfully (Altrichter et al., 1998, p. 5). Action research intends to improve the quality of professional practice and the conditions in which practices unfold (Altrichter et al., 1998, p. 6). These improvements involve helping practitioners such as educators to deal with challenges and problems of practice in a reflective manner (Altrichter et al., 1998, p. 6). Reflection, which is a key component of action research, encourages educators to reflect on their practices so as to fortify and cultivate progressive features (Altrichter et al., 1998, p. 6). This is particularly important, because educators do not always reflect on changes in the curriculum, for example aspects that have an impact on their day-to-day teaching activities. Action research would encourage reflection, and not simply participation by blindly following curriculum changes. It (action research) encourages educators to experiment with new ideas and strategies, rather than being petrified about implementing curriculum innovations (Altrichter et al., 1998, p. 6).

Feldman (2007, p. 240) explains action research by deconstructing the meanings of each word in the paradigm. 'Action' involves acting within a system that is aiming towards improvement and understanding (Feldman, 2007, p. 242), whereas 'research' refers to the systematic, critical enquiry made public by educational practitioners (Feldman, 2007, p. 243). Also, action research can broaden an educator's knowledge and professional competency (Altrichter et al., 1998, p. 6). Action research is also important as it allows educators to improve the knowledge base of their profession (Altrichter et al., 1998, p. 6).

This dissertation is justifiably informed by action research in that it addresses three key characteristics pertaining to educational research: firstly, the research is on my own professional action. To be more specific, this research may be classified as research in action, rather than research of action, or an evaluation study, research for action, or even an evaluation of material (Sagor, 2005, p. 5); secondly, I feel justified that I am indeed doing action research as I am sanctioned to adjust my ongoing actions based on the work reported in this dissertation. As an educator I am free to adjust or augment my pedagogy so as to promote the democratisation of science education in my own educational context; and thirdly, the goal of action research is to improve classroom pedagogy (Sagor, 2005, p. 5). Through action research I intend to improve my educational practices by making science classroom practices more democratic. Every educational context is unique, every learner is different, and therefore teaching could benefit from the use of action research by constantly using creative problem-solving techniques in a science classroom.

Now that I have provided some brief insight into how action research can inform and improve one's practices as an educator, I shall specifically offer some justification for what attracts me to this particular notion of action.

To begin with, I firstly am embarking on this research study in an attempt to democratise science education in school classrooms through the use of educational technology, perhaps to contribute to what Elliott refers to as 'the construction of a theory of education' (Elliott, 2009, p. 31). Elliott, drawing on Stenhouse, uses 'a theory of education as an articulation of educators' shared practical understandings of how to make their practice in classrooms more *educational* through concrete and situated action' (Elliott, 2009, p. 31). I equally consider it my task to construct ideas about what can be conceived as democratic forms of teaching through the use of technology, or what Elliott calls 'experimental actions in the particular contexts of their practice' (Elliott, 2009, p. 31). In relation to this view, I consider my use of action research as an opportunity to enact my role 'in generating practically valid educational research findings that can be cast in the form of educational theory' (Elliott, 2009, p. 31). In a way, I am attracted to action research because I can build on my understanding that educational theory is inseparable from the notion of an educator as researcher in that I (as educator) actually put theoretical concepts to work in this dissertation – a matter of generating a living theory according to McNiff and Whitehead (2009).

Secondly, through an action research project I have the opportunity to offer learners more opportunities through practice. By participating in pedagogical activities, learners learn skills that are important for their future – leadership, team work, negotiation and decision making. In this way, learners will hopefully acquire important insights into what needs to change in the curriculum. Alternatively, I use learner subjectivities and experiences to improve on my teaching. Quite importantly, the most important reason for encouraging learner participation through this study is 'to redress a power inequity' (Thompson & Gunter, 2009, p. 418). Learners are generally disenfranchised in their schooling, and their participation in this action research study is a way of beginning to disrupt power relations in science classrooms.

Thirdly, for the purpose of deepening grade 10 learners' understandings of science education, as well as their achievement in school, I thought it apposite to establish an action research network learning community on Facebook, which could enhance the learners' self-reflection. This view builds on the ideas of Day and Townsend (2009, p. 180), for whom the building and sustaining of action research networked learning communities afford educators (as practitioners) and learners opportunities to take ownership of their learning and work together as a group to solve problems of mutual concern. In the words of Day and Townsend (2009, p. 183), '[action research] networks [through technology] are intended to provide systems, structures and cultures which can support the development of thinking and practices through collaborative action'.

Fourthly, and quite importantly, my reason for doing action research is motivated by an inclination to do well in my teaching after five years in the profession. It is not unusual for action research to be considered as an in-service professional development approach through which educators like myself can continuously improve the quality of our work 'through systematic reflection on action' (Altrichter & Posch, 2009, p. 214). Again, Altrichter and Posch (2009, p. 224) hold that action research-based professional development approaches such as the one I embarked upon are promising for individual educators like myself to reflect on and develop our practice. Through action research, educators can be supported to build new competences and renewed teaching innovations – in this study through educational technology.

Fifthly, I started off from the assumption that learners' voices are often muted in the pedagogical activities of the science classroom because their views often are not recognised as worthy of consideration. Yet action research, as being 'mindful of social justice', requires that educators give recognition to the voices of learners, that is, that they have something to say in the science classroom in relation to their learning. Griffiths makes the point that part of being mindful of social justice through action research involves recognising learners' independent voices and acknowledging that they have something worthwhile to offer in the process of their learning (Griffiths, 2009, p. 89). Of course it would be a bit too ambitious to talk about democratising science education as doing 'action research for social justice' or even 'action research as social justice', because the latter two approaches would focus primarily on a redistribution of material resources (Griffiths, 2009, p. 95). But to talk about action research as an approach to teaching and learning that can assist in encouraging learners to speak their minds and to engage actively in learning activities could in some ways orientate them to becoming 'mindful' of an important aspect of social justice, that is, to begin to see things also from the points of view of others. Hence my attraction to action research as initiating learners into pedagogical activities that can make them 'mindful' of important aspects of social justice – that is collaborating with educators by articulating their independent voices in a spirit of recognition of the other's views. Figure 2 below succinctly captures my motivation for doing action research:

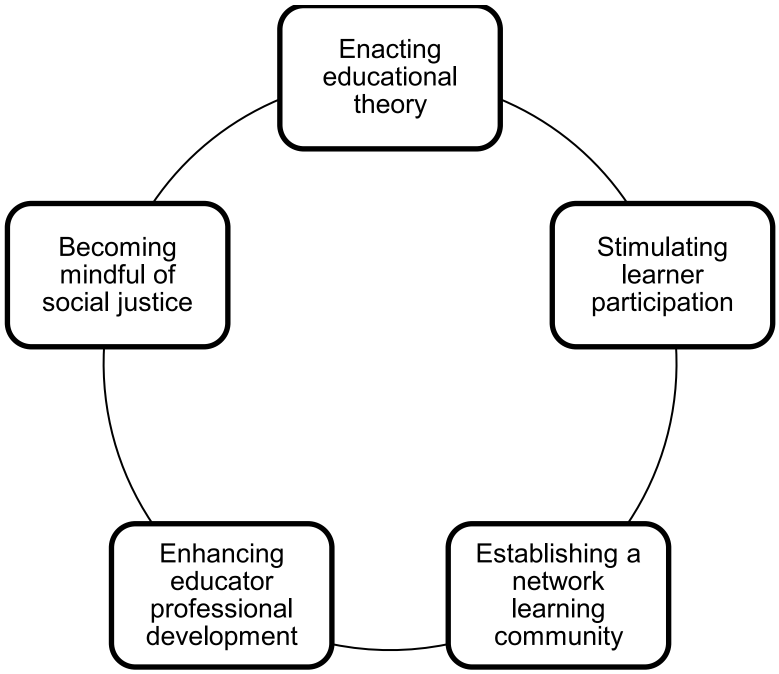

Figure 2: Motivation for doing action research

Thus far I have given some justification for why I am attracted to action research and why action research seems to be a salient educational research paradigm for this dissertation. My impending contribution to educational theory, encouragement of learners to participate and raise their views in pedagogical activities, motivation to function in a networked learning community, and intention to improve my own professional development are some of the reasons why I intend to use action research. I shall now offer an account of how action research has emerged and what major theoretical views guide my educational action research agenda in this dissertation.

2.3 Towards a Cyclical Method of Action Research

Before I offer some explanation of how I use the cyclical method in this dissertation, I shall give an account of how action research originated. Firstly, I will provide some explanation of the work of Kurt Lewin, generally considered the pioneer of action research; secondly, I will briefly discuss some of the importantly theoretical contributions to educational action research in the work of Elliott (2009), Cochran-Smith and Lytle (2009) and McNiff and Whitehead (2009); and thirdly, I show how I use a cyclical method in relation to teaching science to a grade 10 class through technology.

2.3.1 Background to Action Research

Since the early part of the 20th century, action research has been concerned with three interrelated aspects: the development of educational research aimed at *solving social problems*, in the work of Moreno, Collier and Lewin in the 1940s to 1960s; the cultivation of *self-development*, which involved careful reflection on the individual and collaborative practices of people, informed mostly through the work of Stenhouse, Elliot, Kemmis and McTaggart and Carr and Kemmis in the 1970 and 1980s; and the enhancement of teaching as a profession through the recognition that educators are *knowledge producing with voice* who can enact critical change in schools, as propounded in the work of Cochran-Smith, Lytle and Goswami in the 1990s (Noffke, 2009, pp. 8-10). Figure 3 represents some of the key reasons why action research originally emerged as an approach to social research.

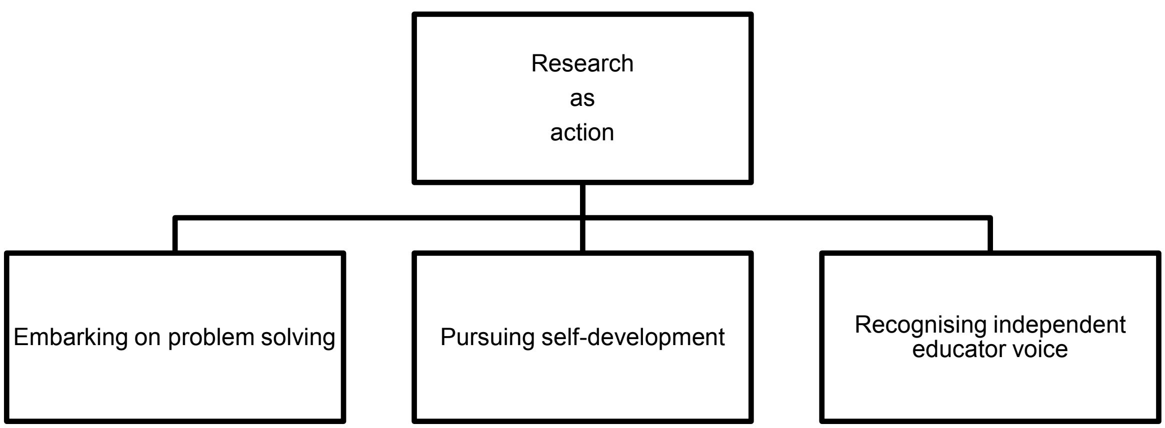

Figure 3: Reasons why action research first emerged

Firstly, action research as an approach to solve societal problems can be traced back to the work of Kurt Lewin (an American psychologist), who in the 1940s explained action research as 'proceeding in a spiral of steps, each of which is composed of planning, action and the evaluation of the result of action' (Kemmis & McTaggert, 1990, p. 8). Lewin's position on action research points towards understanding and changing and/or solving societal practices through phases of inquiry (McKernan, 1991, p. 11). Lewin attempted to resolve some societal problems through experimental inquiry comprising action cycles of analysis, fact finding, conceptualisation, planning, implementation and evaluation of action (McKernan, 1991, p. 9). Subsequently, in the 1950s and 1960s, action research was used in the study of industry (McKernan, 1991, p. 10).

Secondly, action research aimed at the self-development of people 'depends not on any particular methodological standpoint but rather on a commitment to creating space for a community of inquirers to engage in a good conversation with each other about how best to express their educational values in action' (Elliott, 2009, p. 37). What I deduce from this position of Elliot is that enhancing one's self-development depends on how one engages with others and how to find solutions to classroom problems through our shared understandings. In a way, self-development through action has a dual function: for educators to reason practically (*phronesis*) about issues in the classroom; and for educators to change their classroom practices to something better or something more worthwhile (Elliott, 2009, p. 36).

Thirdly, action research as a 'stance on practice' (Cochran-Smith & Lytle, 2009, p. 47) offers educators a compelling framework within which to enact change that is grounded in the everyday politics of classroom practices. This is so because educators are afforded a 'voice' that enables them to interrogate and enact inventive pedagogies that address the real learning needs of learners (Cochran-Smith & Lytle, 2009, p. 47). By affirming their 'voice', educators develop the distinct potential for rethinking, resisting and reforming the ways they think about and take action in classrooms (Cochran-Smith & Lytle, 2009, p. 39). The narratives educators produce through systematic reflections on teaching and learning 'contain knowledge within them' because the 'self' cannot be separated from the action educators embark on (Cochran-Smith & Lytle, 2009, p. 40).

What follows from the aforementioned historical moments in the ways that action research effects change in classroom practices is that doing action research cannot happen without invoking the idea of problem-solving, pursuing self-development, and affirming one's voice as an educator in classrooms. These are the actions that drive my own desire to do action research in relation to the democratisation of science education through technology in a grade 10 classroom.

In the following section I shall draw on the work of McNiff and Whitehead (2006) as an extension of the pioneering work that has already been done in the field, particularly showing how I became situated as a researcher-practitioner in the context of this dissertation in terms of the three backgrounds mentioned earlier. Action research as a way to solve societal problems relates primarily to improving social contexts (McNiff & Whitehead, 2006, p. 36). McNiff and Whitehead (2006, p. 36) suggest that there are three social purposes for conducting action research: improving practices through improving learning; promoting ongoing democratic evaluation of learning and practices; and creating good social orders by influencing the education of social formations. As a researcher-practitioner, all three of the aforementioned aspects seem to guide my pedagogical practices.

About improving practices through improving learning, it can be said that such actions do not happen spontaneously and require some form of systematic approach (McNiff & Whitehead, 2006, p. 37). This involves reflection on the part of individuals on what needs to be done differently in relation to others (McNiff & Whitehead, 2006, p. 37). Individuals then produce an explanatory account of the processes they undertook and make it public (McNiff & Whitehead, 2006, p. 37). This means, that practitioners produce a respectable body of theory that clarifies what is involved in understanding work as a living practice (McNiff & Whitehead, 2006, p. 37). As an educator I work in a department at a high school with many life sciences educators and often reflect on what I do in relation to what my colleagues do in their classroom practices. By reflecting on other educators' views in relation to their practices, I adjust my teaching so as to improve my own practices. This improvement may pertain to enhancing classroom practices through the use of educational technology, and to explore how it can make it more democratic or even less democratic. Whenever learners conduct scientific research on a local wetland as part of their curriculum, for example, I encourage them to look at what individuals have done in the field of research on wetland ecology and how they can possibly do things differently. I then encourage them to make their findings and explanatory account of what they have done public through the use of social media such as Facebook. By making their findings public via social media they could receive constructive input from other learners who might engage with their work.

In relation to societal problems, researcher-practitioners evaluate their work by promoting an ongoing democratic evaluation of learning and practices in relation to their own values, and do not always require external evaluation (McNiff & Whitehead, 2006, p. 39). Although researcher-practitioners are at all times conscious of the need for stringent testing and evaluation when research is conducted (McNiff & Whitehead, 2006, p. 39), they seem to retain a measure of honesty and the capacity to listen and act on critical feedback (McNiff & Whitehead, 2006, p. 38). This willingness to listen may be seen as an important dynamic that enables action research to solve societal problems. The critical insights and judgements of others can allow one to improve one's own teaching practices and the learning of others.

In addition, by creating good social orders through influencing the education of social formations, researcher-practitioners can constitute their own social orders and, in turn, learn to amend their philosophy in order to improve their practices. Whitehead and McNiff (2006: 39) suggest that, when individuals think for themselves and hold themselves accountable for their educational influence, they can contribute towards creating good societies. In my own classroom practices I see all learners as legitimate participants in pedagogical practices. I ensure that learners' viewpoints are respected and that they are not subjugated in any way. For the aforementioned reason I remain attracted to action research as a 'living practice', as espoused by Whitehead and McNiff.

Action research towards self-development encompasses the exercise of educational influence to improve practice (McNiff & Whitehead, 2009, p. 69). Whitehead and McNiff

(2006, p. 65) suggest that, for a practitioner-researcher, the goal of research is to improve learning so as to improve practice. The process by which this achievement is attained is then conveyed to all stakeholders involved. This improvement is not imposed, but rather exercised through influence to promote improved change (McNiff & Whitehead, 2009, p. 62). As Elliot (2009: 36) suggests, enhancing one's self-development depends on how one engages with others, therefore engaging in a manner that encourages individuals to change from within rather than having change imposed on them may be seen as a means to improve practice, and consequently self-development. Influence may have far-reaching implications for the practitioner-researcher and the individuals with which they engage. As an educator I am influenced by my interactions with colleagues, books, family and culture. These influences have an impact on me as an individual, and on the learners whom I teach. Therefore, as a research-practitioner it would be advantageous for my action research to encourage my own self-development and the capacity of others to think independently about influences they might encounter in order to enhance their development.

2.3.2 Contemporary Action Research

Thus far, I have shown that action research in the main is framed by at least three considerations, namely embarking on problem solving; pursuing self-development; and taking an independent stance (or asserting your voice). McNiff and Whitehead (2009, p. 12) confirm and extend the aforementioned views on action research by stating that the latter involves finding new ways to improve learning so that one can improve personal and social circumstances. In other words, problem solving can be extended beyond classroom practices, such as making learners aware of and encouraging them to do something about changing societal problems. Furthermore, these authors claim that action research involves rigorous processes of observation (watching what is going on), reflection (thinking about whether it is good and why, and how it can be improved if necessary), monitoring and data gathering (keeping track of what you do and others do). It involves 'testing your provisional claims to knowledge' (asking other people to look at your work, listen while you explain why you think it is good, and giving you feedback about whether you need to rethink some aspects): 'In this way you have created new knowledge of your practice, and you can explain the significance of your research for the new learning and growth of yourself and other people' (McNiff & Whitehead, 2009, p. 12). This brings me to a discussion of the steps (or cycles) involved in doing action research or, more specifically, an adapted version of a cyclical method to be used in this dissertation in order to show how my practices as an educator can be considered as research based.

2.3.3 Contextualising a Cyclical Method of Action Research

In Chapter 1 I presented a provisional action research cycle as proposed by Denscombe (1999, p. 126). I again present it diagrammatically in Figure 4 below.

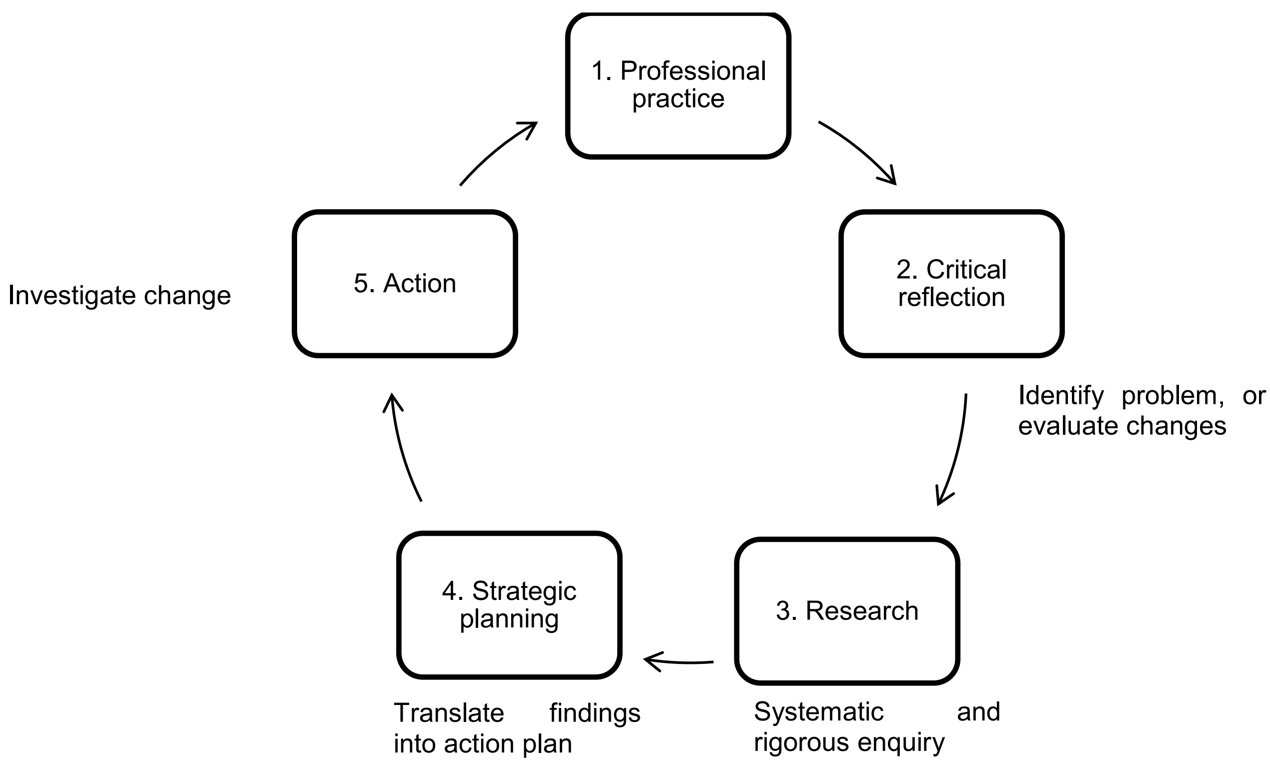

Figure 4: The cyclical method of action research as suggested by Denscombe (1999, p. 126).

With reference to the work of McNiff and Whitehead I now offer an adapted version of a cyclical method of action research to be used in this dissertation (McNiff & Whitehead, 2009, p. 15).

- *Identify the research problem in relation to improving teaching and learning in a grade 10 science classroom*

Except for a few instances, it seems as if teaching and learning is largely undemocratic in my own educational context. Learners appear to be passive participants and, as an educator, I often provide the sole input in a lesson, especially when learners are confronted with contentious issues. Such a context may be considered as inappropriate for achieving the required learning outcomes, such as problem solving and critical thinking skills, constructing and applying life sciences knowledge, and understanding the interrelationship between science, technology, indigenous knowledge, the environment and society. I contend that these learning outcomes can be attained if teaching and learning engender practices such as collaboration and engagement, critical thinking, social justice and other opportunities for educators' professional development. In this study I investigate whether educational technology can promote the aforementioned and therefore the subsequent achievement of the learning outcomes, as well as contribute to the democratisation of science education.

- *Motivate why the use of educational technology can improve science teaching and learning*

Through a literature review I identify a number of proposed improvements that educational technology can make to science teaching and learning. These include the promotion of social interaction and the ability to accommodate heterogeneity amongst learners so as to allow learners to express individual strengths that otherwise would have been stifled by a traditional learning setting (Wankle, 2011, p. 7). Furthermore, identified improvements that I investigate include the promotion of technical literacy and critical reflection (Wankle, 2011, p. 6). Computer-mediated communication has modernised the ways in which many educators liaise with their learners, which I identify as an additional improvement as part of my investigation (Wankle, 2011, p. 7). I then look at whether educational technology may serve as a catalyst for cultivating excitement and interaction among and sharing by learners (Wankle, 2011, p. 7).

- *Justify how educational technology can be used to make science classroom practices more democratic*

A preliminary literature review of educational technology has also allowed me to identify key attributes with regard to making classroom practices more democratic so as to better address contentious issues encountered by learners. I investigate these attributes in my classroom practices through what I consider to be educational technology, namely Facebook, YouTube and Wi-Fi hotspots. Such educational technology is used in different lesson contexts in order to investigate the presence of different attributes identified in the preliminary literature review. Attributes include the creation of a virtual space or sphere for citizen practices such as deliberation, accommodation and social activism; rational critical discourse, which is indicative of deliberative democracy; diversification of ideas and the consequences thereof; heterogeneous participation; overcoming of psychological barriers; liberation from social hierarchies, stereotyping and prejudices; inclusivity and equality; and communicative rationality.

- *Use data gathering techniques such as observations, group discussions and analyses to understand and improve classroom practices, and to monitor actions taken to improve the teaching and learning of school science*

Through my literature review I identified the improvements that educational technology can effect and the attributes required to ensure an improvement in classroom practices towards democratisation. It is my contention that being a participant observer mindful of these attributes (as identified in the literature review) was lacking in my lesson presentations. Field notes (in the form of Facebook screen shots) documenting shortcomings with reference to the identified were recorded and analysed as part of this dissertation. This practice seems to be in agreement with Hardiker's (1989, p. 16) notion that research is a continual interaction between reading, thinking, perusing materials and data, and analyses. As action research inherently involves the active participation of all stakeholders, documented findings (the Facebook discussions as they appear in the screen shots) were liaised with all learners who had been observed. For details on the Facebook screen shots, see Appendix VII. Future actions were planned on the basis of documented evidence recorded in the field notes. I observed twenty-six learners interacting with one another by using educational technology in the grade 10 science classroom. Since educational technology is not confined to the classroom, I also observed Facebook chats or discussion rooms in which the learners communicated with each other on the contentious life sciences issues I identified. Through classroom observations and observations of the virtual sphere where dialogue took place, namely a Facebook chat room, I was able to gauge how effective the implementation of educational technology had been with regard to democratising educational practice. These observations ensured that I constantly updated the way I implemented the use of educational technology to obtain the desired results.

In addition to the observations, I made use of interviews with ten learners. These interviews were not restricted by time constraints and were done both prior to and after the implementation of the educational technology. These interviews concentrated on the learners' experiences of the Facebook group. Interviews were semi-structured and questions were directed specifically at trying to ascertain what, according to the learners, was lacking in my classroom (see Appendix VI for examples of interviews conducted). From the life histories I determined the learners' backgrounds in relation to their use of technology and understanding of democracy. The learners and I liaised with each other about whether the use of educational technology enhanced classroom practices, provided insight into how educational technology could be used more effectively, or whether the use of educational technology contradicted the premise that it can improve teaching and learning in the science classroom.

Informal interviews with educators also assisted in determining whether learners find the use of educational technology to be effective in comparison to the other, traditionally effective teaching pedagogies they had encountered previously.

- *Generate evidence by setting criteria and standards of judgement to show that improvement occurred in relation to the FET life sciences learning outcomes*

As I had already identified the attributes that I wished to integrate into my pedagogy, I used these attributes in conjunction with the assessment standards of the National Curriculum Statement (NCS)[4] to assess the improvement in the achievement of learning outcomes. According to the NCS the assessment standards help describe the minimum level, complexity and scope of what learners should exhibit in their attainment of the learning outcomes. For each learning outcome there is a set of assessment standards. For example, when I look at how I assess learning outcome 3, dealing with life sciences, technology, environment and society, I look at its associated assessment standard, which deals with a learner being able to compare the influence of different beliefs, attitudes and values on scientific knowledge. This assessment standard requires learners to collaborate and engage with each other and, as I have already indicated, collaboration and engagement are among the attributes required by democratic practices. Therefore I used the assessment standards with reference to the attributes to assess whether or not my classroom practices had improved in relation to the attainment of the FET life sciences learning outcomes as part of my broader initiative to enable democratic science education in classrooms.

- *Critically scrutinise your findings in relation to independent and collaborative feedback*

Action research requires that all stakeholders be part of the research at all stages. Continuous collaboration between the learners and me thus was a prerequisite for this action research. I scrutinised my findings in comparison to those of the collaborative feedback obtained from educators and grade 10 learners previously identified so as to determine whether my findings were substantiated. These findings were then further

[4] The NCS is the post-apartheid public school curriculum for grades 10-12 and was implemented for the first time in 2006. Each subject has its own curriculum statement comprising of learning outcomes and assessment standards. The learning outcomes are the same for grades 10, 11 and 12 with the assessment standards indicating the level of competence required for each grade.

scrutinised with reference to the literature review conducted. My findings will be validated by stakeholders as well as researchers conducting research on the use of educational technology in relation to the democratisation of educational practices.

- *Articulate the significance of your action for your own learning and the learning of others*

McNiff and Whitehead (2009, p. 15) suggest that there are three purposes of action research, namely to improve understanding, to develop learning and to influence the way others learn. As the preliminary literature reviews indicate, this research may have significance for the way learners learn and the way educators approach the teaching of life sciences in the national curriculum. The findings of this research are not exclusively pertinent to the educational context I occupy, but I also envisage that they would have a bearing on how other individuals in the education process teach and learn. The very nature of action research is that it is geared towards informing new practices and social growth (McNiff & Whitehead, 2006, p. 248).

- *Modify your ideas and practices in the light of this evaluation*

This research offers me the prospect of influencing my own professional development and, in the light of this research, I can continuously integrate the findings of this research study into classroom practices, including democratising my pedagogies towards helping learners attain the FET life sciences learning outcomes. An adapted action research cycle, based on the work of McNiff and Whitehead (2009), is offered in Figure 5 below.

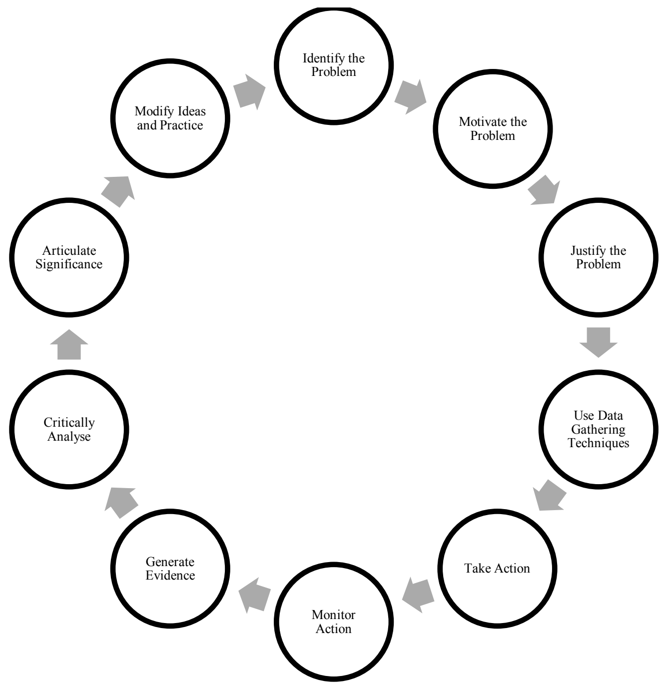

Figure 5: Adapted action research cycle (from McNiff & Whitehead, 2009)

2.4 Educational Research for Social Justice

Now that I have motivated and justified why and how action research is used to investigate my research problem, I shall offer an account of why this dissertation can be considered a contribution to the perspective of 'educational research for social justice'.

Until I read Morwenna Griffiths's (2008) *Educational Research for Social Justice: Getting off the Fence,* I thought that embarking on action research in one of my grade 10 science classrooms involved only improving my and my learners' practices . I had no idea that my action research dissertation could and should be interpreted as a contribution to the huge area of educational research for social justice. Following Griffiths (2008, p. 13), educational action research for social justice 'is concerned both with individual empowerment and also structural injustices; that is, with questions of power and resources available to individuals and to particular communities or sectors of those communities'. My primary reason for doing this research, other than wanting to graduate with a PhD in Education, was to improve my classroom practices, in particular how to teach better using educational technology and simultaneously to create opportunities for some grade 10 learners to improve their learning of life sciences at a local high school. In a way, I am concerned with the individual empowerment of both the learners and myself. My research also involves improving relations between the learners and myself as reflective of the power relations between an educator and learners. What struck me, however, is that some learners have access to better resources (for instance, cell phones and laptops) than other learners, which brings into question the issues of inequality and inequity or social injustice. This is when I began to think about the potential of my research being linked to 'educational research for social justice'. Griffiths (2009, p. 12) outlines three principles that underscore 'educational research for social justice': to continually check and adjust one's practices; to recognise each individual as a valuable and important part of the community, meaning that individuals' interests and opinions cannot be overridden; and to oppose inequalities in gender, class, race and sex and actually do something about changing an unfair and unjust situation (Griffiths, 2009, pp. 12-13). I consider this dissertation as a way in which I continually can check and adjust my teaching to address inequalities in the classroom. Also, doing this project obliges the learners and me to give due recognition to one another's points of view. Any form of structural injustice, such as discriminating against some learners or marginalising them in class, ought to be considered as unfair and inappropriate for classroom practices. Also, some of the inequalities that I practiced in my grade 10 science classrooms involved directing my questions mostly to willing learners, as if other learners might not respond positively, and focussing on those learners who were in possession of more advanced cell phones.

I shall now introduce myself, discuss my imagined audience for whom this dissertation is meant, and mention some relevant aspects of the historical context that shapes this research. In this way I will provide some insights into my situatedness in relation to others – an important aspect of educational research for social justice.

Myself

On completion of a science degree I decided to enrol for a one-year teaching qualification with the objective to pursue a career in the teaching profession. As a learner and now an educator I have always been cognisant that learners have expectations of their educators. Learners resent being passive participants and want learning to be participative, fun and stimulating. Having a particular interest in information and communication technologies I realised the potential of these technologies to augment traditional teaching and learning pedagogies. As a relatively inexperienced educator I possessed the content knowledge to teach well, but relied equally on my ICT competence and skills to augment my teaching. In a globalised world where there is continuous emphasis on the integration of social media into our everyday lives, I began to think of ideas how I could integrate these technologies, which I consider to be educational technologies, into my lessons. This ultimately led me to pursue a master's degree. My MEd thesis focussed on technology and professional development towards critical teaching and learning. In the thesis I explored the use of educational technology in grades 10 to 12 life sciences in my own educational context. I argued that there is the potential, through the application of educational technology in science classrooms, to engender critical teaching and learning and to contribute to professional educator development. In this PhD dissertation I reflect on my own professional development as a science educator through the use of narratives (as they unfolded during discussions amongst the learners and myself on Facebook). Through the narratives I am able to demonstrate how an educator can incorporate educational theories into his practice, promote critical learning in classrooms, allow learners the scope to engage with broader institutional and social issues, and show how educational technology opens up spaces for critical thinking and transformative learning.

Although I cannot repudiate the value of the use of educational technology in teaching and learning, I did, however, encounter limitations that my examiners stressed in particular in my oral defence of my master's thesis. These limitations relate to the creation of relations through which issues of inequality and social justice surface. Being a protagonist of the implementation of educational technology in schools, given the many advantages I identified, it is my contention that I can address some issues of social injustice and inequality through this dissertation.

Target audience

For this dissertation my target audience is stakeholders in education. These stakeholders include individuals who consider themselves novices and are interested in implementing educational technology in their pedagogies. Although there are many advantages to implementing educational technology in classroom practices, one cannot ignore the shortfalls. My aim is to address the concerns of sceptics with regard to the weaknesses of educational technology. In addition, it is my hope that the research undertaken for this dissertation could be implemented by schools and universities to promote the use of educational technology for democratisation. Furthermore, school subject advisors and policymakers who are responsible for broad educational change are also included as my target audience. I hold that they could facilitate the integration of educational technology into schools and consequently improve teaching and learning. Although my educational context is significantly different to the context of these stakeholders, it is my view that this dissertation may provide the impetus for stakeholders to find value in it and to apply the findings to their own educational context.

Historical context

The historical educational context of South Africa is rife with social injustice and the marginalisation of many individuals who were not part of a specific race group. The dark period in South Africa's history was known as apartheid. In contemporary South Africa apartheid is no more, but the democracy and social justice that were yearned for are still absent from post-apartheid society. Educational policies have tried to instil the values of democracy, such as learner participation, through the introduction of an outcomes-based education approach (OBE). This educational policy was geared towards learners reaching learning outcomes and attaining certain skills by reaching these learning outcomes. It also provided the impetus to maximise learner participation, which can be seen as an attempt to democratise educational practices.

In the current educational context there seems to be a drive by education policy makers to encourage democratic practices, which can be seen as a means to maximise learner participation. Technology holds much promise to promote inclusivity and equality if all have access to information and communication technologies (Robinson et al., 2002, p. 285). The contemporary South African context sees learners who have access to mobile phones, more so than to computers. With the advent of the smartphone, a single device is able to take photographs, record videos, browse the Internet and have built-in GPS to take you to a destination of your choice. These phones have the same capabilities that desktop computers have. Although many schools have forbidden the use of these on the premises, learners still bring their mobile devices to school. My contention is that educators need to familiarise themselves with these devices and try to use the technologies (found in these devices) as tools for promoting democratic practices. However, although all learners have smartphones, some have better devices than others, which may entrench the recognition of social injustices. It therefore is my aim to address the pros and cons of the use of educational technology in my context as an educator in a previously disadvantaged school that suffered the marginalisation I mentioned during the apartheid era. Hence, this dissertation holds some promise to contribute towards a better understanding of social injustice, as educational technology can also be used to educate learners about undemocratic practices.

2.5 Summary

In this chapter I have offered a defence of action research and why the latter paradigm of educational research affords me an opportunity to take a stance by implementing educational technology in a grade 10 science classroom with the aim to democratise pedagogical practices, and to cultivate opportunities for improved learning and teaching. In the next chapter I examine the importance of democratising science education.

CHAPTER 3

DEMOCRATIC EDUCATION AND SCIENCE EDUCATION: ON THE POSSIBILITY OF DEMOCRATISING SCIENCE EDUCATION

3.1 Introduction

Considering that this action research study involves ascertaining how the use of educational technology in a grade 10 science classroom at a local high school can enhance the process of democratisation, I deem it important to approach the discussion of the democratisation of education on three levels: firstly, I shall establish the link between democracy and education and why this connection, as a way of giving expression to education for social justice, seems to be important for my action research study; secondly, I shall investigate how a Rancièrean notion of democratic education (with reference to the work of Gert Biesta, Maarten Simons and Jan Masschelein) extends liberal views of democratic education in school classrooms; and thirdly, I shall specifically examine the relationship between science education in schools and democratic education.

3.2 Democracy and Education

In this section I focus on three prominent democratic education theorists whose seminal ideas on the subject have significantly influenced understandings of democratic education. These theorists are liberal democrats whose work has inspired many, including myself since having been introduced to their seminal thoughts. By way of introduction, democratic education comprises ‘the ongoing transformation of uninformed, routine habits of thinking and acting into informed, enlightened habits of reflective inquiry…infused with a deep concern for social cooperation and scientific thoroughness…’ (Dewey, cited in Katz, 2009, p. 35). This view of democratic education is contrasted with another problematic view of education that aims to prepare an individual for adult life in order for him or her to ‘assume[s] the roles and responsibilities of an adult in society’ (Katz, 2009, p. 35). The latter view of education is consistent with the Christian National Education view of education in apartheid South Africa, namely that the youth should be socialised to become adults, as if societies do not undergo change (Morrow, 1989, p. 52). This latter view of education would not have worked for my action research study because learners should be educated to think critically for themselves, and not wait to be prepared for adult life, where rapid societal change may in any case be prevalent; hence my attraction to democratic education that aims to prepare learners to participate in deliberative discussions with other learners and with myself, and to be attuned to the requirements of social justice (Robertson, 2009, p. 125). I now turn to a discussion of some of the main ideas on democratic education as espoused by Amy Gutmann (1987/1999), Maxine Greene (1995) and Eamonn Callan (1997).

3.2.1 Amy Gutmann on Democratic Education

More than a decade after Amy Gutmann's first edition of *Democratic Education* was published (Gutmann, 1987), the revised edition, with a new preface and epilogue, continues to sustain her compelling argument that education remains political (Gutmann, 1999, p. xiii) and should continuously be informed by democratic theory (Gutmann, 1999, p. 14). Her argument that education is political stems from the Deweyan view that education is a form of 'conscious social reproduction' that focuses on 'ways in which citizens are or should be empowered to influence the education that in turn shapes the political values, attitudes, and modes of behaviour of future citizens' (Gutmann, 1999, p. 14). In other words, because education includes 'every social influence that makes us who we are', it can be claimed to be political (Gutmann, 1999, p. 14). Also, the primary aim of a democratic theory of education is 'to cultivate [in learners] the skills and virtues of deliberation' (Gutmann, 1999, p. xiii). For Gutmann, 'deliberation is not a single skill or virtue [but rather] it calls upon skills of literacy, numeracy and critical thinking, as well as contextual knowledge, understanding and appreciation of other people's perspectives' (Gutmann, 1999, p. xiii). Considering that democratic education aims to engender in learners skills and virtues of deliberation, a democratic classroom can help secure learners opportunities to collectively pursue justice with other learners (Gutmann, 1999, p. xiii). Here, justice refers to learners deliberating with one another and giving due recognition of one another's points of view through listening, reflection and disagreement in an atmosphere of mutual respect.

Gutmann is not alone in linking democratic education to the notion of deliberation. There are at least two democratic decision-making models, namely the aggregative and the deliberative models of decision making (Biesta, 2009, p. 103). The first model is concerned with the aggregation of preferences with regard to choosing policies or public officials according to a democratic decision-making process. This model considers values as subjective and non-rational and involves simply a competition between private interests and preferences (Biesta, 2009, p. 103). Aggregation relies mostly on majority rule, which might not always reflect the most convincing decisions. Over the past two decades, democratic decision making has been changed into a deliberative transformation of preferences – a form of decision making that involves argumentation by participants towards collective action (Young, 2000, p. 22). Whereas the aggregative model looks at which preference has the most numerical support, the deliberative model ensures that the individuals participating in the decision-making process are persuaded by the most appropriate reasons, rather than coerced (Young, 2000, p. 23). Deliberation happens when reflection on preferences takes place in a non-coercive manner because it 'rules out domination via the exercise of power, manipulation, indoctrination, propaganda, deception, expression of mere self-interest…' (Dryzek, 2000, p. 2). This deliberative model also shows congruence with the core values of democracy, as it allows individuals to engage with each other under inclusive equality (Young, 2000, p. 26). Of course, the argument can be used that educators in classrooms have pedagogical authority, as they decide when a pedagogical episode begins and ends, without considering the agency of learners. Hence, deliberative democracy might not be possible in such classrooms. However, if educators engage with learners under conditions of inclusive equality they would not consider themselves only as decision makers with unchallenged authority, but rather as agents who actively promote learner participation under conditions of 'inclusive equality' – that is, recognising the autonomy of learners to contribute to the learning process. What follows is that a deliberative approach to learning has a robust educational perspective because it allows individuals to gain new information and look at situations from different perspectives, or enlightens them to perceive that their judgments may be based on prejudice, ignorance or misunderstanding with regard to the judgments made by others. In this way, individuals become more tolerant to and knowledgeable of the interests of others (Warren, 1992, p. 8).

A deliberative decision-making model entails several normative ideas that are a prerequisite for such a model to be integrated successfully (Katz, 2009, p. 105). In relation to such normative ideas, Young (2000, p. 24) makes an interesting delineation between reasonableness and rationality. Young (2000, p. 24) sees reasonableness as a necessary condition for deliberative decision making, and rationality as supplementary to it. Reasonableness, as defined by Young (2000, p. 25), is the willingness to listen to others who want to explain why their ideas are (in)appropriate or wrong/right. This perspective therefore not only sees deliberation as a form of political decision making, but entails the emergence of deliberation as a communicative virtue. Rationality, in turn, involves giving an account of one's reasons in the light of what others have to say. Therefore rationality is considered as supplementary to reasonableness.

Furthermore, democratic education has in mind citizens who deliberate (Robertson, 2009, p. 116). Deliberation, simply put, is a process of discussion among individuals on an equal footing who encourage others to engage in dialogue, taking into consideration alternatives, relevance and worthiness, so as to collectively choose a direction to follow (Robertson, 2009, p. 116). Notions of deliberative democracy primarily denote having a strong public sphere and opportunities for vivid discussion (Held, 1987, p. 3). Moreover, a distinction should be made between deliberators and debaters. Unlike debaters, deliberators are open to reason and the possibility of being wrong (Robertson, 2009, p. 115). Robertson (2009, p. 117) argues that deliberation aims to convert disagreement into agreement. Although disagreement may persist, the mutual respect involved in the process of deliberation will enhance legitimacy, even if it goes against the beliefs of certain individuals participating in the process (Robertson, 2009, p. 118). Supporters of deliberative democratic education propose that a special type of conversation, characterised by difference and disagreement, is required (Witschge, 2002, p. 1). Through persuasion rather than coercion, deliberators are amenable to changing their judgments during interactions within a sphere of deliberative engagement (Dryzek, 2000, p. 1). Also, 'deliberators, unlike debaters, are open to rational persuasion, [and] to the possibility of being shown wrong' (Robertson, 2009, p. 117). The legitimacy of decisions rests upon a deliberative process through which individuals' will is formed [consciously], and not by the expression of some pre-determined will (Manin, 1987, p. 338). And since deliberation is characterised by individuals reaching a consensus through the same virtues that underpin a democracy, such as willingness and respect, it therefore can be regarded as an important civic virtue (Robertson, 2009, p. 115). This civic virtue is important in classroom practices, as it allows learners to communicate with one another and with educators in a democratic manner, making learning two-directional and not just the educator imposing his or her views on the learners.

Young (2000, p. 26) suggests that there are several modes of political communication that should be incorporated as part of the deliberation process, because not all individuals in a public sphere necessarily have the eloquence and articulateness to make their points. These modes of communication include public acknowledgment, rhetoric, and narrative or storytelling. Public acknowledgement necessitates that one recognise participants in conflict resolution, especially if there is a difference in opinion or interest (Katz, 2009, p. 106). Acknowledging people publicly is a matter of greeting them and treating them courteously, even in the event of a serious disagreement. Young (2000, p. 55) suggests that rhetoric can help participants in a deliberation to articulate arguments and statements in ways that are appropriate to a situation. It allows arguments to be articulated with embodied style and tone (Young, 2000, p. 55). Young (2000, p. 56) avers that, in any form of inclusive democratic communication, individuals will have different biases, prejudices or stereotypes, which implies that their understandings of others and interpretations of events would differ as well. A narrative could be articulated (as in storytelling) to deal with these biases, prejudices or stereotypes in ways that cause conflict in inclusive democratic communication. People would offer their narratives of how they understand and explain events in society based of course on their prejudices and ways of understanding.

In the main, the monumental contribution of Gutmann in the revised edition of *Democratic Education* (1999) extends the relationship between democracy and education that was made famous by John Dewey (1916/1966) and John Rawls (1971), on which many contemporary democratic educationists and theorists have built their contributions on a democratic theory of education. According to Gutmann (1999, p. 308), democratic education should, firstly, 'introduce students [learners] to competing perspectives, and should equip them to deliberate as equal citizens about why and when it is justifiable to agree to disagree over an issue…and when it is morally necessary to decide collectively on a single substantive policy (such as racial and gender nondiscrimination)'; secondly, it should cultivate equal dignity and civic equality amongst learners and educators (Gutmann, 1999, p. 312); and thirdly, it should 'teach understanding and appreciation of liberty and justice for all from multiple perspectives' (Gutmann, 1999, p. 315). It is such an understanding of democratic education that I shall examine later on in relation to science education, with the intention to find out how deliberation, the recognition of equal dignity and civic equality, and an appreciation of liberty and justice for all can contribute towards the democratisation of science education in a grade 10 classroom in a local public school. This brings me to another democratic educationist's understanding of the practice.

3.2.2 Maxine Greene on Democratic Education

Maxine Greene's (1995) *Releasing the Imagination* offers a vivid account of human actions in relation to democratic education. She makes a cogent argument for reshaping human imagination through multiple forms of (democratic) dialogue: 'dialogue among the young who come from different cultures and different modes of life, dialogue among people who have come together to solve problems that seem worth solving to all of them, dialogue among people undertaking shared tasks, protesting injustices, avoiding or overcoming dependencies or illnesses' (Greene, 1995, p. 5). In her view, if the aforementioned dialogues are initiated in (science) classrooms, learners are 'stirred to reach out on their own initiatives' (Greene, 1995, p. 5). What attracts me to Greene's account of the dialogical relationship between learners and educators that should occur in the (science) classroom is the fact that a democratic community of educators and learners is never complete or final, but 'always in the making' (Greene, 1995, p. 39). In her words, our democratic classrooms 'ought to resound with the voices of articulate young people in dialogues always incomplete because there is always more to be discovered and more to be said…[that is, we must want our learners] to achieve friendship as each one stirs to wide-awakeness, to imaginative action, and to renewed consciousness of possibility' (Greene, 1995, p. 43). Greene's notion of democratic education is undergirded by at least three aspects: firstly, educators should stimulate learners to 'reach out for meanings, go beyond conventional limits…seek coherence and [their] explanations are to be better able to provoke and release rather than to impose and control' (Greene, 1995, p. 57); secondly, learners should 'tell their stories [or narratives] not only that we [educators] can hear them but so that they can make meaningful the birth of their own rationality' (Greene, 1995, p. 54); and thirdly, educators should be attentive to and 'transform what is inhuman [that is, torture, exclusion, victimisation, hunger, famine and starvation]' (Greene, 1995, p. 114). What follows from the aforementioned understanding of democratic education as participating in dialogues is that the latter is closely connected with arousing in learners an awareness of social injustices by stimulating them to search for 'new beginnings', to open up to others the texts of their 'lived lives', and to show their outrage about human suffering and other forms of injustice.

The need to cultivate dialogues so that learners can narrate their stories and be provoked to 'release their imagination' is based on an understanding that individuals should be included in the deliberative process of engagement. This view of democratic education as inclusion is supported by others, as will be elaborated on now. Democratising education or, more specifically democratic education, may be described as including those who are not part of a democratic sphere in a sphere of inclusion (Biesta, 1999, p. 8). Inclusion is one of the core values of a democratic education, as the whole point of democratic education is ultimately to achieve the inclusion of everyone (Biesta, 1999, p. 1). Inclusion also has a part to play in the legitimacy of democracy, as democratic decision-making (and, I would argue, democratic education) depends on the input of the affected to be part of the decision-making process in order to influence the outcome (Young, 2000, p. 5). Moreover, if one bears in mind that democratisation involves bringing into the sphere of democratic education those individuals who previously were not included (Biesta, 1999, p. 8), inclusion can be considered a fundamental requirement for democratic education. And, as has been discussed previously, Biesta makes the distinction between two assumptions with regard to inclusion, namely internal inclusion, which refers to how we can make our practices even more inclusive, and external inclusion, which looks at bringing more people into a democratic deliberative sphere (Biesta, 1999, p. 5). Whereas the first assumption is focused on making individuals even more attentive to dissimilarity (Biesta, 1999, p. 5), the second assumption demands of those who are in a democratic sphere to bring more individuals into that sphere so that they may be guided into democracy by values such as rationality and tolerance, which are indicative of the democratic sphere (Biesta, 1999, p. 6). Again there is an educational potential for this notion of inclusion, as educational practices in the class can become even more inclusive (internal inclusion) and links can be formed with other classrooms, and with organisations and other schools – examples of external inclusion. This brings me to the view of another democratic educationist on the practice.

Whitehead (1993) also argues for dialogue as the cornerstone of accountable, democratic practice. Similarly, Laidlaw (a student of Whitehead) uses dialogue as a form of action research inquiry which she contends 'can enable the processes of education to be explored, understood and enhanced in ways which lead to the living of better lives (Laidlaw, 1994: 225). In fact, she uses dialogue as a democratic procedure '… to facilitate students to come to an understanding of their own starting points, so that they are in a more cogent position from which to understand the world and act in it'.

3.2.3 Eamonn Callan on Democratic Education

Eamonn Callan's (1997) *Creating Citizens* offers a political account of education that will hopefully teach learners democratic virtues such as justice, tolerance and mutual respect so that they can participate competently in dialogue as citizens (Callan, 1997, p. 28). Callan's notion of democratic education is threefold: firstly, to teach learners to speak their minds without being silenced because of dissent (Callan, 1997, pp. 206, 209); secondly, to encourage learners to participate in a distress-provoking dialogue on the basis that one is not more than the topic of conversation (Callan, 1997, pp. 204, 206); and thirdly, to initiate learners into a sense of justice according to which they accept the responsibility for the rights of others, that is, to care about them as partners, and to restrain themselves from violating others' rights (Callan, 1997, pp. 73, 76, 79).

Following Gutmann (1987), Greene (1995) and Callan (1997), democratic education is an act of the political that implies that educators and learners, firstly, engage in dialogues in which they function as civic equals on the basis that their deliberative speech acts will receive due recognition by the other even in belligerent fashion; secondly, are attentive to social injustices such as the marginalisation and exclusion of the weaker other; and thirdly, embark on communicative action with the aim of solving particular problems and reaching out to that which is still to come, more specifically stimulating one another towards the unimaginable. With the aforementioned background of democratic education in mind, I shall now examine how the former (democratic education) links up with a notion of education for social justice.

3.2.4 Democratic Education and Education for Social Justice

In the previous chapter I explained briefly the connection between my action research study and doing educational research for social justice. Considering that educational research for social justice is central to my research endeavours, I now shall examine what an education for social justice entails before moving on to a discussion of how such a form of education links up with a notion of democratic education. The point is that, if I can show how education for social justice is connected to democratic education, then I can make the claim that doing educational research for social justice is tantamount to an attempt to democratise education. In this instance it would be to democratise science education in a grade 10 classroom through the use (as I will argue for later on in the dissertation) of educational technology.

For the purposes of this dissertation, education for social justice is informed by three categories, that is, distributive, recognitional and associational justice (Gerwitz, 2006, p.

74). Firstly, distributive justice refers to the principles according to which goods are distributed in society (Rawls, 1971, p. 7). If goods are distributed justly, exploitation, marginalisation and material deprivation will be absent (Fraser, 1997, p. 14). My interest is in distributive justice as a way of preventing individuals from being marginalised and thus being excluded from participation in social and educational activities (Young, 1990, p. 49), for instance in science classrooms. For example, if learners in a science classroom are deprived of participating in pedagogical activities because they do not have cell phones, then distributive justice should come into play so that they are supported by being provided with such technology to engage in learning. If not, these learners would be treated unjustly and pedagogical activities would not be geared towards the achievement also of social justice.

Secondly, recognitional justice entails a respect for people's cultures, ways of life, dignity, sense of worth and self-esteem. Misrecognising individuals or groups for who they are, and then preventing them from participating in educational activities, is a form of disrespect towards others (Taylor, 1992, p. 25). For instance, to misrecognise learners on the basis of their economic disadvantages is tantamount to demeaning them, which can cause them to be stereotyped and treated unjustly. Only when 'non-recognition and disrespect' disappear will people experience a sense of dignity (Fraser, 1997, p. 14).

Thirdly, associational justice can be explained as the participation of individuals and groups 'in collective discussion and decision making in all settings that depend on their commitment, action, and obedience to rules – workplaces, schools, neighbourhoods, and so on' (Young, 1990, p. 191). In other words, if learners are excluded from participation in pedagogical activities, in particular if they are prevented from collective discussion and decision making, associational justice would be absent.

The aforementioned views on democratic education, which connect to the thoughts of Gutmann, Greene and Callan, are in agreement with a Habermasian understanding of democratic education. For Habermas, democratic education is unrestricted, argumentative, inclusive and reasonable – that is, no person can exclude the other on the basis that his or her arguments are considered as unworthy of consideration. In the words of Habermas (1996, p. 22), democratic education is governed by

> (a) processes of deliberation [that] take place in argumentative form, that is, through the regulated exchange of information and reasons among parties who introduce and critically test proposals… (b) deliberations [that are] are inclusive and public…[whereby] no one may be excluded in principle; all of those who are possibly affected by the decisions have equal chances to enter and take part…[and] (d) deliberations [that] are free of any internal coercion that could detract from the equality of the participants. Each has an equal opportunity to be heard, to introduce topics, to make contributions, to suggest and criticize proposals.

Thus, what follows from the aforementioned categories of education for social justice is that the practice is linked to the achievement of distributive, recognitional and associational justice. If one bears in mind that democratic education also involves non-marginalisation and the inclusion of all participants, the recognition of their self-esteem and the establishment of opportunities for all (e.g. learners) to participate, then it follows that democratic education is intertwined with an education for social justice. Consequently, in this dissertation I endeavour to democratise education in a science classroom, which also binds me to achieve an education for social justice. The point is that, when one embarks on the cultivation of democratic education, one in fact endeavours to engender an education for social justice along the lines of distributive, recognitional and associational justice. This brings me to a discussion of a different understanding of democratic education, for the reason that I do not want to present my understanding of democratic education solely as something I need to do to learners. Rather, an extended view of democratic education is based on an understanding that learners need to do things for themselves if they want to learn. I now offer such a view of democratic education.

3.3 A Rancièrean Notion of Democratic Education: Extending Liberal Views on Democratic Education

Thus far I have given an account of democratic education as tantamount to performing an education for social justice. Such a notion of democratic education, firstly, relies on the deliberative engagement of people as equals; secondly, includes those who are perceived as marginalised in a discourse of inclusion; and thirdly, stimulates people, by including them democratically, to solve unexpected problems. However, the problem with the aforementioned views and procedures of democratic education is that they assume that everyone who is not yet part of the sphere of democratic education should be included in it. Certainly in relation to science education in classrooms it could be assumed that using educational technology would offer every learner an opportunity to be included in democratic education practices and, hence, that their learning would improve and their achievement in science would be enhanced. In other words, it is taken for granted that democratic education practices would be advantageous for the learning of learners if they (the learners) were to be included in such practices. The problem with such a practice of democratic education is that the practice in itself is not questioned and it is merely assumed that the practice would in fact democratise learners because something is done to them. That is, they are assumed to be organised under conditions of democracy. It is at this juncture that I find Jacques Rancière's view of democratic education appealing for my dissertation.

Rancière (2006) challenges the insistence on current procedures of democratic education in particular in the book *Hatred of Democracy*, and offers a more positive way of thinking about democratic education. The current procedures involve educators and learners being grouped together and organised so that they engage with one another and listen and respond to one another's views in a critical manner. As a brilliant student of Louis Althusser in the 1960s, Rancière distanced himself radically from his teacher's work, specifically his different treatment of the concept of equality (Masschelein & Simons, 2011, p. 3). For Althusser, equality is a promise or reward in the distant future that people have to aspire to attain through democratic education practices. By conceiving equality as yet to be achieved, the Althusserian view holds that a current inequality eventually has to be eradicated through democratic education practices (Masschelein & Simons, 2011, p. 3). In this view, a distance is maintained between a present inequality and a distant equality, and consequently the learner and educator remain separated. Following such a view of democratic education, those learners who are incapable of deliberating and those who can deliberate remain apart because the task of democratic education would be to ensure that deliberation is attained in future science classroom practices.

Rancière challenges the aforementioned view of equality and argues that equality is a claim to be made by all those who are considered as being 'outside' the practice of democratic education (Rancière, 2006, p. 18). In other words, democratic education does not mean that those considered as 'outsiders' who make the claim of equality want to be included in democratic practices. Rather, as equals they 'want to redefine the [democratic] order in such a way that new identities, new ways of doing and being become possible and can be counted' (Biesta, 2009, p. 110). This implies that democratic education 'is no longer a process of inclusion of excluded parties into the existing [democratic] order; it rather is a transformation of that order in the name of equality… [and the] impetus for the transformation does not come from inside but from the outside' (Biesta, 2009, p. 110). In a way, democratic education is about the power of those who have no or little power, those who are less qualified or less competent but who nevertheless intervene to install a momentary disruption and dissensus, that is, they are intellectually equal in the very act of intervention and that they are competent in view of the common [democratic practice] from which they are nevertheless excluded' (Masschelein & Simons, 2011, p. 5). And, for Rancière, 'a dissensus is not a conflict of interests, opinions, or values; it is a division put in the common sense: a dispute about what is given, about the frame within which we see something as given…' (Masschelein & Simons, 2011, p. 82). Put differently, when 'outsiders' intervene they verify their equality as beings that are able to speak and act.

> Equality refers to the assumption (and not the fact) that we all are able to (be qualified), and does not refer to the classic idea that we all have equal capacities, share particular qualifications or should have equal opportunities. Equality for

> Rancière, is always intellectual equality and intellect or intelligence [and refers to] an ability to (speak, understand)… (Masschelein & Simons, 2011, p. 83).

Therefore, assuming that everyone is equal implies assuming that everyone, regardless of their qualifications, 'is able to'; for instance, every learner is able to participate in deliberative moments and has the ability to disrupt such conversations through his or her ability to speak and understand. So, the hatred or fear of democracy refers to the hatred of those who are dominant and more eloquent who think they have a particular reason to govern and control a democratic practice. The dominant actually fear those who intervene in the name of equality, namely the less dominant, often marginalised, other.

The importance of Rancière's work is that he thinks differently about democratic education and inclusion. For him, democratic education is sporadic in the sense that people from 'outside', in other words less powerful or less democratic people, disrupt or interrupt the perceived democratic education practices in the name of equality. In the school where I conducted my research, learners could be considered as not included in democratic education practices on the grounds that they are 'outside' such practices and need to be included democratically. I therefore utilised and supported their learning opportunities through deliberative discourses using educational technology so that they could play a role in interrupting the chain of reasons and consequences, causes and effects that shape their science learning. As learners they are encouraged to create new forms of learning and to discover modes of action to make things happen (Masschelein & Simons, 2011, p. 6). In Rancièrean terms, learners have the equal ability to speak, to understand and to reshape an educational practice.

Bearing the aforementioned background to democratic education in mind, I shall now examine the relationship (if any) between democracy and science education. Doing so informed my endeavour to establish how science education can be democratised through the application of educational technology in a grade 10 science classroom.

3.4 Democracy and Science Education in Schools

Science education in schools in most of the Western world has been widely perceived as comprising of curricula that reflect 'an outdated and discipline-bound view of science' aimed at developing future scientists instead of providing learners opportunities to engage with science issues, for instance climate change, stem cell cloning and nuclear power (Tytler, 2007, p. iv). Instead, constant features that have shaped science education curricula in schools from the 20th into the 21st century include an 'emphasis… on conceptual knowledge, compartmentalised into distinct disciplinary strands, the use of key, abstract concepts to interpret and explain relatively standard problems, the treatment of context as mainly subsidiary to concepts, and the use of practical work to illustrate principles and practices' (Tytler, 2007, p. 3). Furthermore, over the last fifty years the practice of scientific research and technological development has changed significantly.

> The traditional role of the scientist as a lone explorer, or one who worked in small teams, pushing the boundaries of knowledge as part of an intellectual pursuit over which he or she had close control, has largely given way to science that is practised on a large scale, with significant funding, in teams, on projects that can be global, commercial, multi-disciplinary, significantly technologically linked, and often having significant community implications (Tytler, 2007, p. 3).

In fact, 'the increasingly technological nature of contemporary society, and the increasing need to manage resources and the effects of development carefully, places new imperatives on the way the public needs to engage with and respond to science and its products. According to Bauer (2008, p. 111), the public understanding of science (PUS) covers '[First] … a wide field of activities that aim at bringing science closer to the people and promoting PUS in the tradition of a public rhetoric of science. Second it refers to social research that investigates, using empirical methods, what the public's understanding of science might be and how this might vary across time and context. Popular topics that construct a 'social reality' or 'public reality' include: climate change, depletion of the ozone layer, biotechnology, stem cell research, nuclear safety and health issues such as HIV and AIDS and other epidemics (mad cow disease, bird flu)

(Bauer, 2008, p. 115). Controversies involving conflicting views among science experts, or government and science expertise, such as with regard to climate change, stem cell research, inoculation, and a range of environmental issues concerning energy or conservation and management, imply an increasingly important role for science education in preparing future citizens to engage with these personal and public science-based issues' (Tytler, 2007, p. 4). The importance of teaching critical citizenship in schools has also been advocated recently by Johnson and Morris (2010, p. 77). There is widespread consensus that science education in schools under-emphasises 'the ability to analyse and present an argument based on data' (The Association for Science Education, 2006, p. 11) – skills and competencies required to address the aforementioned concerns about science education.

Science education in schools functions in contexts where learners are 'connected' to other virtual learners at a distance. Likewise, in some instances practical work in traditional school science education does not engage learners in grappling with real issues (Layton, 1991, p. 44). The point about practical work is that it should be a distinctive feature of science education in schools for the reason that learners' attitudes to science and to the uptake of more advanced science courses are shaped through practical activity in science classrooms, often contrasted with unpopular 'writing' (The Association for Science Education, 2006, p. 11). Moreover, it is claimed that '[f]our decades after Schwab's (1962) argument that science should be taught as an 'enquiry into enquiry', and almost a century since John Dewey (1916) advocated that classroom learning be a student-centred process of enquiry, we still find ourselves struggling to achieve such practices in the science classroom' (Osborne & Collins, 2001, p. 442). Unsurprisingly, the following ways in which inquiry can be advanced in school science curricula should be noted: Advancing scientific methods and critical testing that involve the establishment of evidence to test hypotheses; emphasising creativity as opposed to learning stodgy facts, and encouraging learners to explore; developing an appreciation for the human nature of science activity and developments in science; teaching questioning as representing the driving force in science, the continual testing and evolution of understandings; advocating diversity of scientific thinking, emphasising the breadth of science activity, its flexibility with methods, and its importation of ideas from other areas; analysing and interpreting data and emphasising that data does not speak for itself but must be interpreted, and advocating that different scientists might come to different conclusions with the same data (Osborne, Ratcliffe, Collins, Millar & Duschl, 2003, pp. 706-709).

Furthermore, in defence of an inquiry-based approach to science education (also my emphasis in this dissertation) in schools, an action-oriented version of scientifically literate persons is articulated as follows: being interested in and understanding the world around them; engaging in discourses of and about science; being capable of identifying questions, investigating and drawing evidence-based conclusions; being sceptical and questioning of claims made by others about scientific matters; and making informed decisions about the environment and their own health and well-being (Goodrum, Hackling & Rennie, 2001, pp. 6-9). In fact, much of the content knowledge I learnt in school and at university has not been used directly in my career as a science educator. In my science classrooms the learners and I encounter tasks that require of us to make decisions. It is my view that learners will become more informed citizens by being taught to locate, analyse and critique information and to form their own opinions, rather than just being able to provide the labels of a drawing of the root, for example. Consequently, I shall endeavour to further explain what the democratisation of science education involves.

Despite some of the weaknesses associated with the implementation of science education in schools, as mentioned above, there also have been some notable attempts to link democracy to science education. This suggests that the democratisation of science education in schools is not an entirely novel idea, although its implementation has probably not been adequate enough. At least some attempts at democratising science education can be identified: Firstly, Quicke (2001, p. 113) links the democratisation of science education to taking risks because doing science can no longer be conceived of as the 'discovery of [an absolute] truth', but rather entails 'developing shared meanings and common frameworks for observing and interpreting the world'. Consequently, an educator's stance towards scientific knowledge is such that he or she recognises its fallibility and the way it can stimulate curiosity and further thought. As noted by Bruner (1986, p. 127), learners are not just 'informed' but are asked to engage in 'negotiating a world of wonder and possibility' – a matter of stimulating learners' imaginations in order that they take risks by moving towards the unimaginable. What follows from such a risk-taking approach to science education is that scientific curricula should be associated closely with the dynamic of social change and possibilities for creating new worlds and new ways of living in a global context, including 'various anticipated and actual dangers which are experienced as threats [such as nuclear war, ecological catastrophe or incurable disease] not only to democratic ideals but to the very existence of life itself on the planet' (Quicke, 2001, p. 126).

Secondly, the democratisation of science education is associated with engaging participants (learners and educators) in deliberation. Newton, Driver and Osborne (1999, p. 555) identify a shift in the position of science education in schools from a view that grounds 'claims for truth in observation alone … [towards] a view of science [education] as a social process of knowledge construction which involves conjecture'. In other words, these authors argue that 'science education [in schools] has an important contribution to make to the general education of students [learners] by developing their ability to understand, construct and evaluate arguments [both as individuals and as contributors to a group]' (Newton et al., 1999, p. 556). By implication, if learners are genuinely to understand scientific practice and if they are to become equipped with the ability to think scientifically through everyday issues, then deliberative practices need to become more prominent in science classrooms.

However, it seems as if the attempts that have been made to democratise science education in schools in relation to being attentive to issues of social justice, as well as linking science classroom practices to interrupting pedagogical activities in the name of equality, have not been convincing enough. For example, Davies (2004, p. 1755) holds the view that science education in schools in the United Kingdom (UK) 'is a rather narrow academic pursuit with little need for elaboration about the connections with the social and political'. In fact, the relationship between science education in schools and learners' 'everyday [social] contexts' is weakly connected (Millar & Osborne, 2000, p. 5).

Likewise, there may still be some way to go before science education in schools is connected to issues about democracy, although the potential for collaboration is clearly evident in some of the literature used. It is with such a wish in mind that I find it apposite to embark on an action research study that might enhance the democratisation of science education in a local school through the use of educational technology. It is with such an approach to science education in mind that educators like me would go beyond emphasising subject matter content and move towards understanding the nature of society and how one can act within it as an informed, ‘scientifically literate’ citizen – a citizen who can contribute to issues that have a scientific dimension, whether these issues be personal (relating to medication or diet) or political (relating to nuclear power, ozone depletion or DNA technologies) (Jenkins, 1999, p. 703) or in the context of South Africa, knowledge based on practical experience (traditional indigenous knowledge) that stems from religion, belief systems, folk wisdom and indigenous culture that’s adds complexity to science communication (Bauer, 2008, p. 117).

In my discussion of the relationship of science education to democracy I now want to focus on three propositions articulated by Wolff-Michael and Lee (2003, p. 262) that hopefully will give science education in schools its democratic character – a position I hope to articulate favourably in this dissertation. These authors argue for the following aspects: Firstly, it should not be a prerequisite that all individuals have a ‘scientific’ background, as society is built on a division of labour – that is, different individuals with a plurality of backgrounds make up a society and do different things. In other words, not all citizens should be scientifically orientated. Secondly, in democratic decision-making processes, science should not necessarily be biased, as different people inform the decisions made and a political decision often is more advantageous for a particular situation than a strictly ‘scientific’ one; and thirdly, science education as promoting participation in community life should be regarded as an opportunity to enhance lifelong learning (Wolff-Michael & Lee, 2003, p. 262). I shall now elaborate on these three propositions to show how science education and democracy can be linked together conceptually.

Science conducted in a laboratory differs from science practised in a community. Despite these different contexts, many science curricula are guided towards pushing learners in the direction of so-called 'laboratory' science, which perhaps is of little relevance for learners who need to function in their community (Fourez, 1997, p. 903). It might be relevant under certain circumstances to know the chemical equation for the production of hydrogen gas in a laboratory or how to mix oxygen and hydrogen. However, knowing laboratory science differs starkly from knowing the negative effects of excessive fuel combustion on the physical well-being of citizens in a community. This has ultimately led to the exclusion of some learners from science, as their societal needs have not been attended to. For instance, the relevance of knowing the debilitating effects of fuel combustion on a community's physical well-being might not even have been discussed by learners exposed to health-undermining gases (Eisenhart, Finkel & Marion, 1996, p. 261). Even with the introduction of the many educational reforms aimed at producing 'scientific' citizens, endeavours to produce 'scientifically literate' people whose knowledge might be related to improving community life have largely been unsuccessful (Shamos , 1995, p. 5).

Wolff-Michael and Lee (2003, p. 264) suggest that there are unfounded assumptions regarding science. Science is perceived as being individualistic and discipline-based so as to enhance rational human conduct, and that knowledge gained from laboratory science will necessarily be used beyond schooling. In addressing these perceptions, educators often have to contemplate how learners might internalise or construct specific science concepts, what content to teach given the time constraints they face, and how learners can transfer science beyond schools. Wolff-Michael and Lee (2003, p. 264) propose a more democratic approach to how science is conceived: Firstly, science should be seen as a process that occurs within collective situations that involve individual interactions; secondly, in decision-making endeavours science should not be regarded as a normative framework for rationality, but as one of many potential resources that can be used in a decision-making process; and thirdly, learning environments should be organised so that they promote participation that can contribute to learner communities engendering lifelong learning.

Science is often conceptualised as comprising 'hard' concepts, theories and models that have to be understood by learners (Lee, 1999, p. 189). One view is that an effective workforce in society requires scientific and technologically literate persons (Hazen & Trefil, 1991, p. 3). Wolff-Michael and Lee (2003, p. 265) suggest that, despite many educational systems promoting science for all (or democratic science), many learners are still just taught basic scientific concepts and theories that often are irrelevant to their everyday lives. Wolff-Michael and Lee (2003, p. 265) also claim that the organisational, competitive and individualistic nature of science, and its claims to objectivity, value-free enquiry and being an isolated enterprise, often result in science marginalising many individuals. This is contrary to the notion of science for all or, more specifically, democratic science education. This traditional, individualistic approach to science has therefore marginalised diverse audiences (Wolff-Michael & Lee, 2003, p. 265).

The public perception of science, according to which the scientist and non-scientist are portrayed as being in conflict, with the non-scientist expressing ignorance and rejection of scientific knowledge, is more complex and ambiguous than is often perceived (Irwin & Wynne, 1996). Everyday science is not unproblematic, objective and coherent (Roth & Desautels, 2004, p. 37). On the contrary, science is uncertain and contentious and provides insufficient solutions to individuals' everyday lives (Jenkins, 1999, p. 703). Democratic thinking about science, or more specifically democratised science education (in schools), offers a more plausible means for individuals to deal with issues in their lives than simply using objective 'scientific' thinking. Objective 'scientific' thinking is more adept at dealing with issues in the laboratory, in isolation from the everyday world many individuals find themselves in (Latour, 1988, p. 6). Wolff-Michael and Lee (2003, p. 266) argue that scientific literacy should be viewed in terms of what they call '[democratic] citizen science'. This entails using a more reflexive (and democratic) form of science to deal with everyday issues, such as the accessibility of safe drinking water, improved farming practices or organised protests (Jenkins, 1999, p. 703; Bauer, 2008, p. 115). In this way, teaching science as being connected to a community's affairs, rather than as an individual's property of knowing and learning, would ultimately result in cultivating a more democratic and relevant form of science for individuals to address issues in their everyday lives (Hutchins, 1995, p. 5). Teaching this form of science hopefully will ensure that learners are competent in their everyday lives (Wolff-Michael & Lee, 2003, p. 267). Thus, teaching science that is less individualistic, more a property of collective situations and not always unreflexive, hopefully will lead to science that is more democratic – a position I hold and hope to develop in this action research study.

Eisenhart et al. (1996, p. 261) furthermore suggest that there should be a move in emphasis from science education focussing on laboratory practices to science that is of immediate concern to learners' lives and communities. This idea of science education involves science educators engaging with learners in ways that would allow them to implement science and technology in their everyday communal experiences (Eisenhart et al., 1996, p. 262). Wolff-Michael and Lee (2003, p. 285) say that learners who participate in activities in which knowledge relating to their communities is produced will develop from adolescents into adults who continue to participate in community activities. Educators should be aware that learners are not a homogenous group (Wolff-Michael & Lee, 2003, p. 285), but rather a heterogeneous group with different intellectual, motivational and emotional needs. Thus, to maximise participation, science education must address the needs of the many individuals who form part of this heterogeneous group so that science will become more appropriate in learners' everyday lives. A misconception regarding laboratory science is that it is often seen as the yardstick for measuring science teaching and learning (Wolff-Michael & Lee, 2003, p. 285). Teaching from such a perspective encourages learners to view the world from a scientific viewpoint, which would prevent learners from developing their own construction of the world. These approaches therefore promote learners who are conformist rather than autonomous (Wolff-Michael & Lee, 2003, p. 285). Autonomous individuals who contribute to other forms of knowing and relating to the world can contribute to resolving issues in decision-making processes (Wolff-Michael & Lee, 2003, p. 285).

Science education promoting democratic teaching and learning therefore should acknowledge that science is only one disciplinary knowledge source that involves many knowledge sources, including the social sciences, humanities, ethics, law and political science in community action (Wolff-Michael & Lee, 2003, p. 286). Science education thus should not focus on bridging the gap between science and the community through theoretical hypothetical lessons in relation to the community, but rather science should be used in real-life situations linked to learners' everyday lives in order to promote lifelong learning.

3.5 Summary

In this chapter I have given an account of democratic education along the lines of some liberal views, with specific reference to democratic educationists such as Gutmann, Greene, Callan, Habermas and Rancière. The aforementioned democratic theorists primarily offer a view of democratic education that, firstly, encourages learners to engage in dialogical relationships; secondly, engenders social justice practices aimed at eliminating the exclusion and marginalisation of learners; and thirdly, stimulates learners to solve problems and to venture into pedagogical breakthroughs.

I then showed that democratic education is intertwined with an education for social justice. This implies that the cultivation of democratic education in science classrooms happens concurrently with education for social justice, along the lines of distributive, recognitional and associational justice. This was followed by the development of a view of democratic education that not only confines learners' pedagogical activities to being included in democratic practices and to adhere to the 'rules' of dialogical relationships as put forward by 'insiders'. But, 'outsiders' or often the marginalised and less powerful learners have a right to democratic practices by virtue of the intellectual equality, that is, their ability to think, write and speak. Finally, I showed that the democratisation of science education in schools is possible because opportunities can be created in classrooms for learners to engage in taking risks, participate equally in deliberations, and connect science content to everyday issues and community affairs in order to solve contentious matters relating to science education. In a way, democratic education becomes an enabling practice for democratising school science. That is, if participation, deliberation and disrupting action are constitutive of democratic action then the aforementioned practices can give rise to democratising further education school science.

In the next chapter I focus on educational technology in relation to critical and reflective teaching and learning as instances of democratic education. I specifically shall examine the relationship between educational technology and democratic education on the basis that has in mind transformative action that can give rise to enhancing educator professionalism through concentrating on what it means to engage in reflective action and also becoming critical for educators and learners.

CHAPTER 4

DEMOCRATIC SCIENCE EDUCATION, EDUCATIONAL TECHNOLOGY AND AUTONOMOUS ACTION

4.1 Introduction

In the previous chapter I argued that democratic education is inherently political and that the democratisation of science education would open up opportunities for learners and educators to deliberate on, recognise and acknowledge one another's pedagogical voices, and attend to the eradication of human suffering – a matter of provoking learners to become socially just. In this chapter I give an account, firstly, of what technology entails. Secondly, I focus on a discussion of educational technology and its links to critical teaching and learning as an instance of democratic education. Thirdly, I attempt to reconceptualise the notion of critical teaching and learning and its implications for educational technology with reference to the seminal thoughts of Gilles Deleuze and Felix Guattari.

4.2 On Technology

Generally, 'technology' refers to the use and knowledge of tools, techniques, crafts, systems or methods with the aim of solving problems or manufacturing something artistic. The word 'technology' is derived from the Greek word *technología* (a combination of *téchnē* [an 'art', 'skill' or 'craft'] and *logía* [the study of a branch of knowledge of a specific discipline]) (Garrison & Anderson, 2003, p. 33; Smeyers & Depaepe, 2007, p. 1). The term can be applied either generally, or to specific areas, of which examples include construction technology, medical technology, and information and communication technology (ICT). ICT consists of all technical means used to handle information and facilitate communication, including computer and network hardware, as well as the necessary software. In other words, ICT consists of IT as well as telephony, broadcast media, and all types of audio and video processing and transmission.

I shall now look at the history of technology to explore existing barriers and enablers, as well as why some technologies work and others do not. Although this dissertation deals primarily with ICT, it should be noted that earlier technologies, such as the abacus, chalkboard and even textbooks, have played a fundamental role in supporting learning and knowledge production over centuries (Selwyn, 2011, p. 44). These technologies remain important today in everyday classroom practices. For example, disadvantaged schools lacking ICT resources primarily make use of textbooks. The chalkboard, which is not even regarded as being a technology, was heavily hyped in its initial introduction, much like a new technology that holds the promise of improving teaching and learning (Selwyn, 2011, p. 44). Technologies such as radio, film and television also were seen to have educational potential. According to Selwyn (2011, p. 59), these technologies did not live up to expectations – for various reasons. However, through the development of microelectronics in the 1960s up until the present, many of these technologies have converged to perform the functions of radio, television and recorder into a mobile telephone, for example.

The advent of microelectronics in the 1960s contributed to education by assisting with tutorial and coaching instruction, drill-and-practice instruction, problem-solving, dialogue systems, simulation/computer-as laboratory, database use and educational games (Selwyn, 2011, p. 54). As a result, the student-to-computer ratio in the US, for example, was reduced from 125:1 to 18:1 during the 1970s and 1980s, as IT firms such as Apple, Tandy and IBM were supported by government and private sector donations to integrate ICT into schools (Selwyn, 2011, p. 54). The over-enthusiasm to integrate ICT into schools was justified by the claim that technology could contribute to producing computer-literate citizens (Besser, 1993, p. 63). This enthusiasm further was boosted by the promise that computer-assisted instruction encouraged critical thinking, increased learner motivation and creativity (Besser, 1993, p. 64). From the 1960s to 1980s there was a fast growing body of supporting evidence showing the positive impact of ICT on teaching and learning (Martin & Norman, 1970, p. 123). The use of educational technology in schools was often sporadic in actuality, and Hawkridge's (1983) overview of the relatively slow uptake of technology in education attributed it to factors such as restrictions in the quantity of software, unreliable hardware and software, negative perceptions of educators, the technology being confined to certain individuals and therefore deemed to be elitist, concerns over commercial bias, educators' ambivalence and socio-political bias.

According to Oppenheimer (1997, p. 45) there is a continuous cycle of events throughout history that characterises the failure of the integration of technology into schools. The cycle starts off with the promise of transformative potential and enthusiasm. This is followed by inconsistent use of the technology in the classroom due to challenges facing educators, such as insufficient resources and funding, educational bureaucracy and educator resistance, which finally lead to the die-off of the initial enthusiasm. The cycle then starts over as a new technology is introduced that promises to be better than the previous one. The new technology consequently experiences the same challenges, ultimately leading to its failure. Oppenheimer (1997, p. 46) aptly summarises this cycle as hype, hope and disappointment. History suggests that there are prevailing issues that hamper the integration of technology into educators' pedagogies. These issues may be practical in nature, attributable to inadequate resourcing, technological unreliability, financial cost and educators' lack of confidence (Selwyn, 2011, p. 59). Cuban (1986) attributes the failure of technology in teaching and learning to different work situations. Although much of the historical evidence presented thus far indicates that the implementation of technology is rarely predictable or even controllable, there still is hope for technology to effect inevitable sustained educational improvement (Selwyn, 2011, p. 59). Following the aforementioned discussion of technology, the conception of educational technology I shall use in this dissertation relates to the work of Garrison and Anderson (2003, p. 34), who consider educational technologies to be 'those tools used in formal educational practice to disseminate, illustrate, communicate, or immerse learners and teachers in activities purposively designed to induce learning'. This brings me to a discussion of educational technology in relation to critical teaching and learning.

4.3 Educational Technology and Critical Teaching and Learning

The promises and pitfalls of information and communications technologies (ICTs) are linked to two motifs of our times: globalisation and the learning society (Lelliot, Pendlebury & Enslin, 2000, p. 45). On the one hand, globalisation can be considered a process by which 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 who are linked through the application of ICTs (Lelliot *et al*., 2000, p. 46). Without access to ICTs, societies in Africa are in danger of exclusion from global development, although not immune to the effects of globalisation (Lelliot *et al*., 2000, p. 47). Of all the African countries, South Africa is the most technologically advanced, and the possibility that schools in the country can promote ICTs is very high (Lelliot *et al*., 2000, p. 50). In addition, the growth of a democratic public sphere can be linked to the implementation of ICTs. According to Bohman (1997, p. 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.

Van der Merwe (2004: 91) argues that ICTs in themselves do not necessarily enhance deep learning, however, if used according to the principles of deep learning, good (that is, democratic) pedagogical practices can be nurtured. Considering that schools also form part of the public sphere, the potential exists for ICTs to have an impact on schooling, in particular teaching and learning in science classrooms – the subject of my investigation in this dissertation.

If institutions like schools want to serve the needs of the 21st century effectively, they will have to be attenuated to the use of ICTs. In the words of Peters and Araya (2007, p. 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, p. 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.

Literature on the use of educational technology in (science) classroom practices abounds. Since the 1920s, American schools have gradually implemented educational technology in the classroom with varying degrees of support and success (Cuban, 1986, p. 8). Kent and McNergney (1998, p. 5), in *Will Technology Really Change Education? From Blackboard to Web*, offer an account of how, on the one hand, technology will hopefully improve the way educators teach and learners learn. Consequently, there seems to have been a demand to integrate computer and related technology into the classroom (Kent & McNergney, 1998, p. 6). On the other hand, there is growing dissent that questions the efficacy of computers and their related technology in classrooms, particularly the ability of technology to deliver quality and affordable education (Kent & McNergney, 1998, p. 6). Raizen, Selwood, Todd and Vickers (1995, p. 7-8) argue in favour of the use of educational technology that, according to them, would significantly alter the way in which science, mathematics and other subjects are taught. It is the latter view that I share and support, by showing in Chapter 6 of this dissertation how educational technology can democratise science teaching and learning in a grade 10 science classroom. More recently, Ashburn and Floden (2006, p. 8) contend that, despite the evolutionary status of educational technology, learners need to consider its use in classrooms along with reading, writing and the acquisition of subject knowledge. For the purposes of this dissertation, I want to echo the view of Burbules and Callister (2000, p. 10), who argue, firstly, that educational technology neither embraces a utopian vision of computers as likely to revolutionise schools, nor joins the chorus of those who consider the movement of computers into schools as wasteful and a threat to educational values and processes; secondly, that educational technology offers ways to rethink teaching and learning along the lines of critical thinking – a matter of democratising education.

Emerging educational technology holds the key to improving knowledge transmission and educator quality (Gimbert & Cristol, 2004, p. 207). Jeremy (2000) suggests that, in addition to educational technology improving learning, it may also improve critical thinking, analysis and scientific enquiry. Evidence suggests that there is a measurable difference between learner achievement and educator quality from the use of educational technology in the transmission and construction of knowledge. Gimbert and Cristol (2004, p. 207) suggest that there are five propositions concerning the integration of educational technology into pedagogical practices. Firstly, the use of educational technology in the classroom affords learners the opportunity for socialisation and language development. This is dependent on the setup of the learning environment. An example of this at the school where I teach would be that there are classrooms with up to 40 learners but only 30 computers. As a result, learners are required to work in pairs. This encourages social sharing and cognition (Gimbert & Cristol, 2004, p. 208). Learners working with educational technology in groups would be encouraged to become decision makers, creators and solvers of new problems.

Moreover, Higgs (2002: 74) offers three interpretations of critical discourse, namely, critical dogmatism, transcendental critique and deconstruction. For him, 'critical dogmatism founded, its critical endeavour, on the *truth* of the criterion of evaluation; transcendental critique founded it on *rationality* and deconstruction on *justice …* Whereas, critical dogmatism perceives criticality as a matter of evaluation by invoking a criterion or set of criteria, and whereas, transcendental critique views the critical operation in terms of the ideal of transcendental rationality, deconstruction, on the other hand, regards the capacity to bring about change as what makes an approach critical, and not the extent to which it can ground its evaluations in firm criteria. In other words, the programme of critique in deconstruction actually seeks to affect and change the way people think, speak and act in relation to others'. My interest in this dissertation is in a notion of being 'critical' along the lines of the latter view such as to empower learners 'to think and act independently, while at the same time focusing on a concern for the other as other' (Higgs, 2002: 74).

Secondly, Gimbert and Cristol (2004, p. 208) propose that, by using the appropriate educational technology, learners are encouraged to use their imagination and to explore at their own pace, based on the nature of the educational technology used. This would be useful for learners with learning disabilities. They therefore would be able to control the pace at which they learn. The software characteristics that are required to assist this type of learner would include design comprising open-ended learning tasks with animated routines, and directions that may be paused and resumed so as to nurture students' learning (Gimbert & Cristol, 2004, p. 209).

Thirdly, what I consider to be considerably important is that the use of educational technology enhances learners' attention span. My own experience is that learners respond better and pay more attention when educational technology is infused into lessons. Guthrie and Richardson (1995, p. 14) suggest that learners are intrinsically more motivated and learn better when technology is infused into learning in the classroom. Guthrie and Richardson (1995: 15) stress, however, that this only occurs when the appropriate technology is used, because the technology sometimes may actually be a hindrance to the learning process, that is certain technology may countenance learning (Gimbert & Cristol, 2004: 210). Okolo and Hayes (1996:12) found that learners spend four times longer reading when using technology infused with animation, but that they are able to recall the knowledge learnt better.

Fourthly, learners (with special needs) benefit from the use of educational technology (Behrmann & Lahm, 1994, p. 105). Technology such as touch pads and special keyboards can grant learners opportunities to learn effectively, despite having physical disabilities, language disabilities and autism (Behrmann & Lahm, 1994, p. 105). The final proposition for the integration of educational technology suggested by Gimbert and Cristol (2004) is that of educator professional development. Gimbert and Cristol (2004, p. 211) suggest that educators should not learn about technology, but should learn how to teach with technology. In doing this, their own professional development is taken into consideration. The educational technology used should be viable and meaningful (Gimbert & Cristol, 2004, p. 212). Gimbert and Cristol (2004: 212) claim that there is a need to integrate educational technology into teaching, as well as into job-embedded professional development at tertiary institutions. I would argue that educational technology can augment teaching and learning effectively, as many educators who have been in the teaching profession for many years have no experience in the integration of technology into their lessons. These educators are not able to take advantage of the five propositions of technology-supported education stated by Gimbert and Cristol (2004, p. 214).

Although there are many advantages to the integration of educational technology into lessons, Gimbert and Cristol (2004: 214) suggest that care needs to be taken when considering integrating educational technology into science lessons. Educators should look at how effective the technology used is so that it will improve and not impede the teaching and learning process. This may be done by seeking assistance from other educators who have successfully implemented educational technology in their teaching practices.[5]

Furthermore, regarding the successful implementation of educational technology in the classroom, Gimbert and Cristol (2004, p. 214) argue that educators ought to continue their professional development with the aid of professional and collegial support from colleagues, so that they can develop themselves to use technology in their pedagogical practices. In some Western Cape schools, commitments are made by organisations such as *Khanya* (as has been mentioned earlier), which send individuals to schools to train educators to use educational technology in a way that improves their (educators') professionalism. An educator who is technologically competent when learners are using educational technology has been shown to stimulate the learners' critical thinking (Gimbert & Cristol, 2004, p. 214).

[5] I have found that, once teachers have been exposed to the use of technology in their classes, they become enthusiastic to repeat its application in their lessons.

Moreover, Jeremy (2000, p. 76) has done research on the use of educational technology in pedagogical practices and has identified four fundamental characteristics that are related to the work of Gimbert and Cristol (2004). The first characteristic described by Jeremy (2000, p. 77) is that of learning through active engagement. The active engagement involves experience, interpretation and structured interaction with peers and educators to improve the learning process (Jeremy, 2000, p. 77). When learners are passive, however, they are not able to apply what they have learned to situations outside of the classroom (Jeremy, 2000, p. 77). Although active learning can be obtained without the use of educational technology, the whole basis for its use (that is, educational technology) is that it is guided by active engagement. Therefore, incorporating educational technology into classroom practices congruently results in the active engagement of learners. And, if active engagement is absent, it follows that the use of educational technology might not be implemented appropriately. Simply put, the effective application of educational technology gives rise to active engagement in learning.

Another characteristic that Jeremy (2000, p. 79) has identified is that the use of educational technology in teaching encourages the participation of learners in groups. Jeremy (2000, p. 79) suggests that social contexts afford learners the opportunity to acquire complex skills that they would otherwise not be able to gain alone. So, if educational technology encourages the active participation of learners, the learning process can only be improved through the creation of a social context in which educational technology promotes learning in groups.

The next characteristic that I would like to discuss is that of providing frequent interaction and feedback. I was fortunate to study at a tertiary institution that has really embraced the use of educational technology. This institution makes use of an interactive online classroom program called WebCT. The program allowed me to obtain all the PowerPoint notes presented in my lectures, aided me in doing many tutorial exercises designed by the lecturer, and permitted me 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, on completion of which a detailed memorandum was provided instantly. This is an example of frequent interaction and feedback. If this educational technology was not used, the opportunities for feedback and questions would have been few and this would have impeded the learning process.

The final characteristic that Jeremy (2000, p. 82) has identified is related to the way that learners learn through connections to real-world contexts. Many learners in classrooms see little relevance to the work they cover in class, or they cannot see the real-life applications of the work they do in the classroom. To enable learners to apply the knowledge they have acquired to real-life situations does not require the memorisation of content, but rather that learners grasp and understand concepts. Jeremy (2000, p. 82) suggests that traditional exercises do not allow learners to apply their knowledge effectively, due to the varying contexts. He claims that, by using educational technology, learners can effectively apply their knowledge to varying contexts. Students have access to many tools that scientists use, such as Google Earth. I have used Google Earth in my teaching practice, and shall elaborate on this in Chapter 5. For example, scientists recently have discovered a new mammalian fossil specimen that is presumed to be the missing link in the evolution of *Homo sapiens*. The discovery was brought about through the use of Google Earth. In teaching evolution to grade 12 learners, I have to discuss fossil formation with them. By using Google Earth the learners can view the discovery site and therefore this section of grade 12 life sciences no longer is arbitrary. A real-life connection is made between what is learnt in class and the latest scientific developments. Research indicates that learners' performance increases due to the use of educational technology that links classroom practices and real-life situations (Jeremy, 2000, p. 82).

In addition, educational technology offers media for the explication, analysis and assessment of arguments in and beyond the physical boundaries of the classroom. Therefore, with regard to critical teaching and learning, more specifically democratic education, educational technology could provide a means for educators and learners to occupy a space for 'communication, community building and the co-construction of knowledge' (Smeyers & Depaepe, 2007, p. 7). As mentioned previously, 'technology' and 'networks' are terms that are sometimes used interchangeably (Smeyers & Depaepe, 2007, p. 4). There are different definitions of the word 'networks'. Traditionally, networks may be seen as entailing telephone networks or mail networks, also termed point-to-point networks. The definition of a network that I want to focus on is described by Burbules (2007, p. 43) as a space and place for collaboration. Technology and networks can jointly be used as a medium, space and place for collaboration in the promotion of critical teaching and learning, that is, democratic education. Moreover, educational technology 'is interpreted in relation to a set of key principles including communication, transparency, knowledge, innovation, regulation, accountability, ownership, citizenship and power' (Smeyers & Depaepe, 2007, p. 5). I use technology as a practice that offers a medium or 'a path of point-to-point communication', which provides a space where educators and learners can spend time and collaborate on a shared project (Smeyers & Depaepe, 2007, p. 7). Technology thus is that medium that offers educators and learners a space for 'communication, community building and the co-construction of knowledge' – a matter of enhancing their (educators') democratic practices (Smeyers & Depaepe, 2007, p. 7). In this study I want to discover the potential of applying educational technology to enhance democratic education, in other words how my competence and expertise (skills) as an in-service educator in a public school can be improved, and how I can better engender critical teaching and learning. Hopefully I can show how the use of educational technology can push my understanding of teaching and learning in the science classroom to unimagined possibilities.

With the advent of various technologies, networks can be described as virtual 'places' where people spend time, interact and work in collaboration (Burbules, 2007, p. 44). For example, the Mxit (an instant messaging service) phenomenon requires individuals to be 'online' for communication between them. It is this 'online' space that represents a virtual 'place' enabling individuals to communicate. Moreover, online networked environments support community building, communication and the sharing of resources (Burbules, 2007, p. 44). These environments offer spaces for communication, interaction, observation and opportunities to act on (Burbules, 2007, p. 45). Blog sites and YouTube are examples of network environments or spaces that provide educators with vast resources for teaching and learning. On most of these educational websites, resources are not just merely added, as the nature of many of these sites is that there is collaboration among and discussion between various professionals in the field of education about what is relevant to be loaded onto these websites. Content is added to these websites in a critical manner. Therefore these networks provide a space in which professionals in the field of education can learn from one another. This represents critical learning on the part of educators, because the space enables them to engage with one another, share ideas to reflect on and ask questions to improve particular understandings. In an online space, new ways of thinking come to the fore (Burbules, 2007, p. 46) – thus corroborating the idea that the use of educational technology could engender critical thinking. Scriven and Paul (in MacKnight, 2000, p. 38) view critical thinking as an 'intellectually disciplined process of actively and skillfully conceptualising, applying, analyzing, synthesizing, and/or evaluating information gathered from, or generated by, observation, experience, reflection, reasoning, or communication, as a guide to belief and action'. Following MacKnight (2000, p. 38), it is a form of 'intellectual excellence required for full participation in the social, economic and political life of our society'. Learners who acquire critical thinking skills can exercise 'reasoned judgement', that is, they are capable of examining 'logical relationships among statements of data, construct arguments, respect diverse perspectives, view phenomena from different points of view, and have the flexibility to recast their thinking when reason leads them to do so' (MacKnight, 2000, p. 38).

Following such an understanding of critical thinking, MacKnight (2000, p. 39) argues that online communication, for instance, puts emphasis on learners' comprehension and knowledge of an argument and thus on how to interact meaningfully with ideas and one another. The latter would invariably involve asking the right questions, listening to one another, sharing work, respecting one another's ideas, and constructing understandings in new ways (MacKnight, 2000, p. 39). What follows from the aforementioned is that critical thinking is possible through the use of educational technology – a view I support and find useful to develop in the next chapter. In addition, the creation of a technology-enriched classroom environment is said to have a positive influence on learners' critical thinking skills by establishing opportunities for learners to construct knowledge rather than passively digest information. As a result, collaborative interaction unfolds and more complex manipulations take place, rather than just the recall of facts (Hopson, Simms & Knezek, 1991, p. 110).

What makes these online virtual spaces places for community building, communication and the sharing of resources is that they expand opportunities and efficacy for people occupying these spaces (Burbules, 2007, p. 51). Embodied experiences are often limited by disability, infirmity, illness, chronic pain, isolation and physical appearance, which may lead to judgement by others (Burbules, 2007, p. 51). But in an online, virtual space, individuals are not confronted by these limitations. In an online environment, individuals explore different identities and perspectives that they otherwise would not have explored in an everyday environment (Burbules, 2007, p. 52). How this relates to critical teaching and learning is that critical teaching and learning are characterised by discussion and argumentation towards emancipatory action. Therefore, if the use of these networks encourages educators and learners to articulate provocative opinions just to see where a discussion will lead, then it can only lead to emancipatory action – that is, improving thinking about and beyond the constraints of distorted situations. For example, learners would be better placed to understand and contribute to solving real-life problems.

This brings me to the following question: Does educational technology improve learning? In answering this question, researchers have made use of empirical data to determine the 'cause-and-effect' relationship between technology and education (Selwyn, 2011, p. 84). An experimental design that can be used to aptly investigate the nature of education and technology has been seen as a tedious approach (Selwyn, 2011, p. 84). To date there has not been an empirical research design able to take into consideration social, cultural, economic and political variables in investigating the influence of technology on education (Selwyn, 2011, p. 85). Research by Means, Toyama, Murphy, Bakia and Jones (2009) in online learning environments indicates that research methodologies are often designed to obtain positive conclusions in the field of educational technology. Results from such studies indicate that learners learn better online than on campuses (Lockee, Burton & Cross, 1999, p. 33). Despite such claims, tangible evidence for sustainable change is proving to be elusive (Selwyn, 2011, p. 85).

A synopsis of over 350 reports carried out by Russell (2001) concluded that a lack of evidence can be attributed to the different perceptions of what learning is. His research documented the Internet and learning. Wavering results were obtained, indicating that the use of technology improves memory working and perceptual learning (Small & Vorgon, 2008). In contrast, other results point to a decrease in learners' cognitive skills and mental performance (Sigman, 2009, p. 14). This indicates that there is no clear answer to whether technology improves learning. Dutton (2008) suggests that research in the field of technology and education is mistakenly following a substitution paradigm. By this he implies that empirical studies are looking at technology-based learning being better than non-technology-based learning. Instead, he suggests that it would be more relevant to look at the educational worth of digital technology (Selwyn, 2011, p. 87). It is my intention in this dissertation to investigate the value that educational technology can add to the democratisation of science education, rather than looking narrowly at whether educational technology can improve learning. As Selwyn (2011, p. 89) has suggested, finding sufficient proof for whether technology improves education is difficult. I contend that this dissertation can contribute more to the research field of education and technology in this way. In other words, I need to find out whether educational technology can democratise education and simultaneously improve teaching and learning, despite indications in the literature that its implementation does not improve learning.

My next move is to answer the following question: Does educational technology displace the educator? Selwyn (2011, p. 116) defines an educator as a person who educates others by supporting their learning in an organised, institutionalised setting. Fundamentally, the educator's role is to lead learners. Whilst these explanations of teaching are straightforward, many argue that the nature of teaching is much more contested. Researchers often argue that teaching should be viewed in terms of being a 'science' or an 'art' (Selwyn, 2011, p. 117). Teaching in terms of a 'science' refers to the systematic and procedural ways in which information is conveyed to learners. Teaching in terms of an 'art' refers to the improvisation and expressiveness an educator draws on during a lesson (Selwyn, 2011, p. 117). One therefore would assume that an effective educator should be able to draw upon 'scientific' and 'artistic' prowess. However, when technology is introduced the educator's role has to be re-evaluated. Some researchers propose that technology will displace educators, whereas others contend that technology offers support to teaching (Selwyn, 2011, p. 117). Selwyn (2011, p. 117) suggests, however, that the role of the educator is rarely cut and dried. It is my intention to delve into this debate to provide greater insight into whether the educator will be displaced or not.

Looking at the assumed and actual impacts of technology can provide greater clarity about whether the educator will be displaced or not. Many share the view that technology can bring about a number of enhancements to the ‘science’ of teaching (Selwyn, 2011, p. 118). These improvements relate to the procedural elements of educators’ jobs and the learners’ learning (Selwyn, 2011, p. 118). Educators are constrained by bureaucratic and administrative duties involving the tracking and monitoring of learner progress, which may be lightened through the use of technology (Selwyn, 2011, p. 118). Educators are thus able to focus on the actual interaction with the learners. In addition, educational technology may provide invaluable support in the planning and preparation of lessons. This also affords educators the opportunity to improve their own learning in their subject areas and their professional knowledge (Selwyn, 2011, p. 118). As a novice educator I often used the Internet as a resource in lesson preparation. As a student teacher, social networking allowed me to stay in contact with fellow student teachers, who served as resource for me in lesson planning.

Educational technology such as interactive whiteboards can provide educators with pedagogical support. The implication here is that educators are afforded the opportunity to alter their teaching styles and knowledge-delivery strategies. Educators are now able to switch between different modes of teaching, such as individualised, communal and communicative forms of pedagogy (Selwyn, 2011, p. 119). In contrast to the aforementioned positive portrayals of educational technology, in terms of which educators will be more empowered, there are those who are of the opinion that technology poses a fundamental threat to the role of the educator (Selwyn, 2011, p. 119). It is foreseen by some that technology will displace the educator. The proponents of this view envisage the creation of satellite campuses that drive education towards a distance approach. Such campuses will focus on learner-centred and learner-managed educational provision and may threaten the physical need for an educator to be in the classroom (Daniel, 2010). Daniel (2010) refers to these campuses as 'mega-schools'. The rationale behind them is to place the learner at the centre of the learning process and reduce the educators' role to the periphery of teaching.

As has been mentioned, technology can empower educators and many would say there is value in having an educator as part of the learning process. There is a need to recast educators' role by taking into consideration educational technology (Papert, 1996). Papert (1996) proposes the process of learning as a 'co-construction' of knowledge through which the learner interacts with different resources. The suggestion here is not the displacement of, but rather a diminished role for, the educator, who is seen more as a facilitator or supporter guiding learners' learning as they use educational technology. Consequently, educators are no longer regarded as the leading proponents in the teaching and learning process (Papert, 1996). Through the use of social media technology that are inherently linked to learning that is collaborative, creative and inquiry based, educators' roles may be seen as diminished (Selwyn, 2011, p. 123). Social media technology has seen the traditional connection between the educator and the learner changing from 'sit down and be told' to a 'making and doing' culture. To this end, the teaching and learning process is a collective endeavour to address and solve problems through open-ended enquiry (Papert, 1996). Education therefore has shifted towards a learner-centred and learner-driven approach that has seen the role of the educator change to that of a coordinator and designer of the learning process using educational technology, rather than that of a knowledge transmitter (McWilliam & Taylor, 1998, p. 29).

However, technology use has seen only a minority of educators using technology in an imaginative and exciting way, as the majority of educators seem to be using technology in a bounded and restricted way (Selwyn, 2011, p. 124). The school where I teach has received an injection of funds to promote the use of educational technology. However, technologies such as smart boards are used in a very restricted manner and educators do not take full advantage of their capabilities. This can be attributed to old, disinterested or incompetent educators. Learners in these classrooms often have a better understanding of the technology in the class. Educators are set in their traditional way of educational provision and are reluctant to destabilise or subvert their authority in the classroom (John & La Velle, 2004, p. 323). Although there are educators who are pragmatic in their approach to the use of technology in education, others appear to be reluctant to use it (John & La Velle, 2004, p. 323). Technology use by educators may also be tactical. Tyak and Tobin (1995, p. 473) suggest that educators tend to use technology only when it fits into their wider job area. For example, educators may not use an interactive smart board as it may be regarded as presentational in nature, or they may have an authoritative concern when communicating with learners via social media. The educators' use or disuse of technology in these instances can be regarded as a strategic decision based on the context.

The variance in the cases of actual and predicted use of technology may be linked to performativity. This refers to influences on an educator such as time, discipline and authority (Apple & Jungck, 1990, p. 26). Apple and Jungck (1990, p. 227) suggest that educators feel technology may intensify time constraints, rather than alleviating them. Apple and Jungck (1990, p. 227) argue further that when technology is used when time is a constraint, it is perceived as 'getting work done' being substituted for 'work well done'. Another reason for the variance between what is predicted and what is actually occurring in schools relates to educator resistance. This resistance relates to educators not wanting to become part of a fragmented and atomised educational 'assembly line' (Selwyn, 2011, p. 123). He suggests that this contributes to the degradation of the teaching profession. For example, as institutions are gearing towards online learning, concerns have been raised relating to educators' intellectual property rights of material posted online, and what Petrina (2005, p. 38) describes as the 'erosion of academic freedom', relating to educators' concerns of having their work viewed by colleagues and others in the field of education. Consequently, educators may reject and resist the use of technology as part of their educational practices (Petrina, 2005, p. 39).

Despite the advantages technology holds, and some researchers predicting the displacement of the educator, research actually points to technology not displacing the role of the educator (Petrina, 2005, p. 39). At best, technology will only remediate, reconfigure and reinforce the core roles of the educator. Educators have in many instances not avoided technology, but have instead used it to augment their teaching based on the context they find themselves in (Selwyn, 2011, p. 132). However, cases do exist where educators feel that their profession has been deprofessionalised (Petrina, 2005, p. 38).

Some stakeholders in education, including educators, parents and learners, would argue that education is a face-to-face interaction and would be critical of technology-based learning, which is often described as 'disembodied' (Volungeviciene & Leduc, 2006, p. 26). What is required for a successful merger between technology and education is an educator who can address these issues. For instance, in schools we require educators who can assist learners with many self-directed activities through the use of educational technology (Volungeviciene & Leduc, 2006, p. 26). Technology-based learning is often collaborative and therefore an initial impetus from the educator is required for many learning activities to be successful (Volungeviciene & Leduc, 2006, p. 26). Some researchers believe that educators not only support and guide learners in their learning through technology, but that they also support learners' use of technology itself. For example, in my context I had to guide learners to use their mobile devices in a critical and responsible way, making them aware that their choices have actions. Buckingham (2007, p. 44) argues that it would be more constructive to develop a learner's full range of creative abilities to make use of digital technology in a critical manner. If learners attain this skill, they have the opportunity for greater self- and co-regulation in the ways in which they access and use content obtained through technology (Withers & Sheldon, 2008, p. 51). Learners with a critical understanding will be able to grapple with non-technical challenges, such as discerning the authenticity of information obtained through educational technology, and privacy and trust issues when using the Internet (Withers & Sheldon, 2008, p. 51).

When it comes to educational technology there is a tendency for society to look forward rather than backward. Society tends to find it more compelling to look forward to what new developments technology can engender in the quest to contribute towards education, rather than looking at what has already happened with the implementation of technology (Selwyn, 2011, p. 40). Selwyn (2011, p. 41) suggests that framing the development of technology in a long-term perspective would better allow for the understanding of potential ramifications. With such a perspective there would not be a need to revamp technology that has already been implemented and that has encountered new problems. Selwyn (2011, p. 41) suggests that it is important to look at technology integration in an historical context because the social bearings and significance of technology integration are long-running, iterative processes. For example, viewed in terms of historical context, the Internet, an educational technology, is still new and it is still too early to gauge its influence on society and education (Selwyn, 2011, p. 41).

When the advent of a new technology holds the promise of improving teaching and learning, educators often uncritically accept it. Selwyn (2011, p. 42) suggests that taking an historical perspective and 'letting the dust settle' would be more prudent. Such a perspective allows one to look at often exaggerated claims and fears that surround the initial understanding of what the technology can do for teaching and learning. An historical perspective can give a clearer picture of the meanings and significance technology holds (Selwyn, 2011, p. 42). Furthermore, in researching the history of educational technology, the abovementioned benefits can be realised by making use of two approaches, described by Selwyn (2011, p. 42) as the 'contextualist' approach and the 'internalist' approach. The 'internalist' approach charts the progression of one technology. Insight generated here can serve as a guideline for the future development of education (Selwyn, 2011, p. 42). For example, interactive flash animation packages used by educators have undergone many changes over the past few years, with each package building on and improving the previous one. I have seen a progression in the ways this technology has improved in knowledge transfer and user friendliness. The 'contextualist' approach looks at the impact of cultural aspects on the use of technology. For example, in South Africa the most sought-after mobile device currently is the BlackBerry. Despite BlackBerry's global market share being smaller than that of other mobile phone manufacturers, South Africans have taken a special liking to BlackBerry. Similarly, Mxit, an instant messaging service, has tremendous popularity amongst many

South Africans. This indicates that a 'contextualist' approach would do well in understanding the use of technology in an historical context.

Furthermore, in the literature there seems to be some understanding that educational technology stimulates the development of high-order skills, such as critical thinking, reflective analysis and scientific (rational) enquiry (Jeremy, 2000, p. 77). Most learners of the current generation have access to mobile phones, more so than to computers. These mobile devices are able to take photographs, make film videos and browse the Internet, and have a built-in GPS (global positioning system) that can take one to within a metre of your destination. They can do what desktop computers can do, but at a fraction of the cost, and are more accessible. Even though mobile devices are banned from schools, learners persist in bringing these devices to school. My view is that it is impossible to prevent learners from bringing their mobile devices to schools. My contention is that educators need to familiarise themselves with these devices and try to use the educational technology (found in these devices) as tools for critically educating learners. Through my own action research initiative (as reported later in this dissertation), I would like to illustrate how these mobile devices can be used as tools in a scientific enquiry process, in particular how educational technology can democratise science teaching and learning.

This brings me to the question, does technology inevitably change education? Research in the field of education indicates that technology in education is a good thing (Gane, 2005, 471). Widespread agreement exists that technology would bring about general improvement and transformation in most areas of society (Selwyn, 2011, p. 2). Consequently, it makes sense to assume that increased integration of technology in education would be beneficial. Gane (2005, p. 471) mentions that Internet-related technology has had an impact on our everyday lives, changing the way we work, access and exchange information, shop, and interact with people to maintain social ties. Today people shop online, book movie tickets online and communicate with each other online to coordinate their activities. Consequently, Gane (2005, p. 471) proposes that technology has not merely added to our social arrangements, but radically altered them in spheres such as social life, production, consumption and communication. Gane

(2005, p. 471) argues further that education and learning are particularly relevant areas for technological improvement and change. It is evident that there is a link between education and technology, as both involve the production and dissemination of knowledge through interaction with others. This affiliation between education and technology has led many researchers to assume that education is one of the main areas for the improvement and change of teaching and learning in classroom settings (Selwyn, 2011, p. 22).

Now that I have shown briefly how educational technology can be linked to cultivating critical teaching and learning in schools, I need to examine whether critical teaching and learning, as disciplined (MacKnight, 2000), reasoned (Jeremy, 2000), communicative and reflective (Burbules, 2007) action, is sufficient to ensure that new ways of teaching and learning science are realised in schools. I contend that applying disciplined, reasoned and communicative thinking in teaching and learning school science through the use of educational technology is insufficient to engender what Burbules (2007) refers to as 'new ways of thinking coming to the fore'. Remaining devoted to disciplined, reasoned and communicative thinking would merely connect learners and educators to 'an ideal speech situation' (Habermas, 1996) that mutually engages learners and educators in what the other has to say. In this way, critical thinking would remain foundational, because it would be confined to a shared and rational exchange of ideas (Gregoriou, 2004, p. 234), thus preventing educators and learners from thinking beyond their agreed upon interpretations. Bearing in mind that this study aims to use educational technology to contribute to democratising school science, in particular its teaching and learning, harnessing critical thinking as disciplined, reasoned and communicative action would not meaningfully democratise teaching and learning. This is because the democratisation of school science aimed at making educators and learners think beyond their current practices cannot remain devoted to the application of some foundational conception of critical thinking. In other words, critical thinking cannot remain devoted to the realm of 'reaction', such as disciplined, reasoned and communicative thinking, but rather should endorse 'action … [that] celebrates thinking as creation' (Morss, 2000, p. 189). It is the latter understanding of thinking as 'creation' that I now examine in relation to the seminal thoughts of Gilles Deleuze and Felix Guattari.

4.4 A Deleuzo-Guattarian Notion of Critical (Rhizomatic) Thinking and Its Implications for Educational Technology

In an earlier and underdeveloped draft of this chapter, my promoter challenged me to read the work of Deleuze and Guattari in relation to new technologies. I happened to be attracted to Deleuze's book, *Negotiations*, for the reason that the act of negotiating has some connection with democracy. However, I was mostly attracted to the following Deleuzian phrase: 'Never interpret: experience, experiment' (Deleuze, 1995, p. 87). Critical thinking as disciplined, reasoned and communicative 'reaction' involves educators' and learners' interpretations – that is, the way they understand, explain and justify activities, say in the science classroom. However, thinking as a creative act, following Deleuze, is connected to the experiences and experimentations of educators and learners. I realised that what I had been doing in this action research study was devoted to the experiences of the learners and myself, as well as what the learners and I had experimented with in relation to the use of educational technology in the science classroom. Consequently, I began to put Deleuze to work in this study. For the purposes of rethinking critical thinking in relation to Deleuzian thought, I now commence with an analysis of the rhizome as metaphor, since the rhizome allows us to understand the 'connection and movement' of ideas in relation to educational technology, such as using the Internet and other social media to facilitate learning (Sutton, 2008, p. 27). Since the mid-1990s it has also not been uncommon to connect Deleuzian thinking with the boom of the Internet, more specifically the use of educational technology (Sutton, 2008, p. 27).

Gilles Deleuze, a French philosopher, was born in Paris on 18 January 1925 and studied philosophy at the Sorbonne from 1944 onwards. In 1968 he was appointed to the Université de Vincennes (from which he retired eventually in 1987) and, during the same year, he met Felix Guattari, a Marxist psychoanalyst with whom he co-authored and published *A Thousand Plateaus: Capitalism and Schizophrenia* in 1980 (translated by Brian Mussumi in 1987; Morss, 2000, p. 187). In the foreword to *A Thousand Plateaus,* a Deleuzo-Guattarian notion of a plateau is described as follows: '[A] plateau [orchestration of crashing conceptual bricks] is reached when circumstances combine to bring an activity to a pitch of intensity that is not automatically dissipated in a climax' (Deleuze & Guattari, 1987, p. xiv). In other words, a plateau is a metaphor used to describe an intensive state of thought that can be reactivated or injected into other activities. And, progressing from one plateau at a particular level to other plateaus at alternate levels is not linear (or in a straight line), but rhizomatic (Morss, 2000, p. 193). For Deleuze and Guattari (1987, p. 16), thinking that is firmly rooted or anchored in foundational thought (that is disciplinary, reasoned and communicative thought) is 'arborescent' or hierarchical in the sense that one receives information from a hierarchical superior. For instance, subordinate learners receive pre-digested information on life sciences content from educators 'along preestablished paths', and learners and educators 'can never get beyond' what they have acquired (Deleuze & Guattari, 1987, p. 16). In such a unidirectional relationship between an educator and learners, both the educator and the learners cannot think beyond the information transmitted between the two parties. In other words, the interpretations and exchanges between the educator and learners are fixed along a linear and regulated path determined by what is being said and heard.

Rhizomatic thinking, on the contrary, is different from linear, unidirectional thinking. According to Deleuze and Guattari (1987, p. 7), 'the rhizome itself assumes very diverse forms, from ramified surface extension in all directions to concretion into bulbs and tubers … the rhizome includes the best and the worst: potato and couchgrass, or the weed'. The rhizome, '[a subterranean root-like stem] lies upon or slightly under the surface, ready to produce a vertical stem when the opportunity arises' (Morss, 2000, p. 193). Thus, rhizomatic thinking involves a form of communication that builds up a network of interconnections with no central organisation. Understanding thinking as rhizomatic involves mapping the paths of meaning or lines of flight [new shoots and rootlets] that people take to forge linkages (Honan, 2004, p. 269). As Alvermann (2000, p. 118) explains, rhizomatic thinking is about 'looking for middles, rather than beginnings and endings, [which] makes it possible to decenter key linkages and find new ones, not by combining old ones in new ways, but by remaining open to the proliferation of ruptures and discontinuities that in turn create other linkages'. Thus, rhizomatic thinking, through 'starting anywhere', looks for middles and disrupts the taken-for-granted understanding of linear thinking. Learners and educators who are thinking rhizomatically are 'constantly open to new connections and alternative possibilities' (Le Grange, 2011, p. 748). They (educators and learners) would map out new possibilities ('vectors of escape') as they endeavour to move beyond the confines of linear exchanges of information. In this way, critical thinking can be considered as rhizomatic. Next, I offer a brief account of the implications of rhizomatic thinking when using educational technology in order to contribute towards democratising science teaching and learning in classrooms.

Whereas disciplined, reasoned and communicative thinking is linear, hierarchical ('arborescent') and 'striated' (strictly bounded and confining), rhizomatic thinking is chaotic and 'smooth' (that is, unrestricted, open and dynamic) (Ringrose, 2011, p. 602). Rhizomatic thinking allows us (educators and learners) to constantly 'move between deterritorialization – freeing ourselves from the restrictions and boundaries of controlled striated spaces – and reterritorialization – repositioning ourselves within new regimes of striated spaces' (Tamboukou, 2008, p. 360). Territorialisation describes when energy is captured and striated in specific space/time contexts, whereas deterritorialisation is when energy is smooth and momentarily escapes or moves outside normative strata, and reterritorialisation describes processes of recuperation of those ruptures (Ringhouse, 2011, p. 603). If, for example, one experiences deterritorialised and reterritorialised moments of thinking, one maps 'vectors of escape' (in relation to freeing one's thoughts from bounded restrictions) and 'lines of flight' (such as propelling one's thoughts about something in multiple and unrestricted directions) that will rupture established and hardened striated thoughts, thus giving rise to 'assemblages'. For Deleuze and Guattari (1987, p. 145),

> [t]he assemblage has two poles or vectors: one vector is oriented toward the strata, upon which it distributes territorialities, relative deterritorializations, and reterritorializations; the other is oriented toward the plane of consistency or destratification, upon which it conjugates processes of deterritorializations, carrying them to the absolute of the earth. It is along its stratic vector that the

> assemblage differentiates a form of expression (from the standpoint of which it appears as a collective assemblage of enunciation) from a form of content (from the standpoint of which it appears as a machinic assemblage of bodies); it fits one form to the other, one manifestation to the other, placing them in reciprocal presupposition. But along its diagrammatic or destratified vector, it no longer has two sides; all it retains are traits of expression and content from which it extracts degrees of deterritorialization that add together and cutting edges that conjugate.

According to Deleuze and Guattari (1987, p. 504), assemblages have a dual form: a machinic form of content composed of energetic components (the technical aspect), and a form of expression or enunciation consisting of articulated statements (the social or human aspect). The content of the educational technology assemblages that will be investigated in this dissertation entails the social network media discussions posted technically on the Facebook group site. The expressions of or enunciations by the learners and me in relation to three contentious issues in life sciences are examined in this study. Thus, following Deleuze and Guattari, machinic assemblages refer both to the technical content and the human enunciations, such as learner and educator comments posted on Facebook. In turn, an understanding of these assemblages requires that the learners and I evaluate the capacities of these assemblages to democratise science teaching and learning. In other words, the learners and I need to determine the 'lines of flight' or deterritorialisations that rupture the striated or ordered ways of teaching and learning science in the classroom. Failing to create new possibilities for thinking and doing through our experimentation would intensify our hierarchical relations in the science classroom. In turn, the democratic potential of educational technologies would be resisted.

Thus, in this dissertation it is not a question of equating social media networks, such as Facebook, with the rhizome, 'but of thinking rhizomatically *from* and *with the help of* computers and electronic media' (Conley, 2009, p. 34). Deleuze and Guattari passed away on the threshold of the proliferation of the new social media and, although they were 'keenly attuned to the first signs of the massive transformations underway … [t]hey did not, however, experience the full impact of new media' (Conley, 2009, p. 36). The point I am making is that the emergence of social media networks such as Facebook did not occur during the lifetime of Deleuze and Guattari, but they were prescient to the new technologies that would contribute to the formation of 'assemblages' of learning, as in the case of educational technology contributing to establishing positive learning contexts.

4.5 Summary

In this chapter I have argued for the view that using educational technology can bring about transformative, more specifically democratic, action. This is so because transformative action relies both on educators and learners becoming critical (rhizomatic). In the next chapter I focus on the use of educational technology and on its potential to bring about the democratisation of science education in schools – my focus in this dissertation.

CHAPTER 5

EDUCATIONAL TECHNOLOGY AS A MEANS TO DEMOCRATISE SCIENCE EDUCATION

5.1 Introduction

In the previous chapter I offered an account of the use of educational technology and its links to critical (rhizomatic) teaching and learning – the latter, I argued, are instances of democratic education. I shall now move on to a discussion of how the use of educational technology can democratise science education in classrooms. I argue that educational technology has the potential to democratise science education with specific reference to teaching and learning in schools. Thereafter I highlight some of the impediments educators and learners might encounter when applying educational technology in science classrooms, before arguing for a transformative view of educational technology that can possibly democratise science education.

5.2 Democratising Science Education Classrooms through Educational Technology

Technological advancement in areas of social networking, social media, smartphones and tablet computers has provided teachers with a challenge to engage learners on a newly developed front whilst still complying with sound pedagogical practices (McHaney, 2011, p. 1). McHaney (2011, p. 3) suggests that those who embrace technology will thrive and excel, in contrast to those who do not. There are various technologies that have enabled a transition towards more meaningful pedagogical experiences for learners. This transition has presented educators with the challenge of understanding how the technology works and how it can be implemented effectively. The challenges suggested by McHaney (2011, p. 51) should not be a reason for concern, as learners of the current generation are eager and ready to accept educational technology such as Facebook – a situation that augurs well for successful technology implementation in science classrooms. It should be noted, however, that even if there is an indication that learners exhibit a positive attitude towards technology, it does not necessarily indicate that they are able to use it effectively towards improving their learning. A reason for this is that they are not necessarily experts at filtering information that is of relevance to them. The educator's role in the current era is to encourage learners to develop good instincts that would ensure continuity and the credible implementation of science education (McHaney, 2011, p. 51). Although many individuals in education hold the view that learners need to use traditional sources of knowledge, such as libraries, McHaney (2011, p. 51) suggests that it would be more beneficial for learners to be exposed to the wealth of knowledge, albeit of varying degrees of quality, that is to be found on the Internet. Learners often use the Internet as a resource for reports or projects, with varying degrees of success. Although their learning may in some cases be inhibited by the fact that they use Internet resources of low quality, it cannot be denied that their exposure to such a massive resource can only be positive. It is here that educators can help learners filter through the wealth of information on the Internet in order to contribute to a fuller pedagogical experience for them. The ease with which information is accessed and disseminated is a reality for learners, and they need to be able to deal with this reality (McHaney, 2011, p. 51). It should be noted that, even with the wealth of information that is available to learners through the use of various technologies, these should not be used just for the sake of using technology (McHaney, 2011, p. 51). Integrating any new technology into educators' teaching needs to make sense, that is, educators should encourage learners to be more attentive to learning through the use of technology. When I come across a new technology it often requires some imagination to integrate it into my classroom practices successfully in order to make the learning experience more meaningful and exciting for learners. It is this kind of imagination that can push aside obsolete teaching pedagogies to cultivating better pedagogical experiences for learners (McHaney, 2011, p. 53).

In the contemporary era it is hoped that education incorporating ICTs will encourage flexibility of mind, a creative spirit and a network of contact to ensure sustainability in a competitive world (McHaney, 2011, p. xiii). Not all technology may be effective in the pursuit of this endeavour (McHaney, 2011, p. xiii). McHaney (2011: p. xvii) calls current learners 'millennials'. These learners are not necessarily smarter or superior, but do have different expectations of the world to learners of past generations (McHaney, 2011, p. xvii). These learners or 'millennials' are distinguishable from other generations in that they have incorporated social media and other forms of communication technology into their everyday lives. They have also been endowed the capability to customise their social media experience, and are able to commoditise, filter and synthesise information (McHaney, 2011, p. xvii). On the downside, these individuals may have little regard for online privacy, have developed a social order on the web and may engage in inappropriate activities on the web (McHaney, 2011, p. xvii).

Despite this downside, their engagement with the web holds much promise in the sense that technology can help to produce a fuller pedagogical experience for learners (McHaney, 2011, p. xviii). Working towards a fuller pedagogical experience has been aided by the advent of many social computing, social media smartphone device applications to promote such an experience for learners (McHaney, 2011, p. xviii). Various forms of technology thus have converged with one another. The convergence of technology is known as Web 2.0, which consists of five components, namely social computing, social media, content sharing, filtering and web applications (McHaney, 2011, p. xviii). These technologies, which are linked to free information sources, have reshaped the ways in which individuals filter, sort and find relevant information, resulting in new possibilities for learning. Learners inherently expect learning material on platforms of their own choice (McHaney, 2011, p. xviii). McHaney (2011 p. xviii) suggests that when these components are integrated into classroom practices, there is a potential for richer knowledge delivery to the millennials that we encounter in classrooms today. Moreover, Garrison and Anderson (2003, p. 42) posit that educational technology can contribute to democratising classroom pedagogy in the following ways: by keeping an educational group of learners synchronised or acting together; by developing connections between learners' existing mental schema and new content, information and skills acquired; by guiding the way learners interact with one another; and by making it possible for learners to follow individual interests and interactive paths.

In fact, what has been discussed thus far in relation to educational technology is that technology can facilitate learning on-line, such as through Facebook – that is, a form of e-learning that makes it possible to transform teaching and learning in science classrooms. In this regard, Garrison and Anderson (2003, p. xiii) hold that 'e-learning [such as learning through the educational technology of Facebook] can create asynchronous communities of inquiry which have the potential to support the development of communities of learning, while still allowing anytime-anywhere access by students [i.e. learners]'. In this way, e-learning [or educational technology], as I shall show in Chapter 6, can engender what Garrison and Anderson (2003, p. xi) refer to as 'explosive, unprecedented, amazing and disruptive' pedagogical opportunities for both learners and educators.

This brings me to a discussion of various technologies and their uses.

5.2.1 Mobile Phones

One technology that I have identified as an educational technology is the mobile telephone. In the modern era almost every individual owns a mobile telephone and it has redefined the way we conduct our daily lives. McHaney (2011, p. 61) suggests that the mobile telephone has become the main learning tool for the generation of millennial learners. Although most individuals have mobile telephones, phones range from simple communication tools to advanced smartphones with equal or more capabilities than that of expensive desktop computers. But despite the differences in the capabilities of these devices, at the core they all allow for communication between users of mobile telephones and other devices. For this dissertation I will take full advantage of the pedagogical potential of the mobile telephone to show how the educational context of the classroom can be democratised. With the advent of the mobile telephone, and its accessibility to learners, there has been a reassessment of the use of these devices in classrooms as tools for teaching and learning. At the school where I work there is a strict policy against the use of mobile telephones on the premises. This is due to school management having to address many variables, such as learner safety, privacy concerns and whether mobile telephones can be viewed as important and integral resources for educators and learners. Although primary research conducted in this field suggests that mobile technology can change the educational landscape, there has been a slow rate at which mobile technology has permeated this landscape (McHaney, 2011, p. 61). There is no doubt that the future of education is heading towards what researchers term ‘m-learning’, where mobile technology defines education (McHaney, 2011, p. 61).

Modern mobile phones, also called cellular or cell phones, have come a long way from the bulky, heavy and overpriced devices that were launched by the Motorola group in 1973 (McHaney, 2011, p. 61). Today, mobile phones are small, inconspicuous and have the same processing power as expensive desktop computers had just a few years earlier. These mobile phones are no longer regarded only as devices for communication, but have evolved into mobile computing platforms known as smartphones. These smartphones have the same capabilities as many desktop or laptop computers, such as Internet connectivity, word processing, media playing, still and video cameras, videoconferencing, GPS navigation, email services, sound recorders and text messaging. The first smartphone was manufactured by Nokia in 1996 and sparked a revolution in the mobile phone circuit as competing phone manufacturers began to integrate sophisticated microprocessors into smartphones (McHaney, 2011, p. 62). The implication was that third party software developers were able to design many applications that would work on the hardware that was incorporated in these devices. This can be viewed as an important development for teaching and learning, as many of the applications developed have an educational potential.

Following the advent of the smartphone in 1996 there have been many developments in the smartphone market. In 2005, Nokia rebranded a division of their smartphone section as a mobile computer, and Apple launched the first iPhone in 2007. With the launch of the iPhone, many third-party software developers started to develop applications specifically for the iPhone operating system that could be downloaded on Apple’s highly successful online music store, iTunes. Many of these applications were designed specifically for teaching and learning (McHaney, 2011, p. 62). The applications designed for the iPhone platform are specific to the iPhone operating platform. However, in 2008 a number of companies in the information technology sector, such as Google, Intel, Motorola and eBay, formed the Open Handset Alliance to counter Apple’s domination of the smartphone sector. Google developed an open source platform known as Android. This meant that many third-party software developers could develop applications for phones running such an operation platform (McHaney, 2011, p. 63). Many of the applications developed for the Android operating platform are free of charge, and many have educational potential.

As an educator I use my mobile phone as a teaching tool. Traditionally, educators who have embraced technology in the classroom use laptops or desktop computers connected to data projectors to augment teaching and learning. These laptops and desktop computers are used to better convey content to learners in a more fun, intensive and effective manner. PowerPoint, images, YouTube, the Internet, flash animations and videos are just some of the resources available to educators to enhance the teaching and learning process. In most cases, laptops or desktop computers are very expensive, and some classrooms have limited Internet connectivity that is difficult to maintain. Given the South African context, where there is a shortage of classrooms, let alone laptops or desktop computers, it is my contention that smartphones can be a more than adequate replacement for an expensive laptop or desktop. I often connect my smartphone, which was manufactured in 2008, to a data projector through a video cable to present work using PowerPoint and other of the educational resources I have mentioned. These devices are much cheaper than expensive laptops or desktop computers, but have the same functionality for teaching and learning.

5.2.2 Social Computing

While investigating whether using educational technology can democratise classroom practices, I identified another key technology with which to pursue this endeavour, namely Web 2.0. Web 2.0 is not necessarily radically different from the Internet we have become accustomed to since its inception in the 1950s, but it redefines the World Wide Web to incorporate web-based applications that promote information sharing, interoperability and collaboration. What attracted me to this technology was its educational potential. McHaney (2011, p. xviii) suggests that incorporating Web 2.0 into classroom pedagogy creates the potential for rich knowledge delivery. Web 2.0 is an interactive form of technology, consisting of 'architectures embodying a principle of decentralisation underlying the Internet' (Peters & Roberts, 2012, p. 132). A deep transformation has occurred with Web 2.0 technologies. Instead of going onto the web to read static content, users, and especially young people, increasingly go onto the web to share their ideas and creations. The rise of user-generated content and media, such as blogging and social networking, has created revolutionary new social media that use the Internet as a platform through Web 2.0 technologies (Peters & Roberts, 2012, p. 133). For this dissertation I discuss two forms of social computing, namely social networks and social media.

Social networks have changed human interaction in a dramatic way. They have revolutionised the ways individuals interact, connect and share information (Towner & Munoz, 2011, p. 34). Essentially, social networks are linked websites that give a sense of a mobile community to people in which there is a sharing of information on a person's character and interests (McHaney, 2011, p. 81). Social networks encourage the communal exchange of text, audio or video in real time. Facebook, MySpace and MSN Messenger are but a few examples of social networking. Social networking allows users to set up online identities, known as profiles. These profiles that can be viewed by others in this online community, and may display bio-geographical information, pictures and the likes and dislikes of the user, as well as what currently is on the mind of the user via a status update (McHaney, 2011, p. 81). Since the inception of these social networking websites there has been a redefining of the ways in which learners study, do homework, read and partake in discussions (McHaney, 2011). McHaney (2011, p. 81) indicates that, in his research and surveys, all learners emphasised the importance of social networks and interwove their academic experience with the social network community they form part of.

Facebook

For the purposes of this dissertation I will look primarily at one of the largest social networking websites, namely Facebook. Given their level of personal involvement and the time learners spend on Facebook, as well as its potential for community development, educators like myself started trying to integrate Facebook as part of teaching pedagogy (Towner & Munoz, 2011, p. 35). Facebook had humble origins, being developed in a dorm room by a Harvard University student, Mark Zuckerberg. Today Facebook is the most popular social networking site, with an ever-expanding user number, already topping 850 million (McHaney, 2011, p. 82). Zuckerberg initially intended Facebook to be a tool for students on campus to be more socially connected, but his creation quickly grew into the phenomenon it is today, incorporating users of different ages, and from different countries and backgrounds, all connected through a single website. Today Facebook is regarded as an essential part of learners' social life, not only as a communication tool but for electronic socialisation (Towner & Munoz, 2011, p. 33). What appeals to many Facebook users is that it allows each user to customise his or her profile in terms of profile pictures, photos and interests, with specific categories such as favourite music, favourite movies, sports played, work information, schooling and qualifications, to mention but a few. This means that the user can portray the profile they would like other users to see. These profiles can be searched for in a similar way to which a search engine such as Google operates, but only displaying profiles and groups. Once a user profile has been found using the built-in search engine, a request to '[be]friend' the user can be sent and, once the request is accepted, the two profiles will be linked together, that is they are Facebook friends. 'Friends' on Facebook are listed under a friend list, and other users can view friend lists. In this way, profiles are stored in a list, much like a telephone directory. A database of profiles is produced and the consequence of this would be that 'friends' of 'friends' can be linked together. Users on Facebook can also join groups. These groups have members who share similar interests. Many groups have already been created by non-profit organisations for doing good, or groups can be created for social reasons (McHaney, 2011, p. 83). These groups may serve as noticeboards to promote events or publicise important information. A group allows members of a Facebook community with similar interests to meet, interact and seek out information with members of the group.

Many learners regard schooling or tertiary studies as being social experiences, and learners are able to communicate with friends or friends of friends through these Facebook groups to gain insight when writing reports or preparing for examinations

(McHaney, 2011, p. 80). This form of social interaction among learners who form part of this community facilitates knowledge creation (McHaney, 2011, p. 81). That being said, many connected individuals all contributing to knowledge production seems to be far more engaging than a group of learners gaining knowledge on a particular aspect from a single educator in a classroom. The point I am making is that being engaged collectively is educationally far more enriching than being subjected to a process of transmission of knowledge, often in a non-engaged way by an educator. In this way classroom practices are democratised through the engagement of learners and educators, rather than learners being subjected to disinterested knowledge transmission by the educator – the engagement of educators and learners therefore should be an assemblage that is both recuperative and disruptive of the striations that order the assemblage (Ringrose, 2011, p. 613).

As Facebook's popularity has increased, educators and learners have come into contact, as they share the same social space (Towner & Munoz, 2011, p. 36). Mazer, Murphey and Simonds (2009, p. 174) suggest that educators with a rich self-disclosure on Facebook increase learners' motivation and affective learning, as well as the credibility of the educators. These relationships built up on Facebook result in learners communicating more effectively in classroom practices, as the learners are more familiar with their educators. This is in congruence with research conducted in the field of social networking, which indicates that online environments such as Facebook increase class satisfaction, a sense of community and learner performance (Beaudoin, 2002, p. 147) – that is, a matter of democratising classroom practices. The privacy concerns, in that that is there is an erosion of the professional boundaries between learners and educators, are often scrutinised (Towner & Munoz, 2011, p. 38). Many teacher training institutions propose that educators always maintain a professional relationship with learners and that they do not become close to their learners, such as friends do, to ensure that there is a relationship of respect between the educator and learners (Towner & Munoz, 2011, p. 38). This may be true, as '[be]friending' learners on Facebook may have certain negative implications for educator freedom, although it does enhance the social relationship between educators and learners and this might not necessarily be harmful for the pedagogical process. '[Be]friending' on Facebook cannot be regarded as the equivalent to befriending an individual in reality (Towner & Munoz, 2011, p. 38). Therefore, there seems to be some distance that is retained and, I would argue, enough space for educators to exercise their pedagogical authority.

Instead, Facebook offers learners a convenient way to be in contact with their educators, as educators are not always afforded the opportunity to communicate with learners to address learners' post-lesson questions or issues of general enquiry (Li & Pitts, 2009, p. 175). It allows learners the facility to communicate with educators when time constraints do not permit face-to-face interaction (Li & Pitts, 2009, p. 175). This is in consonance with the perceptions of learners using Facebook, namely that it is more a learning tool for learners than a means of instruction for educators (Towner & Munoz, 2011, p. 50). The negative perception of Facebook, in particular that it could undermine an educator's pedagogical authority, is due to the fact that there is a general lack of knowledge regarding Facebook's educational potential (Towner & Munoz, 2011, p. 51). Facebook, as various other technologies, is improving in terms of functionality and features that have contributed to it becoming a credible means of knowledge dissemination (Towner & Munoz, 2011, p. 51). It is up to educators to implement Facebook effectively to facilitate forms of learning that go beyond the perception that Facebook is mostly used as a recreational tool (Towner & Munoz, 2011, p. 51).

Research indicates, however, that some learners are less accepting of using Facebook as an informal or formal teaching tool (Towner & Munoz, 2011, p. 49). In these cases it is primarily due to the fact that the learners are not open to the Facebook capability of personal communication with their educators (Towner & Munoz, 2011, p. 49). Educators therefore need to be cognisant of these learners and address their concerns. With regard to learners seemingly disinterested in using Facebook for pedagogical purposes, Towner and Munoz (2011, p. 49) suggest creating Facebook groups, and using the many security filtering options currently available for the creation of Facebook profiles separate from their personal profiles, instead of communicating one-on-one with learners on a personal level. More on these ideas as to how to implement Facebook effectively are reported on in the next chapter of this dissertation.

I use Facebook by creating a group that learners are allowed to join. A group allows members of the Facebook community with similar interests to meet, interact and seek out information with fellow members of the group. For example, learners are able to communicate with friends or friends of friends to gain insight when writing reports or for preparing for exams (McHaney, 2011, p. 80). This form of social interaction amongst learners who form part of this community facilitates knowledge creation (McHaney, 2011, p. 81). And, as has been mentioned, the advantage of being connected via Facebook has pedagogical implications for learners and educators, as the opportunity to be engaged rather than just being subjected to the transmission of knowledge seems to be pedagogically more valuable. The purpose of Facebook groups is twofold: firstly, Facebook can be used as a noticeboard, reminding learners of assignment due dates, test dates and content to be covered in the classroom; and secondly, Facebook groups may be used to encourage discussion among learners and also ensures that all learners are connected. Through this form of engagement, Facebook groups can pool their knowledge when doing assignments and preparing for examinations. Messages can be posted on user 'walls' located on profile pages, or privately, making communication between profiles easier and convenient. Facebook's strength is the ease with which relationships between individuals can be maintained and communicated (McHaney, 2011, p. 82).

Moreover, McHaney (2011, p. 83) suggests that even though many tertiary institutions have worked on ways to integrate Facebook into classroom practices, learners do not necessarily want to expose themselves to their educators. Facebook has developed various filtering mechanisms to ensure that these privacy concerns on the part of users are addressed. As I mentioned earlier, the fact that smartphones are becoming increasingly more powerful and that their capabilities are parallel to those of laptops or desktop computers, means that Facebook can work on mobile phones. Phones can access Facebook via their integrated web browsers, or through specially written Facebook applications. I have already indicated the potential for mobile smartphones as teaching tools and the fact that many are realising Facebook's potential for teaching and learning. The convergence of these two technologies can be seen as an important pedagogical development for teaching and learning. Thus, Facebook has the potential to engage learners collectively, allowing them to interact with one another and with educators autonomously. And, when the latter occurs, science education in classrooms can be democratised because democratisation emphasises that learners and educators engage with one another, listen to one another's views, and offer responses to one another's claims about knowledge. By using Facebook, learners have an opportunity to be included not as 'outsiders', but as collective 'insiders' who can contribute meaningfully to the pedagogical process. They can express their voices through messages in cryptic style and in this way remain connected and involved.

The next form of social networking I would like to discuss is that of instant messaging (IM).

Instant messaging, such as Mxit, BlackBerry messenger (BBM) and WhatsApp

In South Africa, instant messaging has become the most popular form of communication since social computing's transition from exclusively using desktop computers to an excessive use of mobile smartphones. Examples of instant messaging are Mxit, BlackBerry messenger (BBM) and WhatsApp. Instant messaging has gained popularity, as it allows individuals to communicate in real time and is inexpensive. Instant messaging services have evolved from the days when only texting between individuals could be achieved. In recent times, instant messaging services as those I have mentioned allow for group chat, which allows for many individuals to communicate with one another in real time. Pictures, videos and other forms of media can now all be exchanged between individuals in a group chat. Instant messaging services do not have the level of customisation of profiles that social networking sites such as Facebook have, and therefore the privacy concerns of Facebook users do not exist on this platform. Instant messaging services allow anonymity, which may have positive as well as negative implications for users, as I addressed in the previous chapter. Already television shows such as 'The Verge', a form of interactive TV, are encouraging viewers to provide their input in a discussion through Mxit. Texts sent are displayed on the screen, allowing viewers to voice their views despite not being in the TV studio. For the purposes of this dissertation I would like to explore how instant messaging can be used as a teaching tool in a discussion forum. It is my hope that a democratic classroom can be created through instant messaging services that would engender interactive, inclusive teaching and learning.

Videoconferencing (incorporating Skype)

Another form of social networking that I would like to discuss is that of videoconferencing. Videoconferencing is similar to instant messaging services, but as the name indicates it involves a video component. Like instant messaging, videoconferencing allows two users to communicate privately or multiple users to communicate collectively. This form of communication is not necessarily revolutionary, as illustrated by television news coverage where reporters in different locations communicate with news anchors. What can be considered an important development is that almost any novice with a computer with a webcam and an Internet connection has the same functionality as news channels. As I have mentioned, many technologies are converging and this also is the case with videoconferencing. Skype, one of the most popular videoconferencing tools, allows for communication between landlines, mobile phones and desktop computers – an indication of this convergence. A further indication of this is that the Microsoft Corporation recently bought Skype (Rapid Response Team, 2011). And, since Microsoft has a mobile and a gaming division, which manufactures consoles such as the Xbox 360, one could presume that it will not be long before people are able to videoconference from their living rooms via gaming consoles. It does not take much imagination to realise that Skype can be used as a teaching tool. Hypothetically, a virtual learning environment can be set up in which learners all sit in front of their computers, televisions or phones at home, school or wherever they have cell phone reception to communicate with one another and with their educators. An educator can easily distribute course content in the form of diagrams, audio and video through Skype. This would be a revelation for distance learning. There are various implications for this form of learning, but in South Africa we still are a long way from making this hypothetical scenario a reality. Many South African schools lack the infrastructure to enable these forms of learning, as learners are unable to afford the hardware required for this functionality. Also, Internet bandwidth in South Africa is relatively expensive. However, if schools can make such facilities available to educators and learners, then Skype can be used effectively to contribute towards the democratisation of the science classroom by encouraging deliberative teaching and learning (Michelle, 2010, p. 3). For instance, in a science classroom learners can be connected via Skype to other learners at a different school. The learners can engage with these other learners and at times disrupt discussions on contentious issues in life sciences. This process of rupture can propel other learners to do likewise. That is, via Skype, other learners can offer perhaps unheard of views to be considered by learners in the science classroom. In this way, the science classroom will be democratised.

Twitter and YouTube

The next form of social computing that I would like to discuss is that of social media. Social media allow users to disseminate content in the form of text, video and audio to encourage interaction.[6] The introduction of social media has democratised information and knowledge, allowing educators and learners to become knowledge producers rather than just consumers (McHaney, 2011, p. 100). There are many forms of social media that can be used to engender democratisation. As has been discussed in Chapter 3, democratisation does not only involve educators and learners collaborating, participating and engaging with one another, but also that both parties disrupt the forms of engagement on the grounds that they, firstly, have an equal opportunity to exercise their autonomy, and secondly, can rupture their learning by creating possibilities for unexpected breakthroughs to emerge. However, achieving the aforementioned democratic practices depends on the 'assemblages' that learners construct on the social media discussion sites.

Social media that can contribute to enhancing democratisation include blogging, RSS, podcasting, screen casting and wikis. In South Africa, by far the two most readily available and feasible forms of social media are YouTube and Twitter, largely because they are compatible with many of the mobile devices that learners own. Twitter, also termed a form of micro-blogging, incorporates facets of social networking, instant

[6] Initially Facebook was a social network. Recently it has evolved into a form of social medium as well.

messaging and blogging. Twitter was created by Jack Dorsey in 2006 and was initially called *twttr* to coincide with the naming of other forms of texting services involving character code acronyms, such as sms (short messaging service) and mms (multimedia messaging service) (Chamberlin & Lehmann, 2011, p. 377). Dorsey's idea behind Twitter was that it would allow individuals to send text messages to a group of individuals, in contrast to sms's, that only allow one individual at a time to receive a text message (Chamberlin & Lehmann, 2011, p. 377). It was only in 2007 that Twitter took hold, when it was used by conference attendees at the South by Southwest (SXSSW) Conference (Miller, 2009). Twitter allowed conference attendees to communicate with one another regarding presentations and events at the conference. Today there are over 10 000 000 Twitter users (Miller, 2009). Twitter allows individuals to send 140-character messages to individuals who subscribe to them. In this way, all subscribers receive the message when an author sends a text message, known as a tweet. What appeals to users of Twitter is that it does not have a steep learning curve, as it does exactly what it is supposed to do, unlike much other Web 2.0 technology. It is also compatible with many devices, such as tablets, smartphones and computers, thus making it accessible to many (Chamberlin & Lehmann, 2011, p. 379).

As a Twitter user I am able to reach all my learners who subscribe to my tweets. In this way I can remind learners of homework, assignments and content to be covered in a test. Twitter also allows subscribers to comment on these tweets. Twitter therefore has the potential to allow real-time relationships in a virtual sphere (Chamberlin & Lehmann, 2011, p. 376). In this way, Twitter has the potential to be an important networking and learning tool (Chamberlin & Lehmann, 2011, p. 376). I use Twitter to share resources. Through peer networking with individuals with similar interests, Twitter can become a continuous source of new ideas (Chamberlin & Lehmann, 2011, p. 377). Subscribing to professional people's tweets allows a subscriber to tap into a list of other followers who in many cases have the same interests. The use of Twitter may also have positive implications for distance learning. Chamberlin and Lehmann (2011, p. 378) indicate in their surveys that distance learners who are unable to communicate and interact with fellow learners encounter feelings of confusion and are often conflicted regarding course content, in contrast to learners on residential university campuses,. They suggest that a

Twitter network between distance learners can overcome this problem, because Twitter can be a means for distance learners to ask fellow learners questions regarding course content.

In addition, Twitter can push discussions past the constraints of a classroom and can be used as a source of information for learners (Chamberlin & Lehmann, 2011, p. 110). This may be achieved by allowing learners to follow individuals in fields such as business or medicine who tweet about their job experiences. Twitter has an integrated search tool that allows users to search for individuals who tweet about their field of work. For learners this can be a rich stream of ideas, resources and knowledge (Chamberlin & Lehmann, 2011, p. 381). It could even be a virtual form of job shadowing (McHaney, 2011, p. 110). Thus, Twitter allows educators and learners to tap into a global network in various fields of education (Chamberlin & Lehmann, 2011, p. 375).

Many celebrities in sport, music and television use Twitter as a means of reaching their fan base. For many of these individuals, Twitter has become an important public relations tool. Many higher education institutions have begun to use Twitter for public relations and also to develop a sense of community amongst students and university academics. Useful information, such as reminders and safety information, can be disseminated among learners quickly (McHaney, 2011, p. 109).

Another popular social media site is YouTube. Burke, Snyder and Rager (2009, p. 1) suggest that creative classroom techniques incorporating technology such as YouTube can be used to promote a productive and enriched learning environment. YouTube is a popular video-sharing website where users can upload, view and share video clips for scholarly and non-scholarly communication (Duffy, 2006, p. 119). YouTube is regarded as an important in-class and online resource for educators who wish to establish a sense of classroom community (Burke et al., 2009, p. 1). YouTube can be used to integrate relevant content and to encourage reflection amongst learners (Burke et al., 2009, p. 1). YouTube was created in 2005 as a public-access platform allowing users to access www.YouTube.com from mobile devices and desktop computers with an Internet connection. On average, 100 million videos are viewed each day and approximately

65 000 video clips are uploaded every day, making it one of the largest social networking sites on the Internet (Duffy, 2006, p. 123). Many learners enrolled at tertiary institutions already rely heavily on the Internet for educational purposes (Burke et al., 2009, p. 2).

YouTube's educational potential lies in the fact that it forms part of some of the technology used by learners in their everyday lives. It therefore is familiar to them and they are adept at having to use it in their educational practices (Burke et al., 2009, p. 2). When used in teaching and learning, YouTube is said to support learners' digital learning style, as they have become habituated to using technology for learning (Burke et al., 2009, p. 2). There is not a steep learning curve for using YouTube, therefore users who are not familiar with this form of social media can to learn to use it easily and its use will provide them with marketable skills for future careers (Burke et al., 2009, p. 2). If learners are instructed to use YouTube effectively, they can be taught how to use or create content that will give rise to more engaging learning environments (democratic, I would say) (Burke et al., 2009, p. 2).

Since YouTube can be accessed from any device through an Internet connection, it has implications for (distance) learning. Pre-recorded lessons can be uploaded onto YouTube, thus allowing learners to stream content on various devices. Learners can access these lessons at any time, from any place and for free. I constantly use YouTube as a means of enhancing my professional development. I often stream YouTube clips posted by fellow educators demonstrating how to do practicals that now form part of the new CAPS (Curriculum Assessment Policy Statement) curriculum.

Lecturers at tertiary institutions are posting videos online (vidcasting) for use by both online and in-class learners (Burke et al., 2009, p. 2). In this way educators can expand their existing audience, increase the ability to provide online courses and enhance an institution's awareness of programmes (Burke et al., 2009, p. 2). This provides yet another means to engage learners in the learning process (Burke et al., 2009, p. 2).

Some of the features that ensure that learners do not remain passive participants and that maximise learning lie in the following YouTube characteristics. YouTube contains a wealth of videos, including movies, TV shows, music videos, video blogging and short, original videos (Duffy, 2006, p. 123). Having learners exposed to different sources of content can only be beneficial to them. YouTube also allows users to upload videos. In my classroom I allow learners to upload videos of practical work conducted in class recorded with their mobile devices. I do this to show that the 'striated' spaces of learning they currently occupy can be 'deterritorialised' to engender new meaning paths. This also requires that the school 'assemblage' (policies on using cell phones) should be rethought – the latter aspect has also been negotiated with the school community (educators, parents and learners). So, videos are used to generate discussion amongst learners. I also encourage other classes that are yet to conduct these practicals to refer to the videos as a form of preparation. Some content on YouTube may be regarded as inappropriate, however, and YouTube encourages users to flag these videos so that they can be removed. YouTube's ability to generate discussion comes from it allowing registered users to comment on video clips. These comments appear as text bubbles that arrange the comments in the form of dialogues. Furthermore, YouTube allows users to rate videos, and the number of times a video is viewed is displayed and can provide an indication of its effectiveness. For example, a video uploaded by two university academics on a mathematics concept has received approximately 1 million views, thus indicating its success (Burke et al., 2009, p. 2).

Because video clips on YouTube can be paused, the pace of a lesson can be dictated by an educator or by a learner's level of understanding. This affords the learner an opportunity to reflect on the imagery in a video clip during the lesson. Another feature of YouTube is the ability to attach notes to videos, which means that it can be played in a classroom and notes can be added at specific tracking intervals. The videos can then be viewed and the notes can help promote class discussion and provide brainstorming opportunities (Duffy, 2006, p. 124). YouTube also offers educators the opportunity to mute audio in a video clip, the implication being that educators are afforded the opportunity to narrate learners' contributions through a specific clip.

5.3 Impediments that Make Educational Technology Unattractive for Use in Science Classrooms

The use of educational technology in teaching and learning is important to prepare learners to function in an information age (Bingimlas, 2009, p. 235). In order to effectively integrate information and communication technologies (ICTs) in the classroom it is imperative that integrators such as educators identify impediments to overcome the barriers to their use (Bingimlas, 2009, p. 235). An understanding of the barriers to integrating educational technology may serve as a point of reference, allowing educators to successfully integrate educational technology (Schoepp, 2005, p. 1) into their practices

The integration of ICTs into teaching and learning is a complex process that is confounded by a number of difficulties, referred to as boundaries or impediments (Schoepp, 2005, p. 1). Researchers have categorised these impediments into extrinsic and intrinsic barriers (Bingimlas, 2009, p. 237). However, what is viewed by researchers as extrinsic and intrinsic barriers to integrating ICTs into classroom pedagogy differ considerably. Ertmer (1999, p. 47), for instance, regards extrinsic barriers as 'first order', pertaining to support, resources and training, while 'second-order' barriers pertain to attitudes, beliefs, practices and resistance as intrinsic barriers. Ertmer (1999, p. 48) sees extrinsic barriers as having to do with organisations rather than individuals, and intrinsic barriers as dealing with educators, administrators and individuals.

Becta (2003) categorises impediments in terms of educator-level barriers, including aspects such as lack of time and confidence, and school-level barriers, such as lack of training and technical support, to mention but a few. For the purposes of this dissertation, I investigate how barriers such as lack of access, resistance to change, lack of time, lack of training and lack of technical support affect the implementation of educational technology in classrooms.

The first educator-level barrier identified by Bingimlas (2009, p. 237) is a contextual factor that relates to the lack of confidence on the part of educators to implement educational technology. Similarly, Becta (2003) suggests that educators often feel anxious and lack confidence when having to give a lesson integrating educational technology. Becta (2003) posits that this anxiety is compounded further by educators having a limited understanding of educational technology, and that their learners often pick up on this. Cox, Preston and Cox (1999) suggest that, where educators have identified a lack of confidence and consequently remedied this impediment by extending their use of educational technology, improved teaching and learning can be attained.

The next impediment identified by Bingimlas (2009, p. 238) is that of a lack of educator competence. Many educators lack the skill and knowledge and consequently are not enthusiastic about integrating educational technology into their classroom practices. A survey carried out in 27 European countries concurs with the claim that a lack of skill on the part of educators is a constraining factor preventing them from integrating educational technology into their classrooms (Korte, 2006). Korte (2006) also shows that educators in Denmark choose not to use ICTs due to their lack of ICT skills, rather than for pedagogical reasons.

The last educator-level barrier that Bingimlas (2009, p. 238) identifies is that of resistance to change and negative attitudes. Cox et al. (1999) identify this as a significant barrier towards the effective implementation of educational technology in classrooms. Likewise, Watson (1999) says that educators have contrasting attitudes when integrating educational technology into their classroom settings. Educators' attitudes are important, as these will have an impact on what they do in their classrooms (Watson, 1999). Despite the many benefits that educational technology brings to teaching and learning, many educators still do not use ICTs in their classrooms as they are unclear about the benefits or are of the opinion that educational technology has no benefits (Korte, 2006). Bingimlas (2009, p. 238) claims that educators' resistance to educational technology is not necessarily a barrier, but is symptomatic of other factors. These factors include a lack of technical support, educator expertise or time (Bingimlas, 2009, p. 239). Cox et al. (1999) contend that educators feel that they have no need to change their successful educational practices and consequently do not use educational technology to augment their practices.

Bingimlas (2009, p. 239) identifies four school-level impediments that make educational technology unattractive to use in classrooms. These are lack of time, lack of effective training, lack of accessibility and lack of technical support. Studies indicate that educators do not necessarily have a shortfall of competence and confidence, but instead are prevented from using educational technology in their classrooms due to time constraints (Bingimlas, 2009, p. 239). Sicilia (2005, p. 1) reports in his dissertation that most teachers lack the time to plan lessons that integrate technology, explore Internet sites and explore various aspects of educational software. In most South African schools, educators are required to teach all day and are afforded few non-teaching periods that could be used to plan strategies and ways to integrate educational technology into their classrooms.

The next school-level barrier identified by Bingimlas (2009, p. 239) is the lack of training opportunities for educators to familiarise themselves with the various forms of educational technology available. Gomes (2005, p. 5) says this lack of training not only entails a lack of digital literacy, but also a lack of pedagogic and didactic training on how to use the various educational technologies in the classroom. He suggests that there should be continuous professional development to sustain the appropriate skills and knowledge. According to Becta (2003), training programmes should not simply train educators in how to use ICTs, but the training should be pedagogic. This is further supported by Cox et al. (1999), who argue that many training courses focus on teaching educators basic ICT skills, but do not focus on how educators can develop the pedagogical aspects of ICTs.

Research indicates that another school-level barrier to implementing ICTs is that of accessibility (Bingimlas, 2009, p. 240). Educators are often discouraged from integrating educational technology as part of their teaching due to a lack of resources, which includes home access (Bingimlas, 2009, p. 240). Accessibility also relates to factors such as the organisation of resources, hardware of a poor quality, inappropriate software, and the fact that large classes have only a few computers to use (Becta, 2003). Infrastructure issues such as a lack of broadband Internet also prevent access to the wealth of resources available on the Internet. Osborne and Hennessy (2003, p. 3) posit that these limitations regarding hardware and software influence educators' motivation to integrate ICTs into their teaching practice.

Furthermore, Lewis (2003, p. 41) suggests that, without good technical support in the classroom, educators cannot be expected to integrate ICTs into their classrooms effectively. Technical barriers disrupt the flow of a lesson and educators therefore are hesitant to integrate ICTs into their pedagogical practices. Technical barriers include aspects such as websites failing to open, being unable to connect to the Internet, printer issues and outdated hardware. Just like a science educator requires a laboratory assistant to conduct practical work in a classroom effectively, effective teaching requires technical support so that educators can focus primarily on their teaching and not have to address technical issues disrupting the flow of a lesson. Through the identification of impediments such as lack of access, resistance to change, time constraints, limited training and lack of technical support, educators who have not implemented educational technology as part of their pedagogy can devise a plan to overcome these barriers so as to take advantage of the many benefits educational technology holds.

5.4 Towards a Transformative View of Educational Technology and Its Implications for Science Education

Traditionally, many educational institutions regard mobile technology as a distraction to learners and, at many educational institutions such as my own school, its use by learners is strictly prohibited. These mobile phones are said to encourage texting for non-academic purposes, and for cheating on exams or tests. The fact that these devices have integrated cameras also raises privacy concerns for school management (McHaney, 2011, p. 68). For this action research study, the learners and I were granted permission to use our mobile devices for the duration of the cycles of inquiry. Despite the negative perceptions of the use of educational technology, development in the field of mobile technology is increasingly progressive with respect to its educational potential

(McHaney, 2011, p. 68). Consequently there are implications for educators, as technological convergence is under way that is seeing all forms of hardware and software being directed towards allowing learners opportunities to integrate technology into their everyday lives (Jenkins, 2006, p. 10). This technological convergence refers to the fact that phones that previously only allowed voice calling are now able to act as voice recorders, video players and video recorders, to mention but a few functions. The primary implication for teaching and learning is that learners need to be taught how to use the mobile devices in a productive and respectful manner (McHaney, 2011, p. 69). Only then can the plausible benefits of mobile devices outweigh the aforementioned disadvantages.

Smartphones are becoming platforms that enable and inspire millennial learners' cognitive skills (McHaney, 2011, p. 69). Livingstone (2009) suggests that many higher education institutions are embracing and taking advantage of mobile phone capabilities such as voice, text messaging, instant messaging, email and Internet to ensure classroom registration, tuition payment, scheduling, advising and accessing other university services for academic purposes. Implications for classroom practices are that these devices can act as interaction devices for polling, and that questions can be posed without any disruption to an educator's lesson (Tremblay, 2010, p. 218). Since these devices have Internet connectivity there are implications for distance learning as well – in other words learning beyond the confines of the school. The possibility that learners can communicate with their educators over vast spaces and download course content is indicative of the transformative potential of mobile phones. Here, the transformation of learning refers to the possibility of not being hampered by physical distance to engage critically with textual materials.

Social networking through mobile devices has changed how many learners spend their time, as they can access information and resources and have a sphere for continuing interaction (McHaney, 2011, p. 95). Based on the number of learners that have already joined the Facebook group that I created, I can deduce that almost every learner that I teach has a Facebook account. A similar scenario exists on university campuses. Consequently, many universities have attempted to integrate Facebook groups as part of their pedagogical and administrative interactions with learners, who spend a lot of time in this sphere (McHaney, 2011, p. 96). McHaney (2011, p. 96) indicates that there has been varied success in this form of implementation of social networking, as learners have privacy concerns. These privacy concerns, as mentioned previously, relate primarily to learners '[be]friending' their educators directly, although learners can manage their Facebook profiles in relation to privacy (Aleman & Wartman, 2008, p. 4). Some learners may not have problems allowing educators to see their photos and 'statuses', while others may regard exposing themselves in such a manner to be inappropriate to the professional relationship that should exist in an educator-learner relationship. Furthermore, learners often experience feelings of intimidation or obligation that accompany '[be]friending' individuals in authority, such as educators (McHaney, 2011, p. 96). The educators that I work with believe that how they present themselves on Facebook often relates to their personal lives and that it would be inappropriate for learners to become familiar with their personal lives, much like it is inappropriate for an educator to be friends with a learner. These privacy concerns can be overcome, however, by not directly befriending learners. Instead, the learners should be allowed to join Facebook groups, as these groups provide a code of ethics that members must adhere to.

Members of the higher education community have already realised that social networking sites such as Facebook are ideal platforms to liaise with learners, as they allow for online portfolios, discussion groups and alumni relationship groups (McHaney, 2011, p. 96). McHaney (2011, p. 96) claims that educational institutions would benefit from using social networking in a non-intrusive manner to take advantage of the technological capability to transform education in terms of improving teaching and learning. Social media can be used to determine the perceptions regarding learning programmes. They also can be used to disseminate useful information via the content-sharing capabilities. Social networking also allows continuous interaction and for individuals to feel part of a connected community. (McMillan & Morrison, 2006, p. 73). Learners are able to communicate with their fellow learners and educators in this online space and then be more comfortable when they are in direct contact. Social networks such as Facebook therefore help learners undergo an easy transition to becoming part of a learning environment (Madge, Mee, Wellens & Hooley, 2009, p. 141). In this way, Facebook serves as a means to create a community within a classroom (Madge et al., 2009, p. 141). Just like other forms of social media, however, Facebook is not a panacea (Towner & Munoz, 2011, p. 53). Facebook can be regarded as an invaluable tool facilitating education-related communication amongst learners and educators (Towner & Munoz, 2011, p. 53). Establishing pedagogical communities through Facebook is in fact a way in which classroom practices can be transformed from the dominant transmission mode to a more interactive and engaging way of communication. In this way, using Facebook as a pedagogical form of educational technology can contribute towards democratising classroom practices.

The implications of social media transforming science education are widespread, with an impact on educators' and learners' practices. As an educator I follow the tweets of the Teaching Biology Project (TBP) (2011), an initiative of the African Genome Education Institute (AGEI), which was established to address problems encountered by educators in education. Among these problems are a shortage of content knowledge and skills for teaching science. By subscribing to the TBP Twitter stream, Twitter has allowed me to enhance my personal professional development as a science educator. Since the introduction of the new CAPS (Curriculum Assessment Policy Statement)[7] curriculum there has been a re-emphasis on the practical examination of learners. This has presented me with new challenges in preparing learners for these practical examinations. Fortunately, through the use of social media such as Twitter and subscribing to the TBP Twitter stream I am able to tap into a wealth of resources. For example, one tweet contained a link to the TBP website, where there were videos of how to conduct the various experiments that were required by the new curriculum. Through Twitter I was also able to build a network of educational professionals and organisations in the fields of science education and technology integration in science classrooms. This network has been invaluable in my professional development, allowing me and my network to develop bonds by sharing in this pedagogical community (Chamberlin & Lehmann, 2011, p. 387).

[7] CAPS is a recent modification of the NCS and was first implemented in 2012.With the introduction of CAPS learning outcomes have been replaced with specific aims.

There are many positive implications of integrating Twitter as part of the learners' learning. Learner participation in the classroom is regarded as an important factor in the teaching and learning process, although there still are many impediments to this (Rhine & Bailey, 2011, p. 303). Rhine and Bailey (2011, p. 303) hold that this is primarily due to classroom dynamics, such as class size and time constraints, and personal dimensions, such as gender, age and learning preferences. Learners often feel unintelligent and shy, and are not willing to participate because of large classroom sizes or are unable to articulate themselves in class effectively (Rhine & Bailey, 2011, p. 306). Social media can break down these barriers by encouraging the collaborative construction of understanding, which ultimately makes education more democratic (Rhine & Bailey, 2011, p. 303), and hence highly transformative. Twitter allows learners to engage with me as an educator and to respond to follow-up questions, give insights and share resources. Often the learner who is subjugated by dominant, vocal individuals in the classroom is afforded the opportunity to make a meaningful contribution to teaching and learning (Chamberlin & Lehmann, 2011). And it is very transformative to include less vocal voices in pedagogical activities. Through the insights of learners I can alter my teaching direction so that the learners are able to obtain a better understanding that may meet their requirements. Educators and learners incorporating social media such as Twitter gain empowering skills that will provide opportunities for better civic and educational engagement, with the consequent democratisation of science education (Gammon & White, 2011, p. 329).

Educational technology such as YouTube also has the potential to transform teaching and learning. Many learners perceive YouTube as a good instructional tool (Burke et al., 2009, p. 6). To that end, YouTube can be seen as an important tool for transforming the way science is taught at school level. Educators lacking resources to stimulate learner participation and interest can simply refer to the wealth of educational video clips on YouTube. For an educator, experimentation is not always possible and, even though experimentation is regarded as key when teaching science, using YouTube offers learners the opportunity at least to view how experiments are conducted from the videos of real-life examples and demonstrations, thus transforming the way they learn (Burke et al., 2009, p. 6). Given their context, YouTube offers millennial learners a new technology that makes learning refreshing, interesting and relatable (Burke et al., 2009, p. 6). Clark and Meyer (2002, p. 1) point out that YouTube has the potential to improve teaching and learning by reducing cognitive loads for learners, and that specific videos can be selected to parallel learners' learning literacy. Furthermore, YouTube has the potential to improve teaching through the removal of many superficial texts or graphics (Clark & Meyer, 2002, p. 2). Thus, YouTube can serve as an effective catalyst for and facilitator of discourse and analysis (Clark & Meyer, 2002, p. 2). Burke et al. (2009, p. 6) argue that, based on the wealth of resources on YouTube and the features I mentioned earlier, there is potential to promote discussion and critical thinking – highly transformative practices of teaching and learning.

Duffy (2006, p. 125) opines that the incorporation of YouTube into classroom practices can transform education by improving it in the following ways: YouTube can create a learning community that allows learners to voice their opinions, and to contribute to and share content. Allowing learners to create videos instead of writing reports can be a means to promote visual literacy (Duffy, 2006, p. 125). Duffy (2006, p. 125) suggests that this may serve as a valuable learning exercise. As already mentioned, YouTube can generate discussion amongst learners and educators, which is beneficial because it allows for distinct viewpoints and different perspectives to be voiced (Duffy, 2006, p. 125). For science education, YouTube videos offer several advantages over other graphic and textual media, as they allow illustration of concepts concerning motion and the demonstration of sequential processes, and allow educators to demonstrate dangerous processes in a safe environment (Misanchuk, Schwier & Boling, 1996). In addition, YouTube can be used by learners as a virtual library (Conway, 2006).

5.5 Summary

This chapter has been concerned mainly with clarifying educational technology and showing how such technology can be used in science classrooms to democratise pedagogical practices such as teaching and learning. I have also pointed out that classroom practices can be transformative, and highlighted some of the impediments that educators and learners might encounter when applying educational technology.

Without being oblivious of the stumbling blocks to implementing educational technology in science classrooms with the intent to democratise teaching and learning, I have shown that educators need to contemplate how educational technology such as YouTube, Twitter, Facebook and instant messaging in particular can be used to stimulate critical thinking and collaborative learning. Only then can educational technology transform science education positively (Duffy, 2006, p. 126). In the next chapter I focus on the action research activities in one of my grade 10 science classrooms with the purpose of showing how science education can be democratised and become transformative, notwithstanding the challenges (as highlighted in this chapter) I encountered in doing so.

CHAPTER 6

A DESCRIPTIVE ANALYSIS OF THREE ACTION RESEARCH CYCLES OF INQUIRY IN A GRADE 10 LIFE SCIENCES CLASSROOM: ON THE POSSIBILITY FOR EDUCATIONAL TECHNOLOGY TO DEMOCRATISE SCIENCE EDUCATION

6.1 Introduction

In this chapter I describe and report on the application of three action research cycles of inquiry in relation to the teaching and learning of three contentious issues in a grade 10 life sciences classroom using educational technology as an instrument of action. As mentioned in the introductory chapter, I use social media such as Facebook, YouTube and the Internet to teach learners, firstly, how to apply scientific content to everyday life, which integrates 'learning outcome 1' (showing problem solving and critical thinking skills); secondly, how to use scientific inquiry for community participation, which integrates the previously known 'learning outcome 2' (constructing and applying life sciences knowledge); and thirdly, how to use science education issues for the purpose of achieving social justice, which integrates 'learning outcome 3' (understanding the interrelationship between science, technology, indigenous knowledge, the environment and society) of the grade 10 life sciences curriculum.

In fact, my primary concern in this dissertation is to use educational technology to teach the 'learning outcomes' or, more specifically, what learners are expected to do, and the purposes for learning life sciences as outlined in the current school curriculum. My purpose with using educational technology to teach the aforementioned 'learning outcomes' in relation to key curriculum issues in life sciences in grade 10, such as evolution, pollution and biotechnologies (including cloning and transgenic organisms), is to create learning opportunities (if possible) that can contribute to democratising science education in a local high school. Before I report on three senior phase school science action research cycles of inquiry with a grade 10 life sciences class (including instances of teaching and learning) and show how democratic education practices are cultivated through the application of educational technology, I turn my attention to an analysis of the current curriculum statement for grade 10 life sciences.

6.2 An Analysis of the Curriculum and Assessment Policy Statement (CAPS) for Life Sciences

In this section I shall examine two main developments in educational policy in South Africa: the democratisation of education after 1994, and the curriculum statements following the government's decision to implement an outcome-based approach to education.

6.2.1 Democratisation of Education in Post-1994 South African Schools

Education under apartheid experienced a crisis that was characterised by unequal educational opportunities for black people in a system that clearly favoured reproduction and memorisation. This implies that the education system was used by the government as an instrument to segregate education. Against this background, the democratic government had an important role to play after 1994 to democratise the schooling system in South Africa. The educational system was in need of expansion in order to meet the demands of a democratic society. These ambitions of government regarding educational transformation are clearly reflected in the White Paper on Education and Training (WPET), which was introduced in 1995. The government's aim was to abandon the old, established educational dogmas in order to create the necessary space for a new educational system that would enhance critical reflection, dialogue and rationality. In its quest for an educational framework that would address the challenges of equity and redress, the government introduced outcomes-based education (OBE) a vehicle to address the crisis. Proponents of OBE claim that OBE is more than a mere reform strategy, it is in fact a 'radical paradigm shift' (Claasen, 1998, p. 36).

The first and fundamental policy framework of the Ministry of Education was set out in the Ministry's first *White Paper on Education and Training*. This policy was introduced in February 1995 (Department of Education, 1995, p. 4). The White Paper aims 'to open the doors of learning and culture to all'. It is against this background that the Department of Education put an emphasis on transforming the legacy of the past by building a just and equitable system that provides good-quality education and training to learners, young and old, throughout the country (Department of Education, 1995, p. 11). The policy's primary vision is as follows:

> It should be a goal of education and training policy to enable a democratic, free, equal, just and peaceful society to take root and prosper in our land, on the basis that all South Africans without exception share the same inalienable rights, equal citizenship, and common national destiny and that all forms of bias (especially racial, ethnic and gender) are dehumanizing (Department of Education, 1995, p. 18).

Changing the school curriculum was a high priority for post-apartheid South Africa and recognised the need for a single, national curriculum framework. The 1995 White Paper on Education and Training promoted a vision of a democratic and internationally competitive country with literate, creative and critical citizens (OECD, 2008, p. 169). As has been mentioned, the Department of Education adopted an outcomes-based education approach (OBE), 'borrowed' from competency-based education but inflected with a transformative agenda that has its roots in human rights, social justice, equity and nation building (Chisholm, 2005, p. 96). Curriculum 2005 (C2005) was launched in 1997, overturning the apartheid government's curriculum. C2005 was grounded in OBE principles in so far as 'subjects' were replaced with 'learning areas', each of which had 'range statements' that in turn aimed at 'outcomes' (OECD, 2008, p. 79). The content of the lessons was not prescribed, and the new teaching strategies that accompanied the curriculum were 'learner-centred' (OECD, 2008, p. 80). While many historically disadvantaged schools floundered at implementing the curriculum, advantaged schools achieved greater success (Christie, 1999, p. 12). A Ministerial Committee appointed to review C2005 found that its implementation was '…confounded by a skewed curriculum structure and design; lack of alignment between curriculum and assessment policy; inadequate orientation, training and development of educators; learning support materials that are variable in quality, often unavailable and not sufficiently used in classrooms; policy overload and limited transfer of learning into classrooms; shortages of personnel to support and implement C2005; and inadequate recognition of curriculum as the core business of education departments' (Chisholm, 2000, pp. vi-vii). Following the report, practical adaptations ensued and the resulting change spawned a Revised National Curriculum Statement (RNCS) that placed more emphasis on basic skills, content knowledge and a logical progression from one grade to the next. Along with the values in the Constitution, it emphasised communication, participation, human rights, multilingualism, history, cultural diversity, educators as role models, and that every citizen must read, count and think (Department of Education, 2002, p. 7). The Revised National Curriculum Statement combined a learner-centred curriculum, requiring critical thought and democratic practice, with an appreciation of the importance of content and support for educators that resulted gradually in the phase-in of Grade 12 in 2008 (OECD, 2008, p. 81). Also, the implementation of the RNCS implied that textbooks had to be published and aligned with the RNCS for the Foundation Phase (Grades R to 3), Intermediate Phase (Grades 4 to 6), Senior Phase (Grades 7 to 9) and Further Education and Training Phase (FET, Grades 10 to 12) in all 11 official languages (OECD, 2008, p. 81).

According to the RNCS, the s R to 9 curriculum is organised into eight 'learning areas': languages, mathematics, natural sciences, technology, social sciences, arts and culture, life orientation, and economic and management sciences; and curricula were developed for 29 subjects for grades 10 to 12. Learning outcomes were developed for each learning area or subject at each that spell out what learners will be able to do after having achieved the learning outcomes for the required level (OECD, 2008, p. 170). In addition, learning programmes are developed by educators, supported by national and regional policy guidelines that include work schedules, exemplars of lesson plans, and assessment activities for learners. In the Foundation Phase there are three learning programmes: literacy, numeracy, and life skills; languages and mathematics are specified as learning programmes in the Intermediate Phase; and the Senior Phase has eight learning programmes (OECD, 2008, p. 172).

The RNCS holds educators responsible for initiating learners into achieving the learning outcomes by envisioning educators '…who are qualified, competent, dedicated and caring and who will be able to fulfil the various roles outlined in the Norms and Standards for Educators of 2000 … [that] see teachers [educators] as mediators of learning, interpreters and designers of Learning Programmes and materials, leaders, administrators and managers, scholars, researchers and lifelong learners, community members, citizens and pastors, assessors and learning area/phase specialists (Department of Education, 2002, p. 3). Now the chances that all learners (even those in rural areas, where material resources are inadequate) achieve the learning outcomes are minimal (OECD, 2008, p. 176). It is in this context that I consider my dissertation not only as a contribution towards creating opportunities for learners in an historically disadvantaged school to achieve the learning outcomes developed for the grade 10 life sciences curriculum in the previous RNCS (as this dissertation commenced prior to the new Curriculum Assessment Policy Statement), but also as an opportunity to initiate learners into pedagogical activities that have a democratic orientation. This brings me to a discussion of the national curriculum statements for grades 10 to 12 life sciences, with specific reference to what learners should be able to do and the purpose of studying life sciences.

6.2.2 National Curriculum Statements for Grades 10 to 12 Life Sciences

The National Curriculum Statement s R to 12 (previously known as the RNCS) was amended (with the amendments coming into effect in January 2012), resulting in a single, comprehensive Curriculum and Assessment Policy Statement (CAPS) for s R-12 being developed for each subject to replace subject statements, learning programme guidelines and subject assessment guidelines (Department of Education, 2011, p. 1). The Curriculum Assessment Policy Statement (CAPS), or the new National Curriculum Statement s R-12 of 2012, replaces two curriculum statements referred to earlier, namely the Revised National Curriculum Statement of 2002 and the National Curriculum Statement of 2005. In fact, CAPS serves the purpose of equipping learners with the knowledge, skills and values necessary for 'self-fulfilment, and meaningful participation in society as citizens of a free country' (Department of Education, 2011, p. 2).

Consequently it seems as if CAPS would welcome the democratisation of science education in schools in order to ensure that learners are equipped with competencies and skills to function in a democratic society. In this regard, CAPS wants to encourage learners to engage in 'active and critical learning' – that is, learners must be able to identify and solve problems and make decisions using critical and creative thinking; work effectively as individuals and with others as members of a team; organise and manage themselves and their activities responsibly and effectively; collect, analyse, organise and critically evaluate information; communicate effectively using visual, symbolic and/or language skills in various modes; use science and technology effectively and critically, showing responsibility towards the environment and the health of others; and demonstrate an understanding of the world as a set of related systems by recognising that problem-solving contexts do not exist in isolation (Department of Education, 2011, p. 3).

The Department of Education, through CAPS, explicitly dropped the use of learning outcomes and instead talks about what learners should be able to do, together with the purposes, in this instance, of studying life sciences. My understanding of 'purposes of studying life sciences' involves getting to know why learners have to study the subject, and in particular to encourage them to think and reflect upon their learning. The three purposes of studying life sciences are given as follows: firstly, development of scientific knowledge and understanding in order for learners to answer questions about the nature of the living world around them. Learners are prepared for economic activity and self-expression, as well as active participation in a democratic society that values human rights and promotes acting responsibly towards the environment [that is, application of scientific content to everyday life]; secondly, development of science process skills (scientific investigations) by learners that may be used in everyday life, in the community and in the workplace. Learners should be encouraged to acquire these skills in an environment that supports creativity, responsibility and growing confidence through investigating, reflecting, synthesising and communicating [that is, scientific inquiry for community]; and thirdly, development of an understanding of the roles of science in society, which involves promoting science as a human activity as well as understanding the history of science and the relationship between life sciences and other subjects.

Learners must be taught about the contribution of science to social justice and societal development, as well as the need to use scientific knowledge responsibly in the interests of themselves, of society and of the environment, including understanding decisions that involve ethical issues [that is, science education for social justice] (Department of Education, 2011, p. 11). For the purposes of this dissertation, and considering that I have been working on this study for the past three years, I use learning aims synonymously with the Department of Education's reference to what learners should be able to do, together with the purposes of studying life sciences.

But first I shall discuss the Department of Education's use of life sciences in CAPS and point out where the contentious issues I introduce fit into the grade 10 life sciences curriculum. This will hopefully give an idea of what learners should be able to achieve in relation to grade 10 life sciences content knowledge. According to CAPS, life sciences can be described as 'the scientific study of living things from molecular level to their interactions with one another and the environments' (Department of Education, 2011, p. 7). As a school subject, life sciences comprises a variety of specialisations, which include biochemistry, biotechnology, microbiology, genetics, zoology, botany, entomology, physiology, anatomy, morphology, taxonomy, environmental studies and sociobiology (Department of Education, 2011, p. 7). And, as has been alluded to earlier, life sciences aims to provide useful knowledge and skills that are needed in everyday living; expose learners to the range and scope of biological studies to stimulate interest in and awareness of possible specialisations; and provide sufficient background for further studies in one or more of the biological sub-disciplines (Department of Education, 2011, p. 7). Furthermore, the subject is organised along four knowledge strands: life at the molecular, cellular and tissue level (including chemistry of life, cell, mitosis and plant and animal tissues); life processes in plants and animals (including support and transport systems in plants, support systems in animals, and transport systems in mammals); environmental studies (including biosphere to ecosystems); and diversity, change and continuity (including biodiversity and classification, history of life and earth) (Department of Education, 2011, pp. 7-8). The three contentious issues that are investigated can be categorised under the latter two knowledge strands, namely environmental studies, and diversity, change and continuity.

This brings me to a discussion of the context in which the three action research cycles unfolded.

6.3 The Local School Context and the Grade 10 Life Sciences Learners

6.3.1 The Learning Environment

This action research initiative is happening at the school where I currently am employed. It is a previously disadvantaged school with a rich history of excellent learner achievement despite what can be considered as poor learning conditions such as lack of proper infrastructure and resources. Nevertheless the school has become prestigious (in that it produces excellent matriculation results) despite the fact that it attract learners from previously disadvantaged communities. The school is located in the southern suburbs of Cape Town (refer to map on page 211) in the Western Cape province of South Africa. The school initially served as a school for the children of farm labourers in the Constantia area whose parents had been displaced by the Group Areas Act. These parents continue to support the school in its endeavour to promote academic excellence (Khanya News, 2011). At the time of writing this dissertation, the school had 1 089 learners, giving it on average 30-40 learners in a classroom.

Technology education began at the school when the school was selected by the Western Cape Education Department to be one of 11 pilot schools to participate in a Khanya Mathematics Project. By way of the Khanya Project and its partner, the DG Murray Trust, it is envisaged that the performance of learners taking mathematics and science can be improved through the use of ICTs (information and communication technologies) (Khanya News, 2011). Thus, the Khanya Project opened a new dimension for mathematics education in that the latter could be improved through the integration of ICTs into the mathematics curriculum at the school. The school now has an increased mathematics enrolment and, in addition, the introduction of computers has aided educators in the implementation of the curriculum, as well as in their own computer literacy, and hence in their own professional development (Khanya News, 2011).

Through the efforts of the school's science educators, the school has received funding for ICTs and assistance from an organisation called TRAC (Transportation and Civil Engineering). TRAC is a national, non-profit programme aimed at supporting science and technology education in South African secondary schools (TRAC, 2011). TRAC aims to enable learners to enter careers in science, technology and engineering. They have assisted the school to ensure that its learners can enter these careers by providing equipment such as computers and data loggers, syllabus content, vocational guidance information, and a variety of other material (TRAC, 2011). Through Khanya, the school also forms part of a pilot project in which data loggers are used to conduct experiments in physical science. These data loggers are used to collect and analyse data to encourage more learners to do science (Khanya News, 2011).

The school is also is part of the Dinaledi schools project run by the Department of Education. This project is aimed at increasing access to mathematics and science by learners, not only to improve mathematics and science results, but also to increase the competence levels of the educators who teach these subjects. Through Dinaledi, the school has received funds from the Optima Trust, which is funded by Anglo American in support of the initiative. The Optima Trust has a yearly disbursement of R40 million towards improving mathematics and science education in Dinaledi schools. These funds may be used for learner bursaries, resources in the form of ICTs, or to employ additional educators to improve mathematics and science results. It was agreed by many of the staff members that the best way to improve the educational resources of the school was to improve mathematics and science teaching and learning in the classroom. Subsequently, the school used some of these funds (a small percentage of the R40 million allocated for all Dinaledi schools) to purchase ICTs such as data projectors, white boards, laptops and desktop computers.

The school also has an arts and culture focus. Consequently, it was able to benefit from a pilot project of the Western Cape Education Department (WCED) and Apple Computers in February 2008 that resulted in the installation of Apple technology in the school that is used by the learners and educators for music production and composition

(Khanya News, 2011). In addition, other ICT resources have been donated to the school by ex-students, as well as by trusts and companies to which educators and learners have written for sponsorship in the form of ICT resources for the school.

However, if not used correctly, all this technology in the classroom would become a 'white elephant'. Khanya has ensured that their investments in the form of resources for the school are used effectively. They do this by employing training coordinators who visit the school regularly. These training coordinators offer workshops to educators on how to integrate educational technology effectively into their existing classroom practices. Another educator and I have taken it upon ourselves to provide our fellow educators with some basic ICT competences in staff development activities on an extramural basis. During these training sessions, we cover aspects such as how to connect a laptop to a data projector, how to play DVDs, how to scan documents or pictures, and how to use Google as an educational resource.

The Western Cape Education Department (WCED) also arranges training opportunities for educators. Some of my fellow educators and I have been invited to workshops, such as those offered by Thinkquest. Workshops conducted by this organisation are aimed at supporting educators to assist learners in constructing websites so that they might be inspired to think, connect, create and share information (Thinkquest, 2011). Learners work in teams to build innovative and educational websites to share with the world (Thinkquest, 2011).

Staff development activities at the school with regard to the use of ICTs were offered through seminars and training workshops conducted by organisations such as e-Learning Schools. Ongoing presentations are run with regard to introducing new technology to educators and holding discussions about the importance of connecting ICTs to teaching and learning. This provides an opportunity for networking with other educators and discussing real issues associated with the introduction of ICTs into lessons, as well as using ICTs as an effective teaching tool. During these sessions, speakers often inspire staff through stories of success and determination, and ways to overcome the many hurdles encountered when integrating ICTs into the classroom and curriculum. The workshops offer a hands-on approach to the use of ICTs, thus equipping educators with practical ideas for and skills in the possible uses of ICTs (School, 2011).

What the aforementioned discussion indicates is that the educators at the school are favourably placed to use educational technology in their teaching and to inspire learners to use it. It is in this environment that I began to use my technological competence to contribute to enhancing teaching and learning in the life sciences. I am one of three life sciences educators at the school, and the subject is taught to learners from grades 10 to 12. The life sciences department has a rich history of good results, having obtained a grade 12 pass rate of one hundred percent in 2009, 2010 and 2011, for example. Content taught in the life sciences varies according to year and complexity, and includes various fields of the natural sciences, such as biodiversity, genetics and evolution, to mention but a few. There are about 400 learners on average doing life sciences at the school every year. I am responsible for teaching all the grades in which life sciences is offered – that is, grades 10 to 12. The educators in the life sciences department have a wealth of experience, spanning over 20 years. As a relatively new educator, I have been mentored by these educators and have learned a lot from them because I also attended the school as learner. Despite their wealth of experience, these educators are not very proficient in the use of educational technology to enhance their pedagogical practices. Relationships between my colleagues and I are two-directional, with the result that I can share my expertise in educational technology 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 educational technology can be implemented in their existing teaching practices. For example, these educators have been teaching certain aspects of the human heart for many of years, using an overhead projector (OHP) to project a static picture of the human heart. Using this diagram, the educators demonstrate to the learners how blood passes through the heart in sequence. What I have suggested is that they use a flash animation on a computer, as projecting an animation is able to better convey to the learners the pathway of blood through the human heart. A further suggestion – to use 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 that has been utilised for many years. These colleagues have shown a willingness to learn about how their existing teaching practices can be augmented with the use of educational technology. The educators have now also taken it upon themselves to improve their teaching and learning through the application of technology. In matric, for example, there is a relatively short window in which to finish the considerable content of the curriculum. The life sciences educators at the school have come to the realisation that they can cover a larger amount of work in a shorter period of time by using educational technology. This is another reason why they have embraced the use of educational technology in their teaching practices. An observation I have made through working with these educators is that they tend to use only certain technology. Educators therefore will only use technology if it will improve their teaching. My colleagues often resent using educational technology that is difficult to set up prior to lessons.

Implementing educational technology in the classroom and using it to support learners' learning takes some planning. Certain technology, such as Google, can be used instantly to reach a desired outcome. For example, I have encountered many instances when learners have asked questions that might or might not be related to the work I am teaching that I am unable to answer. I then use Google to search instantly for an answer to the learners' questions, or to search for images by using my own mobile device or allowing learners to use their mobile devices to access Google – that is, a matter of establishing conditions for greater learner participation and empowerment. YouTube is another technology that can provide instant answers to learners' enquiries. By using educational technology there does not have to be a break in the chain of thought. By this I mean that if I did not use this technology (YouTube) and had told the learners that I would do some research and come back to them at a later time, it would have broken their chain of thought and even their interest. The learners' responses to the use of educational technology have been really positive, as they were no longer spectators, but participants in the learning process and had a joint interest in learning life sciences. This brings me to a discussion of the grade 10 life sciences class and its learners.

6.3.2 The Learners

Data on the grade 10 learners were compiled using a questionnaire (see Appendix IV) that was completed by them (the learners). The purpose of the questionnaire was twofold: Firstly, I wanted to establish which technology the learners would be comfortable with when inducing and maximising learner participation; and secondly, the questionnaire served as a means to ascertain the learners' understanding of democratic practices. The data were also used later on in the design of the three action research cycles.

The results of the questionnaire indicated that there were 18 females and eight males (26 learners in total) between the ages of 15 and 16 years in the class. By far the majority of the learners live in the southern suburbs of Cape Town, mostly from middle and working class families residing in historically disadvantaged communities. The learners had been assigned the status of 'high performers' as a result of the excellent grades they had achieved in grade 9. They seemed to be very motivated, critical and focussed on doing well. They also supported and assisted one another with their school work, and worked well in groups. Through the questionnaire I also could ascertain the ways in which the learners accessed the Internet. For the success of the project all the learners would need affordable and easy Internet access. Twenty-three of the learners owned cell phones, nineteen of whom had a BlackBerry. Due to the high cost of Internet data in South Africa, most learners opted for the BlackBerry, which offers cost-effective Internet access. The learners who did not own a BlackBerry device still had Internet access at school, at home and through their non-BlackBerry cell phones, albeit more expensive. All the learners made use of social media. Twenty-four learners made use of Facebook and the two who did not have Facebook accounts indicated that they would be willing to set up such accounts. The responses to the questionnaire indicated that these two learners had not set up Facebook accounts as they felt that it was not especially useful. All the learners were able to access Facebook via their cell phone, at school or at home. The learners who already had Facebook indicated that they accessed Facebook on a daily basis in order to communicate with friends or simply for other recreational purposes. The responses to the questionnaire also indicated that the learners had been using Facebook for over a year, which would indicate that they are adept at using social media. They were introduced to Facebook predominantly by friends. I therefore identified Facebook as the educational technology that would be used in the study. Although a large proportion of the learners suggested that we use BlackBerry messenger, I felt that this would not be effective at maximising class participation as not all the learners owned a BlackBerry phone. Technically learners used BBM because Facebook integrates into BBM.

To establish the learners' understanding of democratic practices, the questionnaire posed questions asking whether they liked working in groups, felt that their opinion was valued by others, whether they valued the opinions of others, what a democracy is, and whether they felt that their classroom practices were democratic. Some of the learners indicated that they did not like working in groups. These learners indicated that, in group activities, some members do not take a task seriously or feel that their opinions are superior to those of other group members. Many of the learners indicated that they valued the opinions of other learners and felt that their opinions were valued. However, when the learners were asked whether they felt that there classroom practices were democratic, many were unsure. This could indicate that the learners did not understand what a democratic practice entailed.

The learners were very eager to learn and had a special interest in doing practical work in the life sciences classroom. They were all in possession of a BlackBerry cell phone and showed a desire to integrate this technology into their learning activities, despite the fact that the school policy did not allow for cell phones to be used at school. The school holds a science exhibition every year and these learners all performed well in their presentations and artefacts, such as posters and models illustrating various themes in the sciences. These learners therefore appeared to be adequately equipped to participate in the three action research cycles of inquiry I shall now report on.

6.3.3 The Facebook Group

I became aware of Facebook for the first time while doing a postgraduate certificate in education (PGCE) in 2007. Many of my fellow PGCE students informed me about the absurd amount of time they spent chatting to each other and that it was a convenient means for all classmates to stay in contact. I then set up a Facebook profile and began to make contact with my fellow students. One PGCE student took the initiative and set up a Facebook group called ‘NOS/PGCE students 2007’. Most of the students in the PGCE class joined this Facebook group and an online community consequently was established through which classmates discussed upcoming exams and planned social gatherings. As a relatively introverted student, this Facebook group allowed me to be part of an online community through which, even today, I get advice from other life sciences educators who now are at different schools around the country. In that particular year, Facebook was the new buzzword and the lecturers could not ignore its potential impact on the relationship between educators and learners. Although not much research had been conducted on the role of social media and teaching at the time, most lecturers stressed the need to maintain the professional boundaries between educator and learner. Despite the concerns of lecturers, I realised Facebook’s pedagogical potential and felt the need to do some research on the topic, which ultimately let me to pursue a master’s degree in the field of science education and technology.

In 2010, as an in-service educator at a local high school, I was invited by the Western Cape Education Department (WCED) and the South African National Biodiversity Institute (SANBI) to attend workshop sessions on innovative ways to teach the grade 10 life sciences curriculum. The workshop session had a twofold purpose; firstly, it involved teachers presenting innovative teaching strategies to other teachers to teach a specific topic in the biodiversity section of the national curriculum and, secondly, the intention was to increase awareness of the importance of biodiversity in the local community. It was hoped that what was learnt in these workshops could be implemented in schools. I came up with the idea of using a Facebook group, among others, to make the local community aware of the importance of a local wetland area, Zeekoevlei, and the threat posed to it by pollution. Through my learners, using Facebook, my initial assumptions regarding Facebook as a potential teaching tool was confirmed and since 2010 I have encouraged all my learners doing life sciences to join the Facebook group, aptly named Mr Waghid's classroom. All my learners have taken to the idea that the Facebook group is an extension of what happens in the classroom.

Fortunately it is relatively simple to maintain the Facebook page. Facebook has an easy-to-use user interface, allowing for videos and pictures to be uploaded and for reminders to be sent to members regarding important dates such as tests and the time discussions will commence. As the learners were quite adept at using Facebook, I wanted to see how far I could push the confines of the current use of Facebook to teach contentious topics. Preparation for teaching the contentious topics began with setting up a lesson plan to show how learning aims would be attained, as well as assessment criteria and the media that were to be used. The first action research cycle dealt with the contentious topic of cloning. Many of the learners had no idea what cloning entailed, so I posted a video in the Facebook group that served as an introduction to and icebreaker for the topic, as well as questions to direct the discussion. All the learners were automatically informed via Facebook notification, e-mail or sms that the first discussion had started once the video and questions had been posted. After the first cycle I felt that the questions were directing the discussion in an 'arborescent' way, and consequently refrained from using questions in the following two cycles to allow the learners to pursue the discussion in a more critical and 'rhizomatic' manner. For the second two cycles of the action research, I again prepared a lesson plan that included learning aims, but merely posted discussion topics and observed how the discussion unveiled while serving as a moderator.

6.4 Action Research Cycles and the Teaching of Contentious Issues

I embarked on the three cycles of inquiry in order to, firstly, to ascertain whether learners can be initiated into an understanding that science education can be democratised through the use of educational technology; and secondly, to initiate learners into democratic practices through a focus on the three 'purposes' of life sciences and what they should be able to do or the learning outcomes that they needed to acquire on completing of the course (to use the language of the previous National Curriculum Statement) in order to make a claim for the democratisation of science education in a local high school.

This brings me to the question: How did I choose the three contentious issues in relation to the goals of life sciences? In my response I shall refer briefly to the contentious issues and how the achievement of learning aims is related to the democratisation of science education in schools.

Three contentious issues forming part of the curriculum assessment policy statement (CAPS) for grade 10 were selected for the three action research cycles. These issues are considered contentious because there is an overlap between content in the curriculum and the learners' understanding of societal issues that are often brought into conflict with their belief and values systems. The aim of introducing these contentious issues into the curriculum is to promote learners' critical thinking in relation to their everyday life experiences. The first action cycle dealt with the issue of cloning. Cloning forms part of the first knowledge strand in the CAPS document, which deals with life at the molecular, cellular and tissue levels. Cloning encompasses three main themes, namely therapeutic cloning, used for organ growth; DNA cloning, for the creation of clones using specific, desired DNA; and reproductive cloning, a form of asexual reproduction. This topic is regarded as contentious because certain aspects of the issue contradict various religious beliefs. On the one hand, a particular religious denomination regards life as sacred and scientists are able to manipulate the building blocks of life, as if playing God, while, on the other hand, there are belief systems that may not find cloning problematic at all, making this topic highly contentious. The second action research cycle dealt with the issue of global warming. This topic forms part of environmental studies and looks specifically at the human impact on the environment. There are contrasting viewpoints with regard to global warming. Some see the evidence for global warming as merely being part of a cyclical natural phenomenon, whereas others see it as signs of impending doom. Those who view global warming as a potential catastrophe propose that we reduce all carbon emissions to zero with immediate effect, which would have huge ramifications for the various industrial sectors of society. People would lose their jobs and would have to find alternative modes of transport to save the environment, making this topic highly contentious. The third action research cycle dealt with the issue of evolution. Evolution forms part of the diversity, change and continuity strand in the CAPS document. Although learners do not have to deal with the more difficult concepts of evolution in grade 10, such as human evolution and natural selection, I felt it necessary to give learners an overview of some of the conceptual ideas relating to the topic that they would encounter in the more advanced grades. In this way, they hopefully would gain a better understanding of the theory of evolution, instead of only seeing examples of evolution (as currently in the grade 10 CAPS document) as separate entities. As with the first action research cycle, evolution is contentious because it contradicts the beliefs of different religious denominations. There currently are three viewpoints on evolution. Some scientists regard the theory of evolution to be incompatible with religious scripture, in contrast to many who consider sacred scripture as fact and evolution as a gross insult to their faith. Others tend to have a more neutral approach, believing evolution and creationism to be able to coexist harmoniously, thus making this area of the curriculum highly contentious.

As alluded to earlier in this chapter, CAPS was devised to allow learners to apply critical thinking without being desensitised to advances on a global scale as they engage with life sciences content. In addition, I would be afforded an opportunity to stimulate learners' intellectual ability, knowledge, skills and values to adhere to social transformation that addresses the imbalances of the past. CAPS is also aimed at addressing the issues of human rights, inclusivity, environmental and social justice, indigenous knowledges, inequality, poverty and problem solving. Considering that CAPS is also aimed at democratising learners' classroom experiences, I deemed it necessary to use educational technology as a means to support the aims of CAPS, as reported on in relation to the three action research cycles discussed below.

6.4.1 The First Cycle

At the start of the first action research cycle I had an opinion with regard to the data obtained. As this dissertation deals with the democratisation of teaching and learning in a grade 10 science classroom, it was my expectation that the use of educational technology fosters democratic pedagogical action. I expected to observe maximum participation by the learners, as well as collaboration and deliberative engagement. However, this expectation was quelled due to various technical issues concerning the use of Facebook. Of the 26 learners that I anticipated would participate in the discussion, only eight learners were involved actively. This was primarily due to login issues, as many of the learners' Facebook accounts were dormant and learners could not remember their passwords. Furthermore, many of the learners' smartphones were unable to display the content that was posted in the Facebook group, which was detrimental to their participation. In the survey, 19 learners had indicated that they owned BlackBerry mobile devices. But as soon as the first learner with a BlackBerry contacted me and raised a problem I knew I had encountered the first major stumbling block in using educational technology to contribute to democratising educational practices. As a BlackBerry user I quickly logged on to the Facebook group and, to my dismay, there only was a blank Facebook 'wall' on which I had posted various questions. It was evident that the limitations of the BlackBerry Facebook application used by many of the learners were in fact hindering their participation. When using a desktop computer, laptop or tablet, a user can select the recently added 'ask question' option. A question can be posed and all members are notified and invited to respond by adding comments or participating in a poll. I had decided to use this 'ask question' option in conjunction with the polling option, instead of the conventional 'post comment' option that many Facebook users are familiar with. The rationale behind this was to ensure that learners were able to voice their opinions in the form of the poll if they felt that they did not want to post comments. However, this new Facebook option was not compatible with many BlackBerry users' Facebook application. The users' mobile devices were not compatible with the social networking software of Facebook, and hence only eight learners participated.

Although the learners initially were not able to participate in the discussion, this issue was soon resolved by using the conventional ‘post on wall’ option. The learners started posting comments on the Facebook group wall and a discussion ensued, facilitated by learners using desktop computers and mobile devices. Despite overcoming the first technical hurdle, another technical issue confronted the learners using mobile devices. They encountered problems loading Facebook comments, which served as the medium for the discussions. Comments on one particular Facebook post reached in excess of eighty-one comments, and the consequence was that the learners’ mobile devices simply did not have the processing power and connection speed to load the ever-growing numbers of comments on one wall post and they consequently were excluded from the discussion. I was hoping to resolve this issue before the second and third cycles began.

Despite the initial technical difficulties encountered by the learners, Facebook as an educational technology afforded learners the opportunity to participate in the discussion at any time. Nevertheless, the discussion at times became a bit fragmented. Some learners were eager to start the discussion, as is evident from a comment such as: ‘Sir, when are we going to have the discussion about cloning because I just watched the video and I have many questions?’. Other learners, however, joined the discussion at different times and the discussion seemed to show instances of fragmentation, as shown in comments such as: ‘Okay, so reading all these comments are going to take forever so I will just post what I think is okay ... so this disadvantage to cloning would by that there is a great possibility of death like … uhm … Dolly the sheep who died at a young age because of a disease and it’s kind of sucky you know like we were put onto this earth with the necessary elements and stuff and if there is a shortage of anything people can’t just clone things because it might lead to lots of deaths … and if something were to go wrong in the process there would like be some serious damage done! So cloning is a no for me because not only is it going against everything god wanted for us it also creates a possibility of lots of diseases developing ...’. I envisaged to resolve the latter concern of fragmented discussion in the second cycle.

Despite the initial teething problems that hampered large-scale learner participation in this first action research cycle, technological expertise enabled me to adapt quickly and find a solution. The discussion using Facebook as a medium was then able to progress and more learners were able to participate. These technical problems, which were not accounted for, had the potential to adversely affect the democratisation of pedagogical practices, because many learners initially were excluded from Facebook discussions on a technical point. I wanted to avoid learners being excluded because they did not have the technology to participate at all costs. I felt that technical problems would discourage learners from using Facebook, and this invariably would impede the potential democratisation of our pedagogical activities.

Analysis of the Facebook observations pointed to technology serving as a medium that promotes societal awareness. This claim can be substantiated by Facebook comments on the use of cloning: 'No, because if the outcome is unknown persons might be putting their lives in danger'. In addition, technology serves as a medium supporting learning, which is confirmed by learners posting links to other websites and pictures. The learners' societal awareness was further confirmed by Facebook comments such as: 'Well cloning animals for agricultural purposes is a lot different than cloning for personal things such as "I really liked that cat". I mean, for those of you who eat meat, ethics doesn't really come into play. Whether or not that cow or sheep was cloned or naturally conceived the intention for it to be killed for food purposes is still the same.' (Appendix, p 233)The Facebook screenshots also highlighted the learners' capacity to communicate uninterruptedly. This observation was also confirmed in an interview with a learner that corroborated the capacity of educational technology to create a deliberative sphere in which learners who traditionally are quiet in class were able to overcome their reluctance to participate. Although the learners were not afforded full anonymity, the educational technology allowed them to participate from their own comfort space, whether at home or at school. Facebook comments such as 'I am against cloning because, firstly, it's unnatural and it's not safe because it's part of an experiment that could seriously go wrong' do not point to learners being subjugated in any way. Rather, many learners demonstrated tendencies to make controversial claims, such as: 'I believe that god created all things living unless scientists find significant information and evidence proving anything else', without any fear of being confronted or questioned.

The screenshot analysis also highlighted the learners' freedom to question me without necessarily experiencing an erosion of the professional boundaries between educator and learner. For example, screenshots on page 231 ('Learners were able to make reasoned claims without fear …'); page 234 ('Learners were able to make reasoned claims without being constrained'; and page 239 ('Learners began to act critically by posting links supporting their thoughts …') corroborate learners' freedom to question. The learners still recognised my pedagogical authority as educator and Facebook group moderator, but seemed to be more comfortable to ask me questions. A typical classroom scenario would see the educator as the main source of knowledge transmission, whereas here there was an equalisation of the relationship between the educator and learner through the use of educational technology. Because the learners were 'online' via their computers and mobile devices they had access to a wealth of information via the Internet. Yet my role as an instructive and strict educator was very dominant. This is evident from comments in which the leaners seemed to expect that I would continue to play an instructional role: 'Couldn't you use cloning to save near extinct animals' and 'Sir, when are we going to have the discussion about cloning because I just watched the video and I have many questions'. These examples show that learning has been democratised minimally because the learners took the initiative to do their own research, thereby taking responsibility for their learning and that of their fellow learners. It is also evident, however, that some learners are unable to adequately filter the wealth of information on the Internet and recognise credible sources. To this effect learners posted comments such as: 'Researchers have found several abnormalities in cloned organisms, particularly in mice. The cloned organism may be born normal and resemble its non-cloned counterpart, but the majority of the time will express changes in its genome later on in life.' Although the validity of such comments may be questioned, the exchange of knowledge amongst learners can only be regarded as beneficial to the teaching and learning process. Not only did learners have access to a wealth of information from the Internet, YouTube videos and articles, but they were also able to make contact with individuals doing research on the topic of the discussion.

By inviting a medical intern to be part of the Facebook discussion, the learners were able to tap into an additional information resource that enhanced the legitimacy of the discussions.

The Facebook screenshots also demonstrated the capacity of educational technology to assist learners in the construction of personal learning contexts. As the learners were able to participate in the discussions from their comfort zones, it allowed them the time and space to articulate comments that demonstrated their ability to think critically. Despite a few learners not demonstrating the skill to filter the wealth of information sources of varying quality, there were indications of learners demonstrating critical thinking. Evidence for this is provided by comments such as the following: ‘I think cloning is dehumanizing, because like sir commented that what if its organs can save your life? Yeah cool, but hey are you just going to cut up another person for your benefit? So you can live and stuff? That’s just mean. If people want to clone why don’t they clone things that we lack? Clone food, it will stop poverty? Oh, and uh, what if they do clone a human? And like it doesn’t go as planned are they just going to kill that deformed baby? Plus, we can’t play God man. That’s just my opinion though.’ The latter comments illustrate the learners’ ability to think critically. By opening their ideas to the scrutiny of other learners, the learners could rethink their own ideas in a critical manner. Initial ideas, such as ‘Cloning is pointless because it is nearly the same as male and female reproduction. There are other alternatives to cloning regarding the making of babies and not only is it pointless but also it is messing with God's ideas and creations’, were later reconstructed by the same learner, who commented: ‘Fruit and veg is the essential needs of a human’s diet so it would need to be cloned so that with the amount of population in the world there is no shortage of it’.

In the initial stages of the Facebook discussion it was my aim to direct the discussion to ensure that the learning aims were being achieved. Questions were posed to direct learners towards achieving the learning aims. As a result, the learners’ chains of thought were very linear. Despite the discussion progressing in a linear manner, there were some learners who demonstrated their criticality by directing the discussion along unexpected ways of doing. Learners began to research the contentious issue of cloning beyond the confines that I had mistakenly placed on them. One learner, for example, looked at cloning in terms of religion, supported by comments such as the following: 'Strange fact regarding the ethics of cloning … religious people are against cloning because they say that life begins at conception though Jewish people do not equate life with conception though some do question the wisdom of cloning, Orthodox Jews generally find no actual reason to object to cloning ....' Other comments included the following: 'Perhaps the biggest reason that cloning should never be explored is because of where it may lead society. Cloning is the creating of a creature (in this case a human) through artificial means. If humans could start cloning, their clones would have the exact same DNA as the parent, which makes them look similar. As the idea of creating humans with specific traits is explored, many will get the idea that they can not only create identical looking humans, but also how they should act. The book Brave New World from Aldous Huxley is a good idea of what would happen if humans dabble too much in playing the hand of God. Eventually, people could be bred with others to create perfect traits as if they were animals.'

On completion of the first cycle, sufficient evidence had been generated to show that the learners' participation on the Facebook discussion 'wall' varied from more participatory to less participatory. Of the twenty-two (out of twenty-six) learners who participated more (those who had lots to say) – at least eight[8] – as is evident on the Facebook 'wall', understood the views on cloning better, listened more attentively to others' views on the subject, revised their views in light of other learners' views, and were able to connect views on the subject to everyday life experiences. Those learners who participated less (not the four whose names did not come up on the site, but rather those who made brief comments – fourteen learners) were mostly constrained by the technical difficulties they encountered when using the Facebook group site, often resulting in frustration and disinterest in learning. Throughout the first cycle I played a prominent role, often guiding the learners towards deeper (critical) thinking, to the extent that, while some learners showed willingness and the ability to summarise ideas, revisit and adapt their earlier views, and speak their minds based on the information they or others had acquired, there were still some who did not consider participation in the learning process as

[8] Bianca, Brandon, Razaan, Fareeda, Justin, Ameer, Taybah and Craig.

necessary (they merely 'logged on' to the site and offered a brief comment or two). This lack of participation was often exacerbated by the technical difficulties they experienced. Thus, although some learners demonstrated the ability to think critically, construct personal learner contexts and show a greater societal awareness, the majority of the twenty-six learners (fourteen) rather were willing 'onlookers' than engaged participants. What is interesting to note is that a learner who seldom spoke in class participated more eagerly (as part of the eight engaged participants) in the Facebook discussion group. This provides evidence that educational technology can stimulate learner participation. As the learners joined the discussion site at different times, it became evident that those who 'logged on' later often did not have the maturity and autonomy to make independent comments. Therefore, continuous participation would increase learner engagement, and hence enhance learning. It is with the latter idea in mind that the learners and I entered the second cycle of action research. My planning of the second cycle was driven by my observation of screen shot (non)activity that learners' participation was minimal.

6.4.2 The Second Cycle

Considering that twenty-two of the twenty-six learners showed a sequence of more to less participation (eight engaged participants and fourteen less engaged participants), with four non-participants, the second cycle of action research was geared towards enhancing engaged participation that could create conditions for learner criticality. By the second cycle, the technical issues hampering learner participation had been addressed. This meant that learner participation hopefully would be maximised and that the learners would be able to participate in the discussion using the form of technology they were comfortable with, whether it be a cellular device, desktop computer or laptop. This situation would prevent their marginalisation, which, if not addressed, would have hampered the opportunity to democratise science education.

During the cycle it was evident that the learners were more adept at and confident in their use of Facebook for learning. They made full use of the Facebook functionalities to help express and substantiate their claims, including uploading photos, posting bookmarks to websites, posting videos and commenting on peers' posts. As Facebook posts are arranged chronologically, the learners could participate at times that suited them. In the first cycle, some learners felt overwhelmed by the many comments on a single wall post and pointed out that it would have taken them very long to read all the comments. In this cycle the problem was negated, as there were more wall posts and fewer comments per wall post, in comparison to the 88 comments, for instance, posted on a single wall in the first cycle. In this way the fragmented discussion observed during the first cycle was also averted, as posts were arranged in a more manageable way.

As has been mentioned before, the first cycle was driven in a linear manner by means of various questions being posed. In this cycle I wanted to limit the role I played to that of a moderator and/or motivator in order to encourage further research on the part of the learners, who would be able to use the technology at their disposal. To this end the learners were merely given the discussion topic and the responsibility was placed on them to guide the discussion. The result was that the discussion was directed along different lines that I could not have foreseen. Learning was no longer linear, and the discussion was pursued along the lines of social, economic and political facets that came into play when the learners addressed the topic of global warming. Although there was enhanced participation in the second cycle, and the technical issues had been addressed, the learners' interactions could not be described as overwhelmingly democratic. This relates primarily to the fact that the learners saw the discussion as a debate, rather than an instance of deliberative action. Many learners wanted to impose their viewpoints on others and some were unwilling to listen to their peers. I thought that the learners ought to be taught skills of deliberation during the third cycle, thus allowing them to be open, willing to listen to others, and even to change their viewpoints in a sphere of mutual respect for one another.

As in the first cycle, each Facebook post served as a forum for engaged participation. However, there were still instances when learners made sporadic, generalised statements on posts. These statements were not only sporadic, but also fragmented and, at times, out of context. For example, the screenshots on page 256 ('… learners … trying to impose their ideas on each other …'); and page 257 ('… some learners were still making sporadic generalised posts …') confirm that some of their statements were quite sporadic and fragmented. To address this issue I encouraged the learners to do further research or referred them to the posts of other learners to try to spark greater interest amongst these learners. Having played a motivational role, I was able to create a culture of learning through Facebook as a form of educational technology. The learners subsequently demonstrated their ability to construct personal learning contexts. In addition, they showed their ability to filter information sources. Website links to reputable news sources were used to validate many learners' viewpoints. Learning was not confined to the discussion on Facebook, but also extended by the learners to the Internet. This demonstrated the learners' ability to think critically and not just agree with any information source. The way in which comments on posts are displayed also allowed the learners to confer with each other and validate research. The learners thus acted critically. The screenshots on page 262 ('Learners demonstrating increasingly more societal awareness and critical thinking'); and page 265 ('The learners continued to show personal construction of their learning contexts, as well as critical thinking') confirm the ability of learners to think critically. However, a limitation brought to the fore by online spaces for engaging in discussion was that the learners were unable to gauge the tone of the discussion. Although some learners might have seemed aggressive and in some cases sarcastic, as is evident from the comments, they actually did not act disrespectfully towards one another. My intention was to address this issue in the third cycle, in which the learners would be reminded to be careful in their selection of words to ensure that a culture of respectful democratic action could be fostered.

As the discussion progressed it became evident that allowing the learners to direct the discussion resulted in the topic of global warming being explored more extensively than I had foreseen. The learners looked at the topic of global warming on an economic, social and political level, demonstrating their ability to think critically as confirmed by the screen shot on page 262 ('There were instances when the learners thought autonomously by coming up with practical suggestions to reduce carbon emissions'). Because of their construction of personal learning contexts, my role became less instructional and more motivational. This cycle already managed to highlight the potential of educational technologies to democratise science education. Features such as uploading photos to allow learners to converse with each other better, and the fact that learners could participate at any time, encouraged democratic learning experiences. Through this educational technology, the learners were able to demonstrate critical thinking and engaged participation – that is, they took responsibility for their own learning and simultaneously reduced my role to that of motivator.

In essence, participation during the second cycle appeared more engaged than in the first cycle, primarily because the learners did not have to contend with the technical difficulties they encountered previously. They concentrated more on the discussions, as is evident from the comments they posted on the Facebook group site. Their comments appeared randomly as they endeavoured to discover personal learning environments to indicate their willing participation and ability to respond to a contentious discussion such as global warming. What I observed is that the discussions and debates were at times very critical, showing that they that understood their learning contexts and were influenced by what other learners brought to the discussions. Likewise, an important observation that I made during my analysis of the Facebook 'screenshots' in the second cycle was that the learners were critical, where criticality involved reasoned and justified thinking. In other words, they expressed their views in a justifiable fashion based on the information they found that corroborated their views on the issue at hand. Consequently, my role also became less instructive and more motivational.

6.4.3 The Third Cycle

Most of the technical issues relating to the use of Facebook had been resolved by the second cycle, thus engendering enhanced learner participation. In addition, through the construction of personal learning contexts and the fact that learner participation increased tremendously, the learners displayed their reasoned ability to think critically, by finding justifications for their views on the contentious issue. In the third cycle I wanted to ascertain whether the learners could also act autonomously and deliberatively, and how their learning would evolve if my role was reduced to that of 'ignorant master'.

In this cycle, the problems encountered during the previous cycles, relating to a lack of learner participation, technical difficulties, sporadic comments offered by learners and, the instructive role I performed, were addressed. Furthermore, the potential of educational technology to democratise pedagogical practices was fine-tuned, focusing in particular on the sporadic comments made by learners and their apparent lack of autonomy. It was my intention to further fine-tune the pedagogical activities in this cycle in order to maximise democratic action. To this end I wanted to address the learners' lack of the skills required for deliberation. Despite the aforementioned deficiencies, I observed and practised positive action during the first two cycles, such as the promotion of more engaged participation, the ability of learners to construct personal learning contexts, their use of critical thinking and, the fact that my role became increasingly more motivational and less instructional. For example, the screenshots on page 268 ('My role, reduced from instructor to motivator'); page 268 ('I performed a motivational role'); and page 276 ('Learners took responsibility for their own learning …') corroborate my less instructional and more motivational role. Furthermore the potential of educational technology (that is, Facebook) to democratise pedagogical practices was further confirmed by the ease with which learners were able to engage with one another at any time or place, and to utilise features such as uploading photos and videos and posting web links to enhance engagement.

Due to the contentious nature of the topic of evolution, which challenges religious doctrine, it was important for the learners to possess the skills necessary for deliberative action, which differs from a debate. As mentioned earlier in this dissertation, a debate is characterised by two opposing points of view held by individuals who try to impose their point of view on others. This is in contrast with deliberation, which is characterised by a willingness to listen to others and an openness to the possibility of changing one's point of view. For this topic it therefore was imperative for learners to show tolerance in the face of their religious beliefs being questioned. A deliberative sphere thus would be more conducive to democratic teaching and learning. To this end I explained the differences between deliberation and debate to the learners prior to the third cycle.

As in the second action research cycle, learners were able to demonstrate critical thinking using educational technology as a medium. Facebook afforded the learners time to reflect on wall posts and respectfully question one another, which is especially important as many of the wall posts were contrary to their beliefs. The learners showed willingness to listen to others and even revised their initial perceptions on the topic of evolution. Critical thinking was also demonstrated in the evidence offered in support of theories on evolution. Screenshots on page 281 ('This learner not only demonstrated autonomous learning …'); and page 283 ('… many learners were able to revise their initial understandings …') confirm learners' willingness to listen, modify their views and to think critically. Thus the deliberative sphere, created through educational technology, facilitated the learning process as the arguments were constructive in nature. Learner autonomy was also observed in this cycle, as learning transcended what learners initially thought was correct, as they began to search the Internet for more credible sources of information that could assist them in the Facebook discussions as confirmed by the screenshot on page 284 ('Because the learners acted autonomously by doing their own research, they were able to think differently …'). One learner even interviewed a religious leader and ultimately changed her perception of the topic under discussion as vindicated by the screenshot on page 273 ('However, through the use of Facebook as a medium of learning, the learners were able to revise their initial viewpoints that saw evolution as a threat to their religious beliefs'). An indication of this autonomy was observed by learners posting links to websites related to research done in the field of evolutionary biology. Educational technology also facilitated rhizomatic thinking. As the learners began exploring the Internet they were exposed to different ideas, which led to them thinking beyond the sometimes linear confines of the discussions as evidenced through the screenshot on page 273 ('The learner demonstrated rhizomatic thinking by stating indirectly that viewpoints on the topic of evolution have been dictated by religion …'). This gave rise to a constant disruption of the sometimes linear direction of the discussion on a post, and new and different ideas came to the fore. These disruptions also encouraged critical thinking amongst the learners, as they had to reflect on these disruptions as vindicated by the screenshot on page 281 ('… In this way the disruption served to stimulate the learners' learning beyond the initial confines they (learners) seemed to impose on the discussion'). The disruptions eventually served as catalysts through which most learning took place. The learners initially were dogmatic about their views. They had an uncompromising approach to the theory of evolution and rejected the theory in its entirety, primarily due to the fact that part of the theory hypothesises that humans share a common ancestry with modern apes, making it highly contentious. Through deliberation and the disruptions caused by the learners, they themselves began to discover that evolutionary biology is a broad field encompassing different aspects, of which human evolution forms only a small part. The learners then developed a more liberal understanding of the theory of evolution and no longer rejected it in its entirety. In some instances, learners made comparisons between hypotheses on evolution and their religious beliefs as corroborated by the screenshot on page 270 ('Learner demonstrating critical thinking and not just accepting researchers' hypotheses regarding the theory of evolution').

An important aspect noted was that there was equalisation of the relationships between myself, the learners and also the scientists' hypotheses. As the educator I was no longer considered the sole source of knowledge, and in this cycle the learners consequently posed fewer questions to me. When questions were asked, the learners merely consulted with me. To this end I was better able to encourage and motivate the learners to do further research. Educational technology afforded the learners an opportunity to do their own research and to express their independent voices. My role was consequently revised from instructor to motivator. The learners also took it upon themselves to assist other learners who had joined the discussion late. In addition, the learners also provided critiques of many scientific hypotheses as vindicated by the screenshot on page 271 ('Learners' willingness to think autonomously so that they can contribute in an informed way'). They no longer saw science as an unchallengeable authority dictating to them what was correct and what was not. This equalisation of relationships between these different stakeholders demonstrates the potential of educational technology to democratise pedagogical practices.

Unlike the first and second cycles, there was a marked increase in the number of interactions amongst the learners. This was achieved primarily through the technical difficulties being averted and also the fact that the learners felt more comfortable using

Facebook as a medium for learning. Each initial comment posted on the Facebook wall by the learners served as a discussion point for a specific aspect of the discussion topic. In the second cycle there was enhanced participation, but all twenty-eight learners still did not participate in the discussion, as some showed a general lack of interest. However, with each post serving as a discussion of a specific aspect, all the learners participated in the discussion, as they could comment on a wall post in which they had specific interest. For example, some learners looked at modern-day human evolution, while others focused on macro-evolution. All these separate deliberations happened in the Facebook group, as all the learners were able to benefit from the these offshoots of the initial discussion topic, As indicated in the appendixes, much of this information could be garnered from Facebook's new feature, which indicates how many group members have seen the post. In this cycle, learner participation was maximised, deliberation was very profound and equal, and there were glimpses of rhizomatic thinking as pointed out by the screenshot on page 284 ('… the learners were able to demonstrate autonomy and rhizomatic thinking …') .

After having made improvements in cycles one and two to increase learner participation, I found that participation and deliberation by the learners was definitely enhanced in cycle three. It therefore can be argued that the use of educational technology, in this instance technology-mediated learning with the support of Facebook, contributed to democratising education in a grade 10 life sciences classroom. This is so for the reason that participation and deliberation constitute democratic action. Also, all the learners participated with informed voices and without being discouraged by other learners' comments. The learners deliberated as they justified their viewpoints, and were prepared to listen to the views of others and adjust their views accordingly. Although many learners' views were steeped in dogma, they nevertheless were prepared to listen respectfully to what others had to say. Likewise, by far the majority of learners acted autonomously having been prepared to wonder about the contentious issue of evolution. There also were moments of rhizomatic learning as illustrated by the screenshot on page 281 ('The learner not only demonstrated autonomous learning, but also rhizomatic thinking …'). Then, I also acted autonomously having been prepared to make my voice heard equally with those of learners without always having given them instructions as in the first cycle. Hence, the grade 10 life sciences classroom has been democratised through the use of educational technology. That is, moments of rhizomatic or autonomous learning suggest that democratic action was at play in the life sciences classroom. I practised my role as educator equally in relation to the voices of learners, thus confirming that democratic action could not have been far removed from the pedagogical activities in the life sciences classroom. I now turn to a validation of the positive learning experiences as a manifestation that the use of educational technology in the grade 10 life sciences classroom definitely contributed to the democratisation of education.

6.5 Validating Learners' Positive Learning Experiences

After the completion of the three cycles of inquiry, I thought it apposite also to interview ten learners (out of the total of twenty-six) to ascertain their experiences of using Facebook in the quest to learn about the three contentious issues, namely cloning, global warming and evolution. This form of validation corroborated the comments I observed on Facebook and of which I have made an analysis using the screen shots. The interviews I conducted can be considered an additional form of validation. I conducted the interviews between 25 October and 5 November 2012, and each interview lasted about fifteen minutes. The learners agreed that because Facebook had revealed their identities, it would not make sense to remain anonymous. In fact, they signed the transcriptions as evidence of their consent that their identity be known. The interviews showed that the learners' learning experiences of the use of educational technology in relation to the three contentious issues were positive. Thus, the interviews further validated the legitimacy of the positive learning experiences through the use of educational technology, along with the Facebook screenshots.

From the transcriptions of the learners' responses to my interview questions, it firstly was evident that educational technology offers the possibility for learners to develop their skills in deliberating relevant to the study of life sciences. The learners seemed to be aware that the participation in the Facebook discussions was central to their learning. As one learner remarked, through Facebook 'you could think about the answers, you weren't timed and you could research it [the contentious issues]'. Another learner said the following in support of using educational technology: 'I preferred learning in this way because it wasn't like too much notes and too much to learn.' Moreover, as the learners navigated through and contributed to the Facebook discussions they felt free to differ with their peers and to make reasoned claims about their support of or disagreement with particular claims regarding contentious matters in life sciences. The learners felt free to express their views directly, without fear of offending other learners. Some of the learners I interviewed remarked the following: 'I think … you conducted the group very well and you took comments off [that is of the discussion block] that hurt people's feelings and it was open and everyone could say how they felt' (I understood that deliberation could not unfold by being prejudiced towards others); 'Yes, I got a chance to hear other people's point of view and opinions'; and '…I have a better understanding now and what other people think and their point[s] of view. On Facebook it is more communication and discussion'. Hence, the use of educational technology enabled the learners to participate and deliberate, thus contributing to their positive learning. This view of educational technology, as influencing learning contexts positively, is confirmed by Thorpe (2009, p. 126), who claims that educational technology offers possibilities for knowledge exchange and positive learning by educators and learners.

Secondly, from the transcripts I could infer that the learners used educational technology to construct personal learning environments in relation to their interests and goals of the life sciences contentious issues. As one learner remarked, '... with global warming I must say I didn't know what it was about, but now that we have discussed it and the learners have said their point[s] of view I understand it way better and the consequences of global warming way better … so yes it has taught me a better awareness and has influenced me because I had no idea and wasn't concerned, but now I am. Also with evolution I learnt to respect what their opinions was [sic] like maybe before I would have said no, creationism. And how can you believe in evolution, but now with both points I have a better understanding'. The aforementioned learner-generated contexts are products of learner interactions, as they used the Facebook discussions to co-construct responses to contentious issues in life sciences. As stated by a learner, 'I have developed a lot as a learner…when the teacher speaks everyone must just understand, but I would say with the Facebook thing you get to hear everyone's point of view and see that everybody does have [opinions]. Like when you look around the class you say oh no he doesn't think that, you just judge them…now with Facebook you see that they actually have a point of view and it's good to see what they actually have, and it helps you understand as well'. The fact that learners construct personal learning contexts through online discussions is also evident in the works of Barnett (2005) and Thorpe (2009).

Thirdly, from the transcripts it seems that educational technology increased the learners' scope of action and expanded their opportunities for experimentation, as the focus moved increasingly to learning rather than teaching on my part. As some learners remarked: '…I've learnt a lot about all this stuff and it gave me more like insight into things I didn't know about…I've learnt how some people think, like religion and god and all that stuff'; '…there is no right or wrong answer and that your answer is taken to another deeper level, so when I read the comments what people had to say…took it from both sides, because there was no right or wrong, so also with the evolution, most people said they believe in creationism because of their religion, but there was one or two in evolution because they say science is fact. Now with that I went deeper and I said the bible is fact and has been dated I also made the comment on Facebook that it was dated in the bible of the stories and how it was made, but evolution has been in there somewhere, but I'm more for creationism and because of the start of it and scientist have proven all of it'; and 'I didn't think any other teacher would have done that, like make a Facebook group and say let's everyone start talking about a specific topic. Other teachers would just stand there and talk'. In quite a Deleuzian fashion, I established a Facebook group to put the enclosures (regular learner activities) of the life sciences curriculum under siege and offered learners opportunities to exercise their intellectual voices autonomously.

Fourthly, the learners valued the role I performed, namely of providing support and encouragement as they learnt about the contentious issues, rather than my traditional role of transmission teaching. They appreciated the way I listened to their views and engaged with them in a relaxed, informal and caring manner, thus aiding them in building their confidence. In a way the learners recognised that I wanted to do less teaching and put more emphasis on equalising our relationships – that is, I placed a high value on their points of view and the insights they offered, and had a far less ‘teachery’ approach (Crossan & Gallacher, 2009, p. 133). This meant that they did not only have to listen to what I had to say in relation to the contentious issues. As confirmed by some learners: ‘…when you teach you don’t only say your point of view is right, you discuss things from both points…I see that. Like when we ask your questions you don’t give one point of view…so it’s actually a big role because most teachers they only teach from their point of view [which] is right, but through your understanding and what you tell us what we discuss makes us remember things more and that is where life sciences as a subject influences more as well’; ‘You played a good role because you listened to everyone’s opinion and didn’t take sides and you weren’t biased’; and ‘…your type of teaching, it doesn’t conform to the norms of other teachers. With other teachers you can’t really ask questions over a weekend or something and you are more interactive than most teachers. And your lessons are not as boring as say example an English lesson’.

In essence, I deduced from the transcripts that the learners’ experiences while learning about the contentious issues in life sciences were remarkably positive. Like McNiff and Whitehead (2009) would do, I considered the explanations offered by the learners during the interviews as living standards of judgement in giving account of their positive learning experiences to themselves and to me. To my mind, they understood what it meant to act critically and autonomously and simultaneously engaging others in deliberation. Learners became intent on being listened to and to contribute towards understanding and reinterpretations of concepts in relation to their independent thoughts – a matter of searching for living standards of judgement based on their own discoveries through deliberative engagement.

6.6 Summary

During the first action research cycle on cloning I found that the learners were experiencing technical glitches with the Facebook group site, which caused frustration.

Consequently, the learners' participation (as is evident from the frequency of comments) was minimal and their responses to the contentious issues were not very informed or extensive – only eight learners participated meaningfully. Those who participated less (fourteen learners) were also constrained by formal examinations as their preparations caused them to be somewhat playful on the Facebook group site. Nevertheless, there was a level of learner participation and it seemed evident that the use of educational technology offered learners opportunities to become more participatory. Paradoxically, however, their participation was somewhat restricted.

Before the commencement of the second cycle (on global warming), the learners and I concentrated on eliminating the technical deficiencies in order to ensure more participation and inclusiveness. Also, I adopted a rhetorical approach to encourage learner participation by asking provocative questions that I posted on the site. After completing the second cycle, I deduced from the learner discussions posted on the Facebook group site that there was better communication amongst and participation by the learners. They seemed to have been more prepared to access information about the content and were involved in small group discussions. In addition, the learners took ownership of their learning by constructing personal learning contexts, without necessarily depending overwhelmingly on my pedagogical authority. I also inferred from the discussions that the learners performed more searches and actually went beyond what they were expected to do. The learners therefore became confident in using Facebook. However, despite the improvements in technical efficiency of the Facebook group, there still was a lack of engaged participation on the part of all twenty-six learners.

In preparation for the third cycle (on evolution) I posted a worksheet on the Facebook group site that learners had to engage with in order to understand theories on the third contentious issue in life sciences, namely evolution. I took this initiative because I presumed that a discussion of evolution would trigger several controversial assertions on the part of the learners. Of course, this worksheet was not meant to be prescriptive, but rather to provide an opportunity for learners to engage with prior knowledge concerning the theoretical debates on evolution. In other words, as a means to foster more learner participation I thought it appropriate to initiate them into recent debates on the contentious issue. In this way their participation would hopefully be enhanced further. What I inferred from the discussion on Facebook was that learner participation and deliberation definitely were enhanced. In fact, some learners, having gained more self-confidence to express their opinions, came up with unexpected ideas (which surprised both the other learners and me), showing that their personal learning had been enriched vividly. It seemed as if their learning constituted an ‘assemblage’ of thoughts on which other learners could draw and develop their own thoughts. They could only have acted autonomously because they regarded themselves as participants whose opinions mattered to both the other learners and me. What was interesting to note is that the learners did not simply build on one another’s thoughts in some linear, hierarchical way, but rather came up at any moment with ideas and information to address the contentious life sciences issue. In a way, they produced ‘offshoots’ of thoughts from the very ‘vectors of escape’ or ‘lines of flight’ that already existed as they endeavoured to contribute towards constructing an ‘assemblage’ of personal learning that largely was in rhizomatic form. And this could only have been done on the premise that they contributed to the formation of the ‘assemblages’ of thought by recognising that they could do so on the basis of a form of ‘intellectual equality’ that at times was unconstrained by other learners’ opinions and by my authority as educator.

Although there were several moments of creative and innovative learning experiences (as observed from the discussions on the Facebook group site), I could not assert boldly that learning had been consistently and overwhelmingly autonomous, rhizomatic and equal. There were instances, especially during the first cycle, when learning was very much ‘arborescent’ in the sense that they wanted to contribute systematically to their own understandings of the contentious life science issue, often relying on others’ opinions, although not exclusively so. During the second cycle I noticed that the learners were becoming more confident, as their participation gradually increased and they developed the freedom to come up with suggestions and ideas playfully to justify their views on the contentious issue. However, in cycle three there was unrestricted openness that brought a flood of ideas in quite haphazard and at times chaotic fashion, quite reminiscent of a Deleuzo-Guattarian construction of ‘plateaus’. It was then that I deemed it salient to start thinking differently about how I would report on the analyses of the three cycles of inquiry. And it also was then that my own readings of Deleuze and Guattari, and Rancière came to the fore. In short, my analyses took a significant poststructuralist turn. That is, I became immersed in thinking autonomously and rhizomatically myself. And, simultaneously I realised that I had an equal voice that can disrupt an form of deliberative engagement. I was no longer satisfied with searching for rational meanings in a linear way but rather to be open to unexpected meanings and encounters that can be disruptive in a democratic sense. The following schematic diagram offers a synopsis of the three action research cycles:

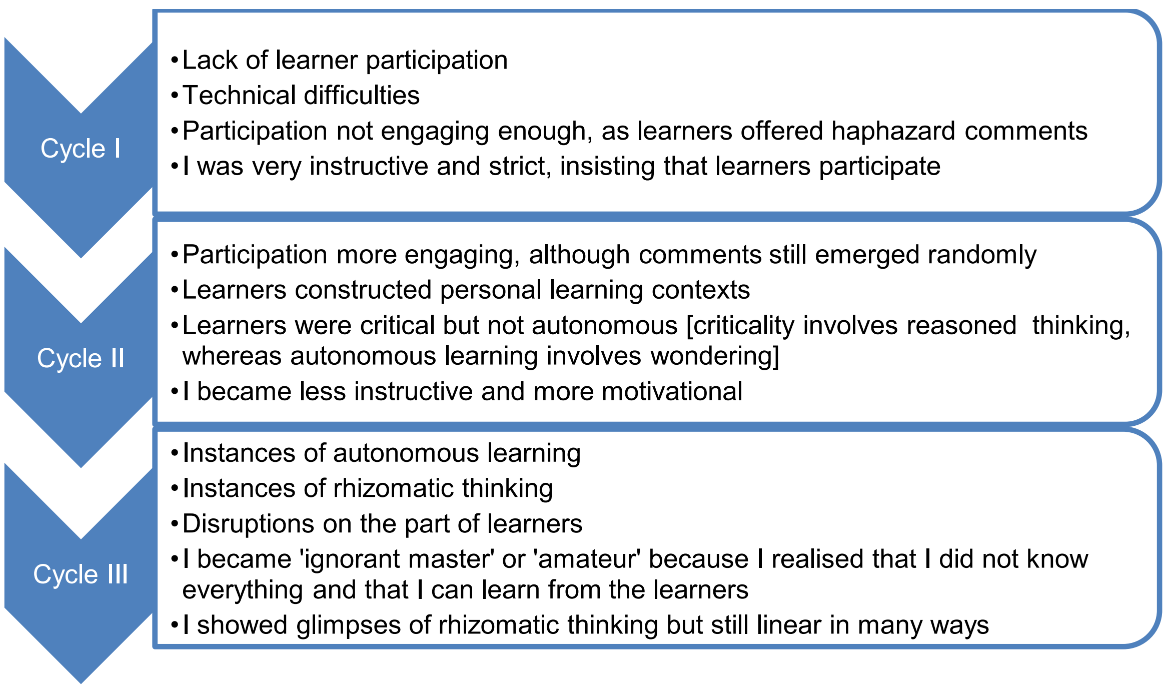

Figure 6: Summary of the analyses of the three action research cycles

In the next chapter I articulate my findings, which emanated mostly from the positive learning experiences of the learners, as well as from my own professional growth as life sciences educator, moving from being intent on seeing things structurally to gradually becoming immersed in the poststructuralist ideas of two major French philosophers, namely Deleuze and Rancière. For once I deemed it necessary to extend my notions of democratic thinking beyond the limits of the liberal thoughts of Habermas, Young, Callan, Gutmann and Greene.

CHAPTER 7

FINDINGS, RECOMMENDATIONS AND LIMITATIONS

7.1 Introduction

My analysis of the three cycles of action research in the previous chapter, in relation to the question whether the use of educational technology contributes towards the democratisation of teaching and learning, led me to find that the grade 10 science class under investigation was indeed afforded opportunities to become democratised. This finding is based on the analyses of the learners' comments (as they appear on the Facebook screenshots) in relation to the three contentious issues, interviews I conducted with ten of the twenty-six learners after the completion of the third cycle, and my continuous reflections on the use of educational technology in relation to my understanding of theories and practices concerning democratic science education. Throughout this study I immersed myself in theoretical ideas about democratic practices, to the extent that I emerged and have continued to develop professionally as an educator who attempts to put new concepts and a new language to work in school science. In a way, very much like McNiff and Whitehead (2009), I generated a living theory (or explanations and or justifications of teaching and learning) that emerged from my interactions with learners as we endeavoured to make sense of the aims of grade 10 life sciences and contentious issues in life sciences, and our continuous engagement through Facebook via the 'Mr Waghid's classroom' site. In other words, this living theory evolved out of my intention to improve teaching and learning in a grade 10 life sciences classroom through the use of educational technology. This intention was based on ideas of democratic education espoused by theorists such as Habermas, Deleuze and Rancière. Rather than imposing theory on our pedagogical activities, I connected my lived experiences with learners in a grade 10 classroom to the seminal thoughts of the aforementioned prominent theorists.

When I began this study, I was adamant that the learners should just participate in, collaborate with and engage in contentious issues in life sciences through the use of educational technology, thus putting Habermas to use – that is, on the basis of democratic engagement learners and I would deliberate and search for agreements. As the study unfolded I was driven by a language of democratic education as participation, collaboration and deliberation. Even my analysis of the first action research cycle seemed to have been biased towards Habermas's notion of democratic engagement. However, as I began to look deeper at the learners' comments on the Facebook screen shots I realised that their interactions and deliberations with other learners and me were not just about the manifestation of a particular form of Habermasian thought, but that I had actually developed new ways of looking at their learning through my deliberate exposure to reading Rancière (on being initiated into Gert Biesta's understandings of learning as confirmed by the screenshot on page 281 – 'The learner not only demonstrated autonomous learning, but also rhizomatic thinking, by disrupting the deliberation, in this case controversially') and later Deleuze (on the advice of my promoter). When I read Rancière I was about to start with the first action research cycle, and when I first read Deleuze and Guattari I was busy with the third cycle of action research. During my analyses of the three cycles of action research I realised that I was attracted more to the work of Rancière and Deleuze. Metaphors like 'amateur' (used by Rancière) and 'rhizome' (used by Deleuze and Guattari) inspired me to locate myself equally and autonomously in relation to the learners. I would not say that my thinking today is entirely Deleuzian (as I am very much guided by 'arborescent' or hierarchical ways of understanding science), and I made some minor adjustments to the way I understand school science and science education even while writing this chapter. For example, when I started dealing with the first contentious issue (that is, cloning), I had things worked out neatly, such as providing the learners with a YouTube clip on cloning and structured questions and lesson plans to initiate learning. Likewise, although I have not entirely relinquished my professional authority as educator I am beginning to look at myself more and more as an 'amateur' educator who is passionate about teaching school science through the use of educational technology and to continuously offer learners equal chances in terms of what I bring to my lessons in order that they remain attentive to the science curriculum.[9] I now offer an analysis of the main findings of this dissertation.

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[9] My excitement about working with learners in technologically-assisted science classrooms was met with

7.2 Findings of Study

7.2.1 Technology-mediated Learning Engenders Enhanced Participation and Informed Deliberation

As has been argued for in Chapter 3, democratic education has some connection with encouraging learners to engage in dialogical relationships; engendering social justice practices aimed at eliminating the exclusion and marginalisation of learners; and stimulating learners to solve problems and to make pedagogical breakthroughs. I have found the aforementioned practices to be in consonance with an enhancement of learner participation, collaboration and deliberation as they endeavoured (through educational technology) to find justifiable explanations for and understandings of the contentious issues in life sciences. To my mind, the dialogical relations the learners established through Facebook discussions are very much in line with Habermas's (1997) view that democratic relations between people are constituted by virtues of self-determination or self-realisation and rational discourse (Habermas, 1997, p. 39). For Habermas, cultivating a rational discourse is about empowering people to decide on the rules and manner of their learning together in a self-determined way, thereby producing cooperative life practices 'centred in conscious political will-formation' (Habermas, 1997, p. 41). As confirmed by a learner: 'I mean [during] interval my group and I would sit down and talk about it [contentious issues] and ask for their opinions and insight into these topics.' The latter is a clear manifestation of the informed participation and enhanced deliberation that emanated from this study. Thus, throughout the second and third cycles, participation and engagement by the learners and me became very intense. Their debates and discussions (as is evident from the analysis of cycle two) and deliberations (with reference to the analysis of cycle three) confirm that the use of educational technology in a grade 10 life sciences classroom engendered opportunities for pedagogical activities to become democratised, as democratic action (as has been argued for in Chapter 3) can be linked to deliberative engagement, which occurred particularly during the third cycle.

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even more enthusiasm for using educational technology when my application for an online tutor position working for the University of South Africa on a part-time basis was successful. I was now responsible for teaching university students about the use of educational technology in classrooms.

7.2.2 Learners Construct Personal Learning Contexts

It is evident that the use of educational technology afforded the learners an opportunity to construct personal learning contexts. Throughout the three cycles of inquiry the learners posted impressive charts and diagrams that they had acquired in their Internet searches to construct their personal learning contexts as they endeavoured to make sense of and debate and deliberate on the three contentious issues. Such a notion of learning, whereby learners construct personal learning contexts,concurs with Deleuze's (1992, p. 3) understanding that in 'societies of control', as opposed to 'disciplinary societies', people use 'new weapons' as they endeavour to enlarge their scope of action, that is their learning. In 'disciplinary societies', institutions like factories, prisons, nuclear families, hospitals and schools function as enclosures that subject individuals to mechanical regimes and rhythms of control that are not always visible to those regulated by procedures of democracy, equal rights and justice (Deleuze, 1992, p. 4). In 'societies of control' (like the science classroom under investigation, I would say) people (learners) never cease to learn as they take responsibility for their own learning whose learning through educational technology is 'continuous and without limit' (Deleuze, 1992, p. 6). They learn by seeing things and making decisions for themselves, without being constrained by enclosure, for example by an educator's view only. By constructing personal learning contexts, the learners have not been confined to specific enclosures within which they are subjected to surveillance, reward and punishment in the form of prescribed and closed lesson plans, tests and assessments. Rather, as is evident from the Facebook discussions and analyses, their learning has been highly personal, contextualised and relevant to their own investigations as they endeavoured to construct and co-construct responses based on their own choices made through the use of the Internet and Facebook discussions or chat rooms.[10] In other words, the personal learning contexts they constructed came about as a result of their own desires, or what Deleuze refers to as 'a production of desire' (Morss, 2000, p. 197). In my view, and especially in relation to the third cycle, the learners took control out of a desire to do so,

[10] For the purposes of this dissertation, I refer to Facebook group discussions as chats or comments posted on the Facebook 'wall' or discussions on the Facebook site.

without necessarily being disciplined or regulated by the demands of a prescribed life sciences curriculum and educator. I naturally encouraged them to participate, but as soon as they became familiar with the topic of investigation through their ‘online’ searches, they felt comfortable and inspired to continue participating on their own without having been coerced to do so further. As aptly put by one learner, ‘Sir I think like sir played like a big role not many teachers do this like open learning into social learning which is like nice so I think sir has made like a mark in that there are other ways of being taught and I think sir has played a big role compared to other teachers that will speak to us like till like after matric’. Thus, the pedagogical opportunities that educational technology afforded the learners in constructing their personal learning contexts (as was evident throughout the three cycles of inquiry) corroborate the argument that educational technology contributed to the enhancement of democratic practices in a grade 10 life sciences classroom.

7.2.3 Learning as Initiation into Individual Autonomy

By far one of the most important findings of this research was the self-determining way in which the learners, both individually and as a group, became involved in solving problems in relation to the contentious issues on Facebook. In a way, the learners took responsibility for their own learning because of their desire to learn and their willingness to cooperate with others in shaping their ideas through the use of educational technology. Simply put, they ‘trusted the responsibility to decide for themselves’ (Krejsler, 2004, p. 496), as is evident from the analysis of cycle three. The learners autonomously showed a keenness to learn more and to ‘surf out’ into spaces relating to the contentious issues that genuinely excited and interested them. In other words, the learners entered ‘spaces of reflection and wondering’ (Krejsler, 2004, p. 499). This happened only after they had displayed the ability to think critically and to extend meanings when explicating contentious issues in life sciences. Whereas cycle two allowed them the pedagogical space to think and act critically, cycle three stimulated their interest in acting autonomously. Through the enlargement of the learners’ autonomy, my role as educator became more that of a consultant, guide, mentor, motivator or moderator. In other words, through my ongoing dialogue with the learners I offered regular guidance as they navigated the web in search of ideas that might substantiate their knowledge claims, eventually leading them to acquiring more autonomy, especially during and after completing the third action research cycle. For instance, after having completed the first two cycles they did research on the contentious issues and posted it on the Facebook group page. By being exposed to educational technology the learners were constantly subjected to the temptation to 'surf out' into spaces on the Internet that interested and excited them in relation to constructing explanations for the contentious issues in life sciences. In a way, their autonomy as learners had been enlarged, giving rise to 'a self-deforming cast that will continuously change from one moment to the other, or like a sieve whose mesh will transmute from point to point' (Deleuze, 1992, p. 4). The latter kind of autonomy was confirmed by one learner: 'Now I don't…have to ask someone first. I only started scrutinising once I knew what the topic was about.'

7.2.4 Equalising Relationships

As mentioned in Chapter 3, equal democratic relationships (following Rancière) depend on the contributions of those people (in this instance, learners) who have no power in the social order, but who can disrupt modes of action to make things happen. To my mind, the learners' contributions to the understanding of contentious issues in life sciences (as corroborated by their insightful and critical contributions to the Facebook discussions) are a vindication of their capacity to speak their minds. They have shown that they possess an equal ability to speak, think and act in their efforts to create a learning environment in which they and others can adjust their views about contentious issues in life sciences. Through their Facebook interventions they verified their 'intellectual equality' (Rancière, 1992, p. 59) to speak, understand, share and construct their opinions in collaboration with other learners. Through the use of educational technology to teach contentious issues in life sciences, the learners were emancipated; more specifically, their learning was democratised in the sense that '[t]he process of emancipation is the verification of the equality of any speaking being with other speaking being[s]' (Rancière, 1992, p. 59). As confirmed by a learner: 'I think in a critical [and autonomous] way…I didn't just accept what others said, I stuck what I had to say and I didn't let criticism phase [i.e. faze] me.'

7.2.5 Learners Becoming Rhizomatic in Their Thinking

What emanated from the analysis of the learner discussions and comments on Facebook is that the learners seem to have become agents of rhizomatic thinking, especially in the third cycle of inquiry. In a Deleuzo-Guattarian fashion, explains Le Grange (2011, p. 745), rhizomatic thinking 'not only enables students [learners] to understand how phenomena/constructs become stabilized or normalised in society but also enables them to ascertain…what the vectors of escape are…[where] best can become worst and worst has the potential to become best through a process called deterritorialisation'. Vectors of escape, or lines of flight (a Deleuzo-Guattarian metaphor), refer to the multiple possibilities in which learners constructed knowledge through Internet searches on the three contentious issues in life sciences under investigation. Like the offshoots of a rhizome that forge links with other rhizomes, the learners' thoughts were scattered and then scrambled together to form new assemblages of knowledge. When offering justifications for their views on the contentious issues, the learners happened to find themselves in 'deterritorialised' knowledge spaces where they departed from 'fixed' ideas, for instance about creationism, to produce new 'reterritorialised' knowledge through the rupturing of their 'old' thoughts (Le Grange, 2011, p. 747). In other words, their understandings of the contentious issues had been subjected constantly to what Le Grange (2011, p. 747) refers to as a 'rupturing or exploding into lines of flight', shifting the way in which they previously thought about the issues. Hence, their learning was influenced rhizomatically. In a way, using educational technology while learning about contentious issues in life sciences offered the learners an opportunity to go on a voyage in which they were challenged to bring into controversy their previous understandings of the contentious issues and never be quite sure what they would come up with. That is, the learners' views on the contentious issues in life sciences emerged as deterritorialised lines of flight that did not cease, 'but [branched] out and [produced] multiple series and rhizomatic connections' in becoming reterritorialised vectors of escape (Deleuze &

Guattari, 1987, p. 15). As noted by one learner: 'Facebook [is] definitely a new way of teaching and learning and it definitely helps us analyse everyone's viewpoints and what they believe and how they were taught in different ways in relation to how they analyse the topic.'

Figure 7 offers a schematic summary of the main findings of this dissertation:

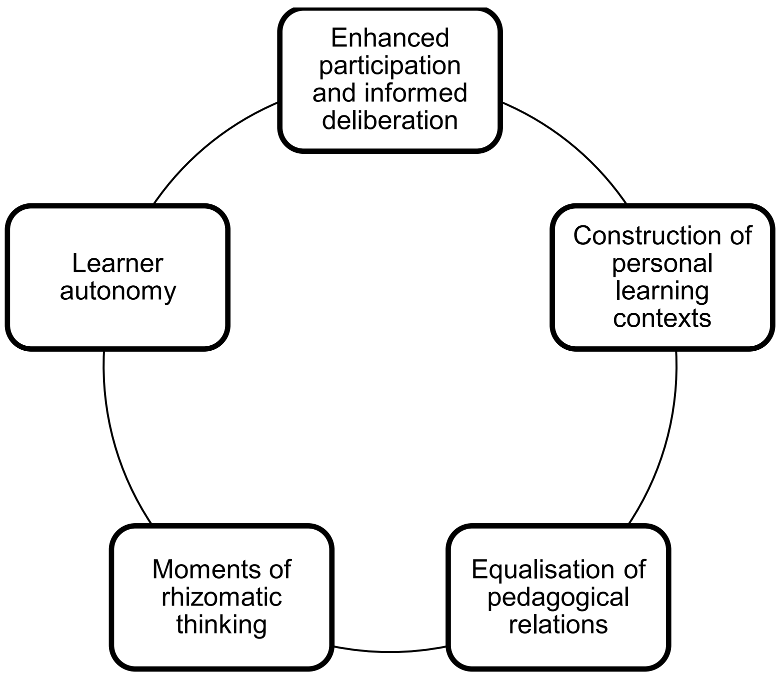

Figure 7: Primary findings of the dissertation

Before I offer a few recommendations for practitioners in action research studies, I would like to reflect on the primary findings above in relation to my own professional growth as a life sciences educator. My own approach to teaching has shifted significantly towards encouraging collaboration and deliberation in classroom activities. In fact, I am now more willing to listen to the views of learners as an 'ignorant master', rather than just offering advice. Similarly, my autonomy as a life sciences educator has reached new heights, as is evident from the leadership role I am beginning to play at school in motivating other educators to improve their teaching through the use of educational technology. In addition, I took the initiative to encourage and continuously engage with learners about the life sciences curriculum in the 'Mr Waghid's Facebook group', to the extent that I have invited another grade 10 class to engage with me on contentious matters in the life sciences. I must admit that I have become very involved with the Facebook home page. I also have set up a 'skydrive folder' from which learners in grades 10 to 12 can access previous examination papers and memoranda. Moreover, as a life sciences educator concerned with various societal issues, such as the degradation of the environment, safety in our community and pollution, I have used the Facebook group to comment on such matters, thus bringing me into continuous contact with learners. My societal awareness has been enhanced to a certain degree through this dissertation, to the extent that other schools in the area have requested that I conduct workshops on enhancing teaching and learning in relation to using technology. I now comment regularly in staff meetings on issues of societal and environmental concern. My engagement with educational technology in relation to life sciences in schools has also resulted in a university drawing on my resources to teach postgraduate students studying towards a teaching qualification.

This brings me to some recommendations in relation to the theoretical thoughts that now influence my teaching of school science.

7.3 Recommendations

7.3.1 Cultivating a Productive Desire to Learn

Using educational technology when teaching contentious issues in life sciences can engender in learners a desire for learning, where desire refers to an autonomous and affirmative force that influences learners' relational encounters with other learners and educators (Zembylas, 2007, p. 334). For Deleuze and Guattari (1983, p. 28), desire is not restricted to a feeling or emotion such as pleasure or fantasy in dreams, but is a force that radicalises learners in becoming deeply connected to other learners in an assemblage that constitutes them. The use of educational technology in teaching learners contentious issues in the life sciences certainly develops in them a critical understanding of knowledge and a desire to connect such an understanding of knowledge to wondering about what confronts them as learners in relation to other learners. As aptly put by Deleuze (1994, p. 192), cultivating in learners a productive desire to learn (through educational technology I would add) means 'composing the singular points of one's own body or one's own language with those of another share or element, which tears us apart but also propels us in a hitherto unknown and unheard-of world of problems'. The learners disagreed as they endeavoured to justify their understandings of the contentious issues, while they simultaneously were stimulated to wonder in search of unknown and unheard-of justifications for the issues that confronted them. In a way, they acquired (and hopefully would acquire) a productive desire to learn, that is to experience pleasure, engage with other learners and take risks (Zembylas, 2007, p. 331), if life sciences were to be taught through the use of technology. Consequently, it is recommended that educational technology be used in teaching life sciences so that learners acquire a productive desire that will enable them to enjoy themselves, experience an assemblage of learning, and take risks in relation to their learning. Put simply, cultivating a productive desire for learning through educational technology can engender democratic spaces in science classrooms in which learners become deeply connected to one another.

7.3.2 Enhancing Rhizomatic Thinking

Through the use of educational technology in learning life sciences, schools should encourage learners to become rhizomatic in their thinking. Rhizomatic thinking would not only promote autonomous learning, but also propel learning into open, unrestricted assemblages that take learners elsewhere than where they were before they learnt life sciences through educational technology. In other words, learning would not be linear, and the learners will never take a one-dimensional or unidirectional path to come up with a credible response to issues that confront them. Rather, in a Deleuzo-Guattarian way they would explore diverse possibilities to construct and co-construct assemblages of learning, where assemblages refer to 'provisional linkages of elements, fragments, flows, of disparate status and substance' (Grosz, 1995, p. 15.). Following such a rhizomatic view of thinking, learners would be constituted into desired spaces of democratisation.

7.3.3 Privileging Trust and Humour

In teaching life sciences through the use of educational technology, educators should become more concerned about privileging trust for themselves and for learners if they hope to respond to the needs of learners in their situated contexts. Ball (2000, p. 17) avers that the trust that traditionally underpinned pedagogic relations has been replaced by competition, to the extent that there now is a shift from an emphasis on collaborative work to a performative culture of producing only winners and losers in learning contexts. This performative culture in learning contexts (such as in schools) has adversely affected learning, so that even humour, which can rupture competitiveness, has been eroded from pedagogic activities, as in the classroom (Thompson, 2010, p. 9). Drawing on a Deleuzo-Guattarian view of humour, Thompson (2010, p. 9) argues that 'rueful humor' can be used as a strategy to 'dedividualize' competitive relations amongst learners, as it can be rhizomatic – that is, 'it [humor] bubbles along through landscapes, throwing up connections and possibilities that are fluid and creative' (Deleuze & Guattari, 1987). Using educational technology in life sciences can bring the 'new weapons' of trust and humour back into the classroom in order to disrupt the performative culture of learning, and in turn can promote the critical and autonomous reflection that Deleuze and Guattari saw as possible in learning contexts.

7.3.4 Democratising or Equalising Classrooms

This action research study confirmed the success of preparing learners in a science classroom for participation in democratic practices, and showed that a science classroom in which educational technology is used to teach life sciences is (and should be encouraged to be) a 'site of the symbolic visibility of equality and its actual negotiation' (Rancière, 1995, p. 55). When a science classroom is regarded as a site of equality, the role of the educator should be that of 'ignorant master' and 'amateur'. Following Rancière, Masschelein and Simons (2011, p. 162) point out that an amateur (science) educator does not only inform her learners about science, but can also inspire them to be 'present'. The educator thus assumes that learners are equal in the sense that they are able to make sense of what the educator 'puts on the table' (Masschelein &

Simons, 2011, p. 163). In other words, an educator as 'ignorant master' and 'amateur' does not consider himself or herself as the only authority who understands scientific subject matter, but believes that learners are equally able to do so and also generate ideas that confirm both their understanding and knowledge of school science. This is what I have found to be the case in my analysis of my learners' comments on the contentious issues. Learners are afforded equal opportunities (chances) to become attentive to contentious issues in life sciences and to make the learning of school science through educational technology possible and exciting. To this end, a science classroom is a site where democratic moments can arise, such as when educators and learners 'are exposed to each other as equals in relation to a book, a text, a thing' (Masschelein & Simons, 2011, p. 164). Put simply, a science classroom where contentious issues in life sciences are taught through the use of educational technology is a place where there is a possibility for movement within the restricted confines of a prescribed curriculum – that is, 'it is a place where knowledge and practices can be released and set free…a sphere in which something [learning] is in play' (Masschelein & Simons, 2011, p. 158).

7.3.5 Extending Data Collection/Construction Procedures

When I began this dissertation, I read and wrote extensively on grounded theory and action research for social justice. I was very discouraged by the data collection procedures and validation methods I knew had to be used to produce authentic data. I anticipated that I would not be comfortable with analysing my journals and portfolios and those of the learners. What this dissertation has afforded me, through the use of educational technology such as Facebook, is a procedure with which data can be 'stored' (recorded) authentically and later analysed and validated. I would only refer to the Facebook screen shots to continuously derive new meanings I happened to construct from the learner discussions posted with date, time and name of the learner. I felt that a more credible and authentic form of data collection had emerged through the use of Facebook. And, as a credible form of validation, I could constantly refer to the Facebook discussions and even respond to comments of the learners in an effort to acquire their legitimate responses. That is, validation took a different form through my constant reference to the Facebook screen shots. It therefore is recommended that the literature on action research be revisited and that new forms of technologically assisted data construction be implemented. Facebook screen shots are taken in real time with time and date and one can always refer to the data generated through the screen shots without unnecessarily (at times) being accused of fabricating data. Likewise, the screen shots enable one to construct meanings from the direct messages of participants without having to listen to often lengthy recordings and transcriptions which are time-consuming to generate. Similarly screenshots are representative of participants' journals and do not have to be hindered by availability and time. Learners and educators, when online, collectively generate their data that will automatically be saved. And, validation can easily be done by merely referring to the site.

7.4 Limitations

Although this action research study can be considered as a momentary disruption of the performative pedagogic activities in the form of assessments, examinations and high achievements into which learners are initiated throughout most of their schooling, it would not be entirely correct to assume that they would now become transformative agents who wish to break away from the traditional expectations of schooling. Most of the learners in this study acknowledged that their experiences were very positive. However, whether their learning would remain rhizomatic remains to be seen. In other words, this study offers a temporary rupture in the order of their learning, but it cannot be used as some form of generalisation that the same would be the case in their future learning. The learners are still dictated to by a prescribed curriculum, authoritarian educators, and an overwhelmingly disciplinary school context. Following Deleuze and Guattari's (1987) position on societies of control, however, which they assert are made possible through new media (like Facebook), learners are least likely to resist how they are controlled by new media – that is, they embrace it without resistance. But their use of Facebook simultaneously 'also [makes] top-down communication and the structures associated with it, if not impossible, then at least increasingly difficult' (Conley, 2009, p. 40). In other words, learners are likely to remain controlled by current instances of pedagogical domination, such as examinations and assessments, but by using educational technology (with its new forms of control) to support their learning, they, and educators, will at least be connected in many ways to a continued possibility of escape. As confirmed by Conley (2009, p. 43), educational technology can enable learners 'to occupy time and space in novel ways…[to] resist the dominant strategies creatively and to experiment with myriad rhizomatic connections'.

In addition, having bombarded the Facebook group site with endless comments, the learners actually overloaded the site with a plethora of information and ideas that did not always invite favourable responses from other learners. Not all the learners were happy to go through all the comments on the Facebook group site, and they often were discouraged by the sheer volume of information on the site, which at times seemed trivial and unrelated to the contentious issues in life sciences that were under investigation. Furthermore, anonymity could not always be maintained, as the Facebook screen shots reveal the identities and photographs of the participants (the learners and me). This can be an ethical dilemma as the identities of participants are instantly revealed. However, with the establishment of trust and mutual understanding amongst educators and learners, the dilemma of disclosing participants' identities can be circumvented through agreement not to open the Facebook site to the broader public.

7.5 Summary

This action research study open up many possibilities for the learners and me to engage deliberatively and autonomously as equals in the learning and teaching process. Through the use of educational technology, teaching and learning became profoundly participatory and engaging; autonomous and rhizomatic; and equal and amateurish. I have no doubt that the teaching and learning school science, more specifically life sciences, through the application of educational technology can become democratic, as educational technology creates possibilities to bring learners and educators into a pedagogic space of play and attentiveness. In essence, using educational technology invariably has the potential to democratise science teaching and learning. This is so because the use of educational technology offers creative and unprecedented possibilities for teaching and learning in the science classroom – that is, possibilities that can further enhance educational research for social justice.

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Appendices

Appendix I: Approval by the Western Cape Education Department

WESTERN CAPE
Education Department
Provincial Government of the Western Cape

RESEARCH

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Private Bag X9114, Cape Town, 8000
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REFERENCE: 20120104-0013

ENQUIRIES: Dr A T Wyngaard

Mr Faiq Waghid
Education Faculty
Department of Curriculum Studies
Stellenbosch University

Dear Faiq Waghid

RESEARCH PROPOSAL: TOWARDS THE DEMOCRATISATION OF SENIOR PHASE SCHOOL SCIENCE THROUGH THE APPLICATION OF EDUCATIONAL TECHNOLOGY

Your application to conduct the above-mentioned research in schools in the Western Cape has been approved subject to the following conditions:

1. Principals, educators and learners are under no obligation to assist you in your investigation.
2. Principals, educators, learners and schools should not be identifiable in any way from the results of the investigation.
3. You make all the arrangements concerning your investigation.
4. Educators' programmes are not to be interrupted.
5. The study is to be conducted from **16 January 2012 till 28 September 2012**.
6. No research can be conducted during the fourth term as schools are preparing and finalizing syllabi for examinations (October to December).
7. Should you wish to extend the period of your survey, please contact Dr A.T. Wyngaard at the contact numbers above quoting the reference number.
8. A photocopy of this letter is submitted to the principal where the intended research is to be conducted.
9. Your research will be limited to the list of schools as forwarded to the Western Cape Education Department.
10. A brief summary of the content, findings and recommendations is provided to the Director: Research Services.
11. The Department receives a copy of the completed report/dissertation/thesis addressed to:

The Director: Research Services
Western Cape Education Department
Private Bag X9114
CAPE TOWN
8000

We wish you success in your research.

Kind regards.
Signed: Audrey T Wyngaard
for: **HEAD: EDUCATION**
DATE: 04 January 2012

Appendix II: Institutional Ethical Clearance

Addendum 2

DEPARTMENTAL ETHICS SCREENING COMMITTEE (DESC)

CHECKLIST

Implementation date: 1 January 2012

Preamble to the Checklist

Researchers, supervisors and departmental chairs have the primary responsibility to ensure that research conducted in their respective disciplines is characterized by methodological rigour and complies with the guidelines of relevant professional bodies and scientific organizations, as well as relevant legislation, institutional, national and international ethics guidelines.

All research in which humans, institutions, organizations or communities/groups are involved must be screened by Departments. The departmental processes for the ethics screening of research proposals should be integrated with the process of approving research proposals in terms of their scientific integrity and rigour. This means that the Departmental Ethics Checklist for the ethics screening of a research project should be considered in the same process as the approval of the research proposal.

The checklist serves as a heuristic (i.e. a guideline) to assist the researcher in evaluating the potential ethical risks associated with the research. The emphasis should be primarily on an honest and critical reflection on, and deliberation about the risk of unjustifiably impacting negatively on the research participants and other stakeholders involved in the research, and not on the completion of the checklist as a mere bureaucratic necessity.

To record that all research proposals in which humans, institutions, organizations or communities/groups are involved have been screened in ethical terms, the Departmental Ethics Checklist must be completed in a manner that attests to the fact that the researcher (and, if applicable, the Departmental Ethics Screening Committee (DESC)) has diligently reflected on the matter.

Process notes:

- All submissions to the Research Ethics Committee must be accompanied by a fully completed Departmental Ethics Checklist. The departmental screening process is where the ethics review process starts.
- When medium or high ethical risk research is referred to the Research Ethics Committee for review, it is important to share the DESC's assessment, experience and wisdom about avoiding or mitigating ethical risks with the Research Ethics Committee. Please record which ethical risks are related to the medium or high ethical risk research, and what should be done to avoid or mitigate these ethical risks on the last page of the Departmental Ethics Checklist, or on a separate page, and indicate in a note to the Research Ethics Committee exactly for what ethics clearance is requested.
- Departments should have a short turn-around time in the processing of Departmental Ethics Checklists, following a time schedule that is well-coordinated with the submission of applications to the Research Ethics Committee.
- Departments are encouraged to involve researchers, supervisors and promoters in the deliberations and/or feedback of the DESC with a view to promote awareness, insight, and opportunities for the discussion of ethical issues related to research.

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DEPARTMENTAL ETHICS SCREENING COMMITTEE (DESC) CHECKLIST (DATA COLLECTION) To be prepared by the researcher (student researcher in consultation with supervisor/promoter) and attached to the actual research proposal, and submitted to your Departmental Chair				
Name of researcher: Mr Faiq Waghid				
Department of Researcher: Curriculum Studies				
Title of research project: TOWARDS THE DEMOCRATISATION OF SENIOR PHASE SCHOOL SCIENCE THROUGH THE APPLICATION OF EDUCATIONAL TECHNOLOGY				
If a registered SU student, degree programme: PhD				
SU staff or student number: 13809709				
Supervisor/promoter (if applicable): Prof. L.L.L. le Grange				
ETHICAL CONSIDERATIONS	**Yes**	**NS***	**No**	**ACTION REQUIRED**
1. Familiarity with ethical codes of conduct				
As researcher I have familiarised myself with the professional code(s) of ethics and guidelines for ethically responsible research relevant to my field of study as specified in the list herewith attached, AND the 'Framework policy for the assurance and promotion of ethically accountable research at Stellenbosch University'	X			If YES: Continue with the checklist. If NS/NO: Researcher must do so before proceeding.
2. The proposed research: (Go through the whole of Section 2)				
a) Involves gathering information directly from human subjects (individuals or groups) (e.g. by means of questionnaires, interviews, observation of subjects or working with personal data)	**Yes** X	**NS**	**No****	If YES: Continue with the checklist. If NO: This checklist process does not apply to the proposed research, except if 2 (b) applies.
b) Involves gathering information directly from companies, corporations, organisations, NGOs, government departments etc. that <u>is not</u> available in the public domain		X		If YES: Continue with the checklist. If NO: This checklist process does not apply to the proposed research.
c) Is linked to or part of a bio-medical research project			X	If YES/NS: REC clearance may be required. DESC needs to decide.
d) Involves gathering of information without consent/assent, i.e. will be conducted without the knowledge of the subjects of/participants in the research			X	If YES/NS: REC clearance may be required. DESC needs to decide.
e) Involves collection of identifiable information about people from available records/archival material to be collected on individuals/groups/lists with personal information			X	If YES/NS: REC clearance may be required. DESC needs to decide.

* NS = Not sure/Don't know

** Please note: If the "No" option is selected it does not nullify the responsibility that rests on the researcher to ensure that ethical research practices are followed throughout the research process. The onus rests on the researcher to ensure that, should any ethical issues arise throughout the research process, the necessary steps are taken to minimise and report these risks to the supervisor/promoter of the study (where relevant), the Departmental Chair , and the REC. Furthermore: If the "No" option is chosen it does not absolve the researcher to seriously consider the possible risk that the research can in some way wrongfully disadvantage research participants and/or stakeholders or deny them fundamental rights.

3. The proposed research involves the gathering of information from people in the following categories:				
a) Minors (persons under 18 years of age)	**Yes** X	**NS**	**No**	If YES/NS for any of these categories (a-f): REC clearance may be required. The DESC must screen the proposal/project and must refer it to the REC if the ethical risk is assessed as medium or high. Then continue with the checklist. If NO for all of these categories: Continue with the checklist.
b) People with disabilities			X	
c) People living with/affected by HIV/AIDS			X	
d) Prisoners			X	
e) Other category deemed vulnerable; SPECIFY here: [See Glossary of SOP for definitions.]			Grade 10 LEARNERS	
f) Stellenbosch University staff, students or alumni	**Yes**	**NS**	**No** X	If YES/NS: REC clearance must be obtained. Complete Checklist and submit to DESC. If NO: Continue with the checklist.
4. Assessment of risk of potential harm as result of research (tick ONE appropriate YES or NS box)				
a) **Minimal risk** (for a classification of risk types, and definition, see Glossary and Addendum 3 in REC SOP)	**Yes** X	**NS**	**No**	If YES: Established ethical standards apply. Proceed to 5, 6 and 7 and completion of checklist. If NO/NS: Proceed to 4b).
b) **Low risk** (for a classification of risk types, and definition, see Glossary and Addendum 3 in REC SOP)	**Yes**	**NS**	**No**	If YES/NS: Established ethical standards apply; researcher/ supervisor/promoter must refer the project to the DESC for further guidance. Proceed to 5, 6 and 7 and completion of checklist. If NO: Continue with the checklist.
c) **Medium risk** (for a classification of risk types, and definition, see Glossary and Addendum 3 in REC SOP)	**Yes**	**NS**	**No**	If YES/NS: REC clearance must be obtained; the research project must be referred to the REC. Proceed to 5, 6 and 7 and completion of checklist. If NO: continue with the checklist.
d) **High risk** (for a classification of risk types, and definition, see Glossary and Addendum 3 in REC SOP)	**Yes**	**NS**	**No**	If YES/NS: REC clearance must be obtained; the research project must be referred to the REC. Proceed to 5, 6 and 7 and completion of checklist. If NO: Continue with the checklist.

5. The proposed research involves processes regarding the selection of participants in the following categories:				
a) Participants that are subordinate to the person doing the recruitment for the study	**Yes**	**NS**	**No** X	If YES: REC clearance may be required. The DESC must assess and advise. If NO: Continue with the checklist.
b) Third parties are indirectly involved because of the person being studied (e.g. family members of HIV patients, parents or guardians of minors, friends)	**Yes**	**NS**	**No** X	If YES: REC clearance may be required. The DESC must assess and advise. If NO: Continue with the checklist.

6. Steps to ensure established ethical standards are applied (regardless of risk assessment)				
a) **Informed consent**: Appropriate provision has been/will be made for this (either written or oral)	**Yes** X	**NS**	**No**	If YES: Develop & apply protocols and clear with DESC. Continue with checklist. If NS/NO: Attach justification & refer proposal to DESC for further assessment and advice.
b) **Voluntary participation:** Respondents/informants will be informed, inter alia, they have the right to refuse to answer questions and to withdraw from participation at any time	X			
c) **Privacy**: Steps will be taken to ensure personal data of informants will be secured from improper access	X			
d) **Confidentiality and anonymity:** Confidentiality of information and anonymity of respondents/informants will be maintained unless explicitly waived by respondent.	X			
e) **Training:** research assistants/ fieldworkers will be used to collect data, and ethics awareness will be included in their training			X	
f) **Mitigation of potential risk**: Likelihood that mitigation of risk of harm to participants is required is medium/high, and appropriate steps have been/will be taken (e.g. referral for counselling)	**Yes**	**NS**	**No** X	If YES/NS: Develop protocols for submission to DESC. Continue with checklist. If NO: Proceed with checklist.
g) **Access:** Institutional permission is required to gain access to participants and has been/will be secured. Specify here from whom: [If the permission letter required is available, submit it to the DESC. If it is not available, apply for it immediately and indicate to the DESC when it will be expected.]	**Yes** SPHS WCED	**NS**	**No**	If YES: Develop application for authorisation, clear with DESC & apply. Continue with checklist. If NS: Refer proposal to DESC for assessment and advice. Continue to 6 (h). If NO: Proceed to 6 (h).
h) **Accountability research***: Institutional permission to gain access to participants poses an obstacle to conduct the research.	**Yes**	**NS**	**No** X	If YES/NS: Refer proposal to DESC for assessment and advice. Continue with checklist. If NO: continue with checklist.
i) **Public availability of instruments to gather data**: [When applicable] Are the instruments that will be used to gather data available in the public domain?	**Yes** X	**NS**	**No**	If YES or not applicable: proceed with checklist. If NS/NO: Obtain permission to use the instrument(s) and submit letters of permission with the proposal to DESC for assessment and advice Continue with checklist..
j) **Use of psychological tests**: [When applicable] Are the instruments that will be used to gather data classified by law as psychological tests?	**Yes**	**NS**	**No** X	If YES/NS: Indicate who will administer these tests, and whether they are appropriately registered and adequately trained to do so. Provide registration number and professional body. Continue with checklist. If NO or not applicable: Proceed with checklist.
k) **Protecting data from unauthorised access**: Are appropriate measures in place to protect data from	**Yes**	**NS**	**No**	If YES: Specify and proceed with checklist.

unauthorized access? If yes, specify what the measures are:	X PC IN PERSONAL POSSESSION			If NO/NS: Develop and put in place appropriate measures. Continue with checklist.

l) **Unexpected information**: If unexpected, unsolicited data is revealed during the process of research, data will be kept confidential and will only be revealed if required by law.	**Yes** X	**NS**	**No**	If YES: Proceed with checklist. If NO/NS: Consult on this matter with DESC. Continue with checklist.
m) **Emergency situations**: If an unexpected emergency situation is revealed during the research, whether it is caused by my research or not, it will immediately be reported to my supervisor/promoter and Departmental Chair for further advice.	**Yes** X	**NS**	**No**	If YES: Proceed with checklist. If NO/NS: Consult on this matter with DESC. Continue with checklist.
n) **Permission to use archival data**: [When applicable] Is permission granted from the custodian of the archive to use it.	**Yes**	**NS**	**No** NOT APPLICABLE	If YES: Proceed with checklist. If NO/NS: Consult on this matter with DESC. Continue with checklist.
o) **The archive itself does not pose problems**: [When applicable] The initial conditions under which the archive originated allow you as a third party researcher to use the material in the archive.	**Yes**	**NS**	**No** NOT APPLICABLE	If YES, proceed with checklist. If NO/NS: Consult on this matter with DESC. Continue with checklist.
7. Conflict of interest				
Is the researcher aware of any actual or potential conflict of interest in his/her proceeding with this research?	**Yes**	**NS**	**No** X	If YES/NS: Identify concerns, attach details of steps to manage them, and refer to DESC for assessment and advice. If NO: No further action required, except signing the declaration and the checklist, and submitting it to the DESC with supporting documentation.

DECLARATION BY RESEARCHER:
I hereby declare that I will conduct my research in compliance with the professional code(s) of ethics and guidelines for ethically responsible research relevant to my field of study as specified in the list herewith attached, AND the 'Framework policy for the assurance and promotion of ethically accountable research at Stellenbosch University', even if my research poses minimal or low ethical risk.

FAIQ WAGHID	
Print name of Researcher	**Signature of Researcher**
Date **15 DECEMBER 2011**	

PROFESSOR LESLEY LE GRANGE	
Print name of Supervisor	**Signature of Supervisor**
Date	

DECISION OF DESC

Referral to Research Ethics Committee: Yes / No
[In the case of a referral to the RESEARCH ETHICS COMMITTEE, this checklist and its supporting documentation should be submitted, as well as the full application for ethics review, together with its supporting documentation, avoiding unnecessary duplication of documentation. Also list the ethical risks that are related to the research proposal that is submitted for review, together with the DESC's proposals to avoid or mitigate these ethical risks. Clearly indicate in a note exactly what ethical clearance is requested for.]]

If no referral is required, state any DESC conditions/stipulations subject to which the research may proceed (on separate page if space below is too limited): *[Or stretch table below if required]*

Any ethical issues that need to be highlighted?	Why are these issues important?	What must/could be done to minimize the ethical risk?

Print name of Departmental Chair	**Signature of Departmental Chair**
Date	

Print name of second member of DESC	**Signature of second member of DESC**
Date	

DOCUMENTS TO BE PROPERLY FILED IN THE DEPARTMENT AND (E-)COPIES SEND TO SU RESEARCH ETHICS COMMITTEE OFFICE. ON RECEIPT OF THIS COPY, THE RESEARCH ETHICS COMMITTEE SECRETARIAT WILL ISSUE A RESEARCH ETHICS COMMITTEE REGISTRATION NUMBER.

Note: Departments are requested to provide staff members and students with a list of professional Code(s) of ethics and guidelines for ethically responsible research relevant to their field of study on which they can indicate by signature that they have familiarised themselves with it. The last item in the list should be the 'Framework policy for the assurance and promotion of ethically accountable research at Stellenbosch University'.
With thanks to the Department of Sociology and Social Anthropology, Stellenbosch University of the initial concept.

Appendix III: Application to Pursue Research at the School

6 December 2011

The Principal
South Peninsula High School

Dear Mr Isaacs

I am reading towards my doctorate in education at Stellenbosch University. My research aims to make a contribution towards democratising a grade 10 science class's pedagogical activities through the use of technology.

The research will encompass the following: (1) the use of the school science classroom; and (2) the use of twenty-six grade 10 learners in 2012 and 2013.

The questionnaires and interviews will be conducted within the parameters of ethics as described by the Western Cape Education Department and Stellenbosch University.

My promoter for this research is Professor Lesley Le Grange (Vice-Dean: Research) of the Faculty of Education.

I would like, if possible, to obtain permission to do this action research study at the school and through the social media network of Facebook. A copy of my research proposal is attached for your consideration.

Yours faithfully

Faiq Waghid

South Peninsula High School

Old Kendal Road, Diep River 7945
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"Not to be served, but to serve"

3 January 2012

Mr Faiq Waghid
12 Pintail Crescent
ZEEKOEVLEI
7941

Dear Mr Waghid

RESEARCH PROJECT: TOWARDS THE DEMOCRATISATION OF SENIOR PHASE SCHOOL SCIENCE THROUGH THE APPLICATION OF EDUCATIONAL TECHNOLOGY

On behalf of the Governing Body of South Peninsula High School I hereby notifying you that your application to do the aforementioned action research project with the Grade 10 learners has been approved.

We trust that this project would contribute towards improving teaching at learning at the school and
look forward to your doctoral dissertation being successfully completed.

Yours sincerely

Bezuidenhout

MRS J. BEZUIDENHOUT.
Secretary of SGB

SOUTH PENINSULA HIGH SCHOOL
OLD KENDAL ROAD
DIEP RIVER
7800

Appendix IV: Life Sciences Questionnaire

Life Sciences Questionnaire

Teacher:	Faiq Waghid	Name:	
Class:		Date:	
Period:		Results:	

Instructions

Please read the following questions carefully. Where more than one option is listed, please circle the letter ONLY of the option appropriate to you. More than one option may be circled where appropriate.

Gender

1) _____

a. Male

b. Female

Home Language

2) _____

a. English

b. Afrikaans

c. Both

d. Other

In which area do you live in the Southern Suburbs?

3) _____

a. Mitchell's Plain / Strandfontein

b. Grassy Park / Lotus River

c. Zeekoevlei

d. Retreat/ Muizenberg

e. Wynberg / Kenilworth

f. Plumstead / Fairways / Diep River

g. Other

Do you own a cell phone?

4) _____

a. Yes

b. No

Which brand of cell phone do you own?

5) _____

a. Nokia

b. BlackBerry

c. Sony/LG/Apple/Android

d. Apple

e. Not applicable

Do you know how to use a computer and a cell phone?

6) _____

a. Yes

b. No

What forms of social media do you prefer to use?

7) _____

a. Facebook

b. Twitter

c. BBM

d. Other

e. Don’t make use of social media

If you do not make use of social media, why not?

8) _____

a. Don't find social media useful

b. Don't understand how to use social media

c. Waste of time

d. Privacy concern over social media

e. Not applicable

Do you use social media on your cell phone?

9) _____

_____

a. Yes

b. No

c. Not applicable

10) _____ **Do you communicate with ALL your classmates via social media?**

a. Yes

b. No

c. Not applicable

Have you participated in a group discussion using the Internet or social media?

11) _____

a. Yes

b. No

c. Not applicable

How often do you use forms of social media?

12) _____

a. Every day

b. Weekly

c. Monthly

d. Seldom

e. Not applicable

13) _____ **Do you have a computer at home?**

a. Yes

b. No

Where do you access the Internet?

14) _____

a. Home

b. School

c. Friend's house

d. Cell phone

e. No internet access

How long have you been using social media?

15) _____

a. 1 year

b. 2 years

c. 3 years

d. More than 3 years

e. Not applicable

Who made you aware of social media?

16) _____

a. Teacher

b. Friend

c. Other

What do you use the Internet for?

17) _____

a. Recreation

b. Work

c. All of the above

d. None of the above

Do you like to work in groups?

18) _____

a. Yes

b. No

c. Unsure

Do you feel your opinion is valued in group activities?

19) _____

a. Yes

b. No

If not, why?

20) _____

....
....
....
....
....
....

Do you value opinions or viewpoints of others in group activities?

21) _____

a. Yes

b. No

If not, why?

22) _____

....
....
....
....
....
....

Do you know what a democracy is?

23) _____

a. Yes

b. No

Do you think classroom practices are democratic?

24) _____

a. Yes

b. No

c. Unsure

Do you feel your teachers should use technology in the classroom?

25) _____

a. Yes

b. No

c. Unsure

What ideas do you have regarding technology use in your school?

26) _____

………..

How do you feel about the audio-visual equipment available for your classroom?

27) _____

a. Bad

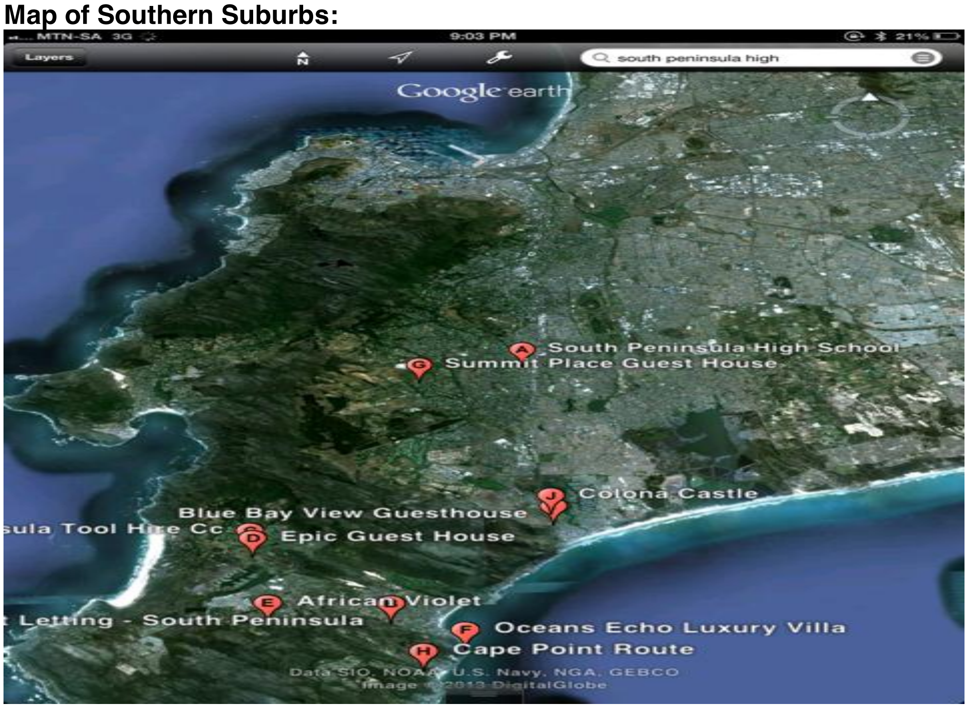
b. Very bad

c. Okay

d. Good

e. Excellent

Map of Southern Suburbs:



Appendix V: Action Research Cycles

Action research cycles	**Action research**	**Purposes for studying life sciences in grade 10**	**Specific goals for learners**	**Action research**	**Classroom observations: Actual teaching and learning**
Cycle 1: Biotechnology, Animal cloning – People for [valuable for medical research] and people against [can recreate human embryos] Strand 1	Identify, justify and motivate the problem	Development of scientific knowledge and understanding	(1) Active participation; (2) Apply scientific content to everyday life through economic activity and self-expression	Data gathering technique (observe, discuss & record) Take action, monitor and gain evidence Analyse, articulate and modify	
		Development of science process skills	(1) Demonstrate creativity; (2) Show confidence through synthesis, reflection and communication	Data gathering technique (observe, discuss & record) Take action, monitor and gain evidence Analyse, articulate and modify	
		Development of an understanding of science and society	(1) Demonstrate understanding of the relationship between life sciences and other subjects; (2) Promote science as a human activity; (3) Show an inclination towards societal development and social	Data gathering technique (observe, discuss & record) Take action, monitor and gain evidence Analyse, articulate and modify	

			justice; (4) Understand ethical issues of society and environment		

Action research cycles	**Action research**	**Purposes for studying life sciences in grade 10**	**Specific goals for learners**	**Action research**	**Classroom observations: Actual teaching and learning**
Cycle 2: Evolution, origin of life [fossils to prove that life originated from water] Strand 4	Identify, justify and motivate the problem	Development of scientific knowledge and understanding	(3) Active participation; (4) Apply scientific content to everyday life through economic activity and self-expression	Data gathering technique (observe, discuss & record) Take action, monitor and gain evidence Analyse, articulate and modify	
		Development of science process skills	(3) Demonstrate creativity; (4) Show confidence through synthesis, reflection and communication	Data gathering technique (observe, discuss & record) Take action, monitor and gain evidence Analyse, articulate and modify	
		Development of an understanding of science and society	(5) Demonstrate understanding of the relationship between life sciences and other subjects; (6) Promote science as a human activity; (7) Show an inclination towards societal development and social	Data gathering technique (observe, discuss & record) Take action, monitor and gain evidence Analyse, articulate and modify	

			justice; (8) Understand ethical issues of society and environment		

Action research cycles	**Action research**	**Purposes for studying life sciences in grade 10**	**Specific goals for learners**	**Action research**	**Classroom observations: Actual teaching and learning**
Cycle 3: Global warming, greenhouse effect, gas emissions Strand 3	Identify, justify and motivate the problem	Development of scientific knowledge and understanding	(5) Active participation; (6) Apply scientific content to everyday life through economic activity and self-expression	Data gathering technique (observe, discuss & record) Take action, monitor and gain evidence Analyse, articulate and modify	
		Development of science process skills	(5) Demonstrate creativity; (6) Show confidence through synthesis, reflection and communication	Data gathering technique (observe, discuss & record) Take action, monitor and gain evidence Analyse, articulate and modify	
		Development of an understanding of science and society	(9) Demonstrate understanding of the relationship between life sciences and other subjects; (10) Promote science as a human activity; (11) Show an inclination towards societal development and social justice; (12) Understand ethical issues of society and environment	Data gathering technique (observe, discuss & record) Take action, monitor and gain evidence Analyse, articulate and modify	

*Action research cycle: (a) Identify, justify and motivate the problem; (b) Use data gathering techniques (c) Take action (with educational technology), monitor and gain evidence; and (d) Analyse, articulate and modify

Appendix VI: Learner Transcripts

[redacted]

I, the undersigned, hereby agree to participate in this action research project about the democratisation of science education in school and also concur that the responses listed below are accurate and represent my views as per interview.

I also give consent to the researcher, Faiq Waghid, that my first name be mentioned in the doctoral research dissertation – 'Towards the democratisation of senior phase school science through the application of educational technology'.

Signature: [redacted]

Date: 23 October 2012

Questions

1. Do you think that you have engaged and collaborated with other learners in relation to the three contentious issues under investigation?

Respondent: Yes I have…I mean interval my group and I would sit down and talk about it and ask for their opinions and insight into these topics. Especially the evolution and creationism were like maybe a main one for us because it really make you think like is our religion really true…for cloning it was ok and we could watch movies on cloning, maybe it's not that bad and for global warming its bad and stuff but yeah it's not like we really interested in it.

Interviewer: So in other words the learning was not confined to the class, you actually took learning into your intervals without even using the Facebook group?

Respondent: Yes, because we didn't think it was just a class activity, we thought it would be better for us to speak about it, coz in class you can't really say what you want to say.

Interviewer: Why do you feel that you can't say what you want to say in class?

Respondent: You might like hurt someone or maybe they will think that you are targeting them, so it better if you do it with friends and you are more comfortable.

Interviewer: How do you feel Facebook actually addressed that problem then?

Respondent: I mean with Facebook, I thought that was a good idea, like you get to see other people's ideas coz they won't like say that to you in person, because you feel more protected that you can just write it down and people can look and attack you for what you did.

Interviewer: So would you then say it allows you to articulate yourself better?

Respondent: Yes, I was like you can think hard, I didn't like want to sound maybe stupid so here you can think hard about it and also think about what you going to say when someone tries to like attack or anything.

Interviewer: Did you feel also that you were going to be under attack?

Respondent: In a way yes, people have different views so if you maybe say think then they would say I don't agree with you… I'm not going to keep quiet.

Interviewer: So therefore do you feel it was better for you to use Facebook?

Respondent: It was better, coz just think in a class discussion not everyone is going to want to say something and you won't actually have your chance to speak without being disturbed or interrupted.

Interviewer: So you are also not confined to time?

Respondent: Yes, because you can do it in your own time and everything.

2. Did you apply critical thinking in addressing the contentious issues? Explain.

Respondent: Hmm…I don't think so…it may be upsetting, letting other people's views in, because maybe they are right.

Interviewer: I know with regard to evolution you all had different points of view and how it relates to evolution, many of you were willing to listen to others but you didn't really want to change your point of view as it related to your personal beliefs. Do you therefore feel that you were critical in your thinking thus?

Respondent: I was speaking to my friend and we were like we believe in microevolution I mean that we accept but with macroevolution, no!

Interviewer: So in that way you did actually change your perception with regard to microevolution because you now believe in microevolution?

Respondent: In the beginning I was like no, but after I spoke to father and heard what he said about microevolution I started to believe in what he said about microevolution

3. Do you have a better awareness of societal issues in relation to science?

Respondent: Yes, I think like I wouldn't have really thought about it if you didn't talk about it so I think it was good that we did it on these three topics, because it's good to make us aware and like be blank when they ask for your opinion. I think I owe it to myself now to look in more depth.

4. How have you developed as a learner now that you have participated with other learners through Facebook?

Respondent: I think I am now open to other opinions, before I was like don't tell me but now that everybody has similar opinions…I am more open.

Interviewer: So you think Facebook is in that way a safety cushion?

Respondent: Yeah, because now they won't like give you dirty looks if you like says something, like there is no tension.

5. What do you think about the role I have played in your learning and would you say that learning has been democratised? Explain.

Respondent: Sir I think like sir played like a big role not many teachers do this like open learning into social learning which is like nice so I think sir has made like a mark in that there are other *ways of being taught and I think sir has played a big role compared to other teachers that will speak to us like till like after matric.*

Interviewer: So now that you have participated in a discussion on Facebook you will be able to participate better in class discussions?

Respondent: Yes, I think it made us more confident now that we know everyone and some people think similar and that they won't be rude or anything so I think it boosts our confidence, like we know the people in class better and we can communicate better.

Interviewer: Is there anything else that you would like to add?

Respondent: I think it was a really good experience, this is the first time we actually did it and it's good to know that teachers sometimes….They think about us all the time but now you have actually taken it put into action about helping us and exposing our minds to better learning and techniques of learning.

[redacted]

I, the undersigned, hereby agree to participate in this action research project about the democratisation of science education in school and also concur that the responses listed below are accurate and represent my views as per interview.

I also give consent to the researcher, Faiq Waghid, that my first name be mentioned in the doctoral research dissertation – 'Towards the democratisation of senior phase school science through the application of educational technology'.

Signature: [redacted]

Date: 24 October 2012

Questions

1. Do you think that you have engaged and collaborated with other learners in relation to the three contentious issues under investigation?

Respondent: The first issue was the cloning, I didn't take part in that one, but the global warming, I did take part in, I read most of the comments and I made my own comments, also the points that they had were similar and some were different, so I took both into consideration with regard to global. And I said even though some people say they are against and some people say they are for, I was both because there is no proven fact that there really is global warming but if there is we shouldn't think there is nothing we can do about it. That was my point of view.

Interviewer: Why did you not participate in the first Facebook discussion?

Respondent: I didn't watch the video.

Interviewer: Was there a problem downloading the video?

Respondent: Yes, but when I went on Facebook I read the comments, but I didn't make my own comments.

Interviewer: So you didn't participate because you felt you weren't properly prepared?

Respondent: Yes.

2. Did you apply critical thinking in addressing the contentious issues? Explain.

Respondent: Yes I do, because there is….Like you said there is no right or wrong answer and that your answer is taken to another deeper level, so when I read the comments what people had to say…took it from both sides, because there was no right or wrong, so also with the evolution, most people said they believe in creationism because of their religion, but there was one or two in evolution because they say science is fact. Now with that I went deeper and I said the bible is fact and has been dated I also made the comment on Facebook that it was dated in the bible of the stories and how it was made, but evolution has been in there *somewhere, but I'm more for creationism and because of the start of it and scientist have proven all of it.*

Interviewer: Do you think you have a better understanding of the concept of evolution?

Respondent: Yes, I understand it way better now.

3. Do you have a better awareness of societal issues in relation to science?

Respondent: Yes I do because with global warming I must say I didn't know what it was about, but now that we have discussed it and the learners have said their point of view I understand it way better and the consequences of global warming way better, so yes it has taught me a better awareness and has influenced me because I had no idea and wasn't concerned, but now I am. Also with evolution I learnt to respect what their opinions was like maybe before I would have said no, creationism. And how can you believe in evolution, but now with both points I have a better understanding.

4. How have you developed as a learner now that you have participated with other learners through Facebook?

Respondent: I have developed a lot as a learner coz nobody in your class it would just be a one on one thing, like when the teacher speaks everyone must just understand, but I would say with the Facebook thing you get to hear everyone's point of view and see that everybody does have. Like when you look around the class you say oh no he doesn't think that, you just judge them, now with Facebook you see that the actually have a point of view and it's good to see what they actually have and it helps you understand as well.

5. What do you think about the role I have played in your learning and would you say that learning has been democratised? Explain.

Respondent: Yes I would the learning has been democratised because when you teach you don't only say your point of view is right, you discuss things from both points, I see that. Like when we ask you questions you don't give one point of view, so it's actually a big role because most teachers they only teach from their point of view is right, but through your understanding and what you tell us what we discuss makes us remember things more and that is where life sciences as a subjects influences more as well.

Interviewer: So your learning improves because it is more democratic and allows you to make a better meaning for yourself.

Respondent: Yes, it has affected me.

Interviewer: Anything else you would like to add?

Respondent: I would just like to say that you as a teacher that this Facebook group really do help students, and thank you for that.

[redacted]

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I also give consent to the researcher, Faiq Waghid, that my first name be mentioned in the doctoral research dissertation – 'Towards the democratisation of senior phase school science through the application of educational technology'.

Signature: [redacted]

Date: 25 October 2012

Questions

1. **Do you think that you have engaged and collaborated with other learners in relation to the three contentious issues under investigation?**

Respondent: Yes I did, I've learnt a lot about all this stuff and it gave me more like insight into things I didn't know about. I've learnt how some people think, like religion and god and all that stuff.

2. **Did you apply critical thinking in addressing the contentious issues? Explain.**

Respondent: No I don't, I have to ask someone first. I only started scrutinising once I knew what the topic was about.

3. **Do you have a better awareness of societal issues in relation to science?**

Respondent: Yes

4. **How have you developed as a learner now that you have participated with other learners through Facebook?**

Respondent: I've learnt a lot from other people's point of view.

Interviewer: So do you think Facebook is a good medium?

Respondent: Yes I think Facebook was good because everybody's comments and things were on.

Interviewer: So you feel it maximised participation?

Respondent: Yes.

5. **What do you think about the role I have played in your learning and would you say that learning has been democratised? Explain.**

Respondent: Sir has played a big role coz like there are a lot of things I wouldn't like ask in class.

[redacted]

I, the undersigned, hereby agree to participate in this action research project about the democratisation of science education in school and also concur that the responses listed below are accurate and represent my views as per interview.

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Signature: [redacted]

Date: 26 October 2012

Questions

1. **Do you think that you have engaged and collaborated with other learners in relation to the three contentious issues under investigation?**

Respondent: Yes sir I think we all gave our honest opinion and everyone respect each other's opinion and sometime we got along and agreed and sometimes we disagreed.

Interviewer: Did you construct yourself a different meaning through collaborating with other learners?

Respondent: No sir, I think we knew what we were saying and stuck to our minds.

2. **Did you apply critical thinking in addressing the contentious issues? Explain.**

Respondent: I think in a critical way and I didn't just accept what others said, I stuck what I had to say and I didn't let criticism faze me.

Interviewer: Did you maybe feel intimidated by criticism?

Respondent: Sir they all had very good ideas, you could see it was well thought out and it did make me feel intimidated at times when they didn't agree.

Interviewer: So were you open to their criticism and were you willing to change your point of view?

Respondent: Yes.

3. **Do you have a better awareness of societal issues in relation to science?**

Respondent: Yes sir, I know how cloning and global warming. How it impacts on the environment more than before.

4. **How have you developed as a learner now that you have participated with other learners through Facebook?**

Respondent: Yes sir, I don't think we would have learnt that much or go into that depth if we discussed it in the classroom or if it was written down as notes.

5. **What do you think about the role I have played in your learning and would you say that learning has been democratised? Explain.**

Respondent: Yes sir I think sir didn't let anything get out of hand on the Facebook, there was no inappropriateness, it was all kept under control and the thought of Facebook was wise.

Transcrip[redacted]

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Signature: [redacted]

Date: 29 October 2012

Questions

1. Do you think that you have engaged and collaborated with other learners in relation to the three contentious issues under investigation?

Respondent: Yes I do believe that and all of us we engaged our ideas into one. We didn't say that was not our own and we don't agree, we brought it all together and made one whole idea. We made one idea out of all our ideas. So it was like a positive aspect

2. Did you apply critical thinking in addressing the contentious issues? Explain.

Respondent: Yeah I go deeper into it because I want to know where it starts. I didn't go onto just one site. I went onto many sites and put all that information into one and one big idea.

3. Do you have a better awareness of societal issues in relation to science?

Respondent: Yes, science does help us and makes us aware of the things that you need to be aware of like global warming and how it affects with the heat and how the temperatures that we are getting.

4. How have you developed as a learner now that you have participated with other learners through Facebook?

Respondent: Yes, because all of them have different types of ideas. There are different views and types of religions and they brought it all together, you can actually see everybody is the same and also not the same in the same way.

5. What do you think about the role I have played in your learning and would you say that learning has been democratised? Explain.

Respondent: The role that sir had on Facebook was quite informing and it helps us with our views and stuff and sir actually told us if our stuff was not like researched enough and yes we were democratised.

Interviewer: Would you like to add anything else?

Respondent: I'm not in favour of this Facebook thingy, but I don't disagree with it either.

Interviewer: So why would you say you don't agree with it?

Respondent: *Not everybody can go on at the same time and when you do go on you must read all of that people's comments. So I'm saying we all have to start at the same time.*

Transcrip[redacted]

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Signature: [redacted]

Date: 30 October 2012

Questions

1. Do you think that you have engaged and collaborated with other learners in relation to the three contentious issues under investigation?

Respondent: Yes I did learn a lot, I learnt about what other people think about the contentious issues in their mind-set.

Interviewer: Do you change your own ideas?

Respondent: Yes, because I changed my point of view because I only thought my reason was right but other people also had opinions.

2. Did you apply critical thinking in addressing the contentious issues? Explain.

Respondent: No I think about other reasons and I think out of the box.

3. Do you have a better awareness of societal issues in relation to science?

Respondent: Yes I do, because we are experiencing global warming and cloning is a big issue and I don't think it is right, people don't have the right to clone people and animals but only for good purposes.

4. How have you developed as a learner now that you have participated with other learners through Facebook?

Respondent: Yes because I have a better understanding now and what other people think and their point of view. On Facebook it is more communication and discussion.

5. What do you think about the role I have played in your learning and would you say that learning has been democratised? Explain.

Respondent: You played a good role because you listened to everyone's opinion and didn't take side and you weren't biased.

Transcrip[redacted]

I, the undersigned, hereby agree to participate in this action research project about the democratisation of science education in school and also concur that the responses listed below are accurate and represent my views as per interview.

I also give consent to the researcher, Faiq Waghid, that my first name be mentioned in the doctoral research dissertation – 'Towards the democratisation of senior phase school science through the application of educational technology'.

Signature: [redacted]

Date: 31 October 2012

Questions

1. **Do you think that you have engaged and collaborated with other learners in relation to the three contentious issues under investigation?**

Respondent: Err yes and for me the students have to be face to face and you could think about the answers, you weren't timed and you could research it, the proper view.

Interviewer: So it allowed you to articulate yourself better?

Respondent: Yes.

2. **Did you apply critical thinking in addressing the contentious issues? Explain.**

Respondent: Yes, Google, because you sitting right in front of your computer you can Google everything that you not clear about and Wikipedia, it really helps you.

3. **Do you have a better awareness of societal issues in relation to science?**

Respondent: I think it helped a lot with things you were unsure about, like the way the people view their religions and their beliefs, not everyone is the same and it gave a broader perspective that you aren't alone and there are more than one religion and you have to respect it. In your daily life you won't really come face to face with someone that practices their religion, and atheist religion, they not going to walk up to you and say I'm atheist, so that gave us an opportunity to view everything and what we think about it.

4. **How have you developed as a learner now that you have participated with other learners through Facebook?**

Respondent: It's definitely easier, you are in your comfort zone, you not like when girls go out they permanently have to make there makeup right, so you comfortable and relaxed and it is easier.

5. **What do you think about the role I have played in your learning and would you say that learning has been democratised? Explain.**

Respondent: When we on Facebook we can Google things, I think my daddy told me once, like when have a headache you go on Google it would a slight headache to something like a brain tumour. We don't have the proper filter to filter the information to find out is it a brain tumour or a headache, so you are there to help with it.

Interviewer: So would you say we are democratised?

Respondent: I think it's easier but there's people that are not available to technology, so it a downside for them.

Interviewer: But the reason why we chose Facebook is because everyone in actuality has a Facebook account, so why do you think some learners wouldn't want to participate?

Respondent: Some either just didn't care or they didn't have access to the internet, some people don't, I had to wait till yesterday before I could back onto Facebook, I had to do it on my phone.

Transcrip[redacted]

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Signature: [redacted]

Date: 1 November 2012

Questions

1. **Do you think that you have engaged and collaborated with other learners in relation to the three contentious issues under investigation?**

Respondent: Yes, I got a chance to hear other people's point of view and opinions.

Interviewer: So you worked with them?

Respondent: Yes and the things I didn't understand they explained and we worked with each other.

2. **Did you apply critical thinking in addressing the contentious issues? Explain.**

Respondent: Yes and hmm, I went with an open mind, I had my opinion, I listened to other people's opinion and it did influence the way a feel.

3. **Do you have a better awareness of societal issues in relation to science?**

Respondent: Yes

4. **How have you developed as a learner now that you have participated with other learners through Facebook?**

Respondent: Yes it was better because I had a better understanding and it was easier for me understand and know what's going on, it wasn't just notes that were given. And people did research and it helped me. I preferred learning in this way because it wasn't like too much notes and too much to learn.

5. **What do you think about the role I have played in your learning and would you say that learning has been democratised? Explain.**

Respondent: I think we are and you conducted the group very well and you took comments off that hurt people's feelings and it was open and everyone could say how they felt.

Transcri[redacted]

I, the undersigned, hereby agree to participate in this action research project about the democratisation of science education in school and also concur that the responses listed below are accurate and represent my views as per interview.

I also give consent to the researcher, Faiq Waghid, that my first name be mentioned in the doctoral research dissertation – 'Towards the democratisation of senior phase school science through the application of educational technology'.

Signature: [redacted]

Date: 2 November 2012

Questions

1. **Do you think that you have engaged and collaborated with other learners in relation to the three contentious issues under investigation?**

Respondent: Hmm…yes, well the Facebook thing that definitely a new way of teaching and learning and it definitely helps us analyse everyone viewpoints and what they believe and how they were taught in different ways in relation to how they analyse the topic.

2. **Did you apply critical thinking in addressing the contentious issues? Explain.**

Respondent: Obviously because, normally when we taught something in school, I won't just like listen to what every teacher says as a fact, I will do research myself and then see how that compares. I can compare information.

3. **Do you have a better awareness of societal issues in relation to science?**

Respondent: Yes, it definitely made me more aware, how science affects the communities and how it impacts on how the communities think.

4. **How have you developed as a learner now that you have participated with other learners through Facebook?**

Respondent: Yes, I have developed, because by each one sharing their own views I was able to learn something different.

5. **What do you think about the role I have played in your learning and would you say that learning has been democratised? Explain.**

Respondent: It definitely has and your type of teaching, it doesn't conform to the norms of other teachers. With other teachers you can't really ask questions over a weekend or something and you are more interactive than most teachers. And your lessons are not as boring as say example an English lesson. I learnt a lot of things of that I didn't know about, like cloning. I didn't actually think of global warming as having an impact on society and how people live.

Transc[redacted]

I, the undersigned, hereby agree to participate in this action research project about the democratisation of science education in school and also concur that the responses listed below are accurate and represent my views as per interview.

I also give consent to the researcher, Faiq Waghid, that my first name be mentioned in the doctoral research dissertation – 'Towards the democratisation of senior phase school science through the application of educational technology'.

Signature: [redacted]

Date: 5 November 2012

Questions

1. Do you think that you have engaged and collaborated with other learners in relation to the three contentious issues under investigation?

Respondent: Yes, because it is a good way of engaging with everyone through Facebook and social networking. In a way we can all communicate share our views and opinions and sometimes learn from one another even though we don't agree with one thing we still learn. It's a better way, instead of going onto any website like Google and takes information, you actually get to share your knowledge and prior knowledge and see if other people think your opinion is worth it.

2. Did you apply critical thinking in addressing the contentious issues? Explain.

Respondent: I would use a view and my view and try to make a view out of it to get one total view.

3. Do you have a better awareness of societal issues in relation to science?

Respondent: Yes sort of.

4. How have you developed as a learner now that you have participated with other learners through Facebook?

Respondent: I think it is a future way of how to teach because everyone uses social networking on their computers and their phones. So instead of having a book in front of you and reading doesn't really sink in. It sinks in more when everyone contributes. You remember better in that way.

5. What do you think about the role I have played in your learning and would you say that learning has been democratised? Explain.

Respondent: Yes, because I didn't think any other teacher would have done that, like make a Facebook group and say let's everyone start talking about a specific topic. Other teachers would just stand there and talk.

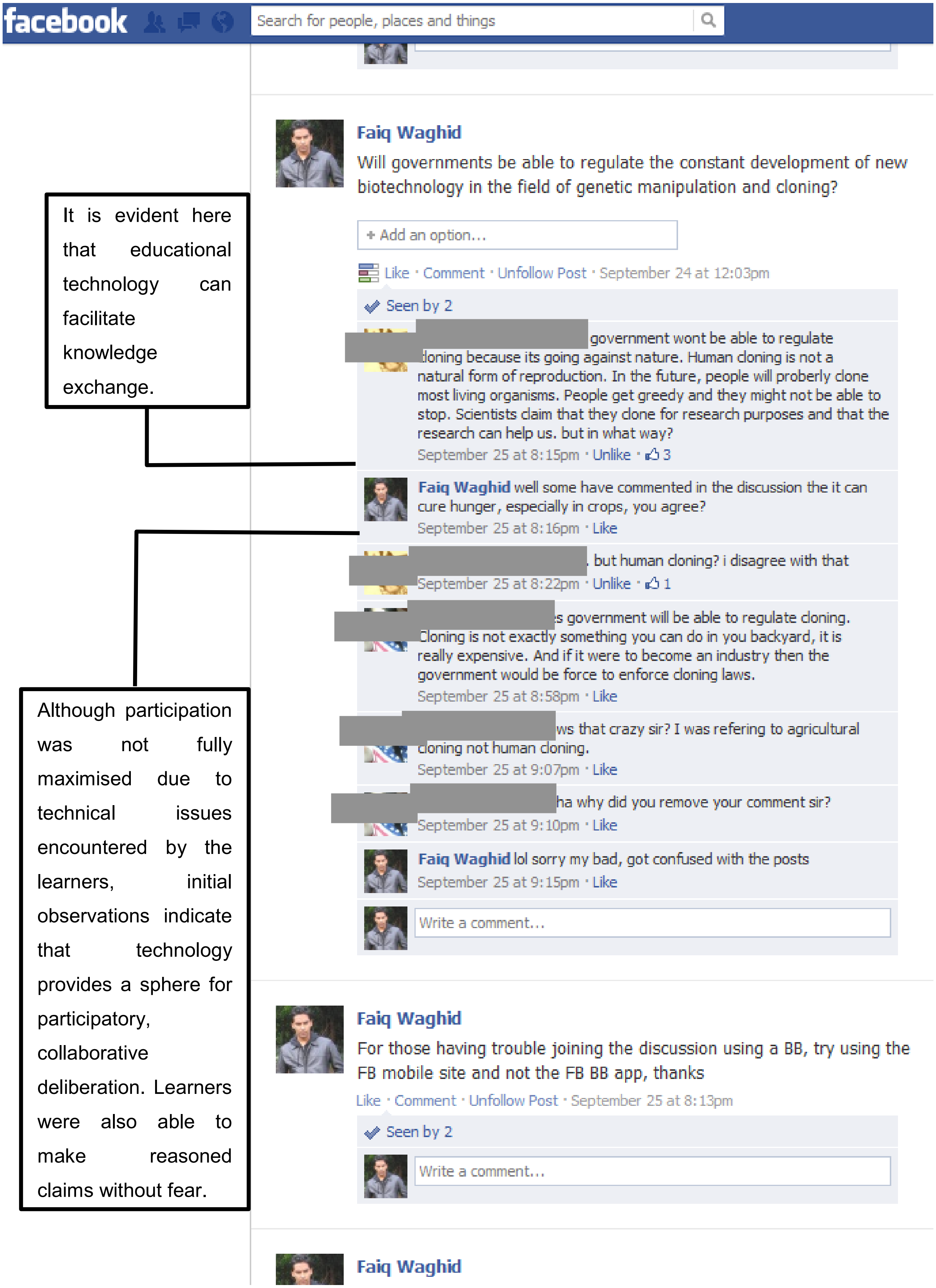
Appendix VII: Analyses of Facebook Screen Shots Cycle I

Encountered first technical issue – learners were unable to view questions posed on Facebook when using their mobile devices.

In this first action research cycle questions such as these were posed. When concluding this cycle I realised that the discussion was being driven by me in a linear manner.

Learners were able to make reasoned claims without fear. They were also able to question me, an indication of the equalisation of relationships between educator and learner.

Although only a handful of learners participated, there were indications of societal awareness and critical learning.



It is evident here that educational technology can facilitate knowledge exchange.

Although participation was not fully maximised due to technical issues encountered by the learners, initial observations indicate that technology provides a sphere for participatory, collaborative deliberation. Learners were also able to make reasoned claims without fear.

Learners slowly got into the discussion. However, in contrast to 'wall posts', I had decided to use the 'pose question' option on Facebook. However, the learners soon messaged me that their mobile devices were unable to view these questions. This therefore resulted in only learners using a computer being able to participate in the discussion.

As mentioned, when using the 'pose question' option on the Facebook group I encountered a number of problems. I then decided to use the 'post on wall' option instead, so that the learners could comment on the wall post using their mobile devices. It was evident that this educational technology provided a sphere for participatory, collaborative deliberation.

As the discussion progressed, the learners began to encounter problems with regard to the comments loading. The mobile devices did have the Internet connection speed to load the comments made by learners, a problem I would have to address.

Learners participated in the discussion by posting directly on the Facebook group wall, thus addressing the Internet connection speed issues.

Learners were able to make reasoned claims without being constrained.

Comments such as these indicate learners demonstrating critical construction of personal learning contexts, as well as societal awareness.

Comments such as these indicate learners' ability to display critical construction of learning contexts and societal awareness. Learners were able to make reasoned claims without fear.

Although the 'pose question' option did not maximise participatory, collaborative deliberation, some of the learners were still able to participate in the initial question posing. The 'pose question' option also allowed learners to aggregate their response through a vote, as indicated. Not all learners posted comments on the questions, while others contributed to the discussion by using the 'Like' option, therefore supporting a participatory, collaborative deliberation.

Learners were able to aggregate responses by 'checking' textboxes.

Comments such as these indicate technology's potential for promoting participatory, collaborative deliberation, critical construction of personal learning environments, societal awareness.

My role as an educator was merely as a moderator.

facebook Search for people, places and things

[redacted]oning is pointless because it is nearly the same as male and female reproduction. There are other alternatives to cloning regarding the making of babies and not only is it pointless but also it is messing with God's ideas and creations
September 25 at 7:28pm · Like

Faiq Waghid Yes clones of animals could all potentially die of a virus due to lack of gene diversity, good feedback
September 25 at 7:32pm · Like · 1

Faiq Waghi[redacted]t in the video they mention cloning is used alot in agriculture, potentially the fruit and veg you eat are clones, what you think of the people?
September 25 at 7:34pm · Like

[redacted]gree wi[redacted]d why would we want to clone animals on the verge of extinction I mean God has a plan and maybe this is his plan• And I really don't think that we should clone people I mean imagine the chaos that it could bring, imagine that clone doesn't like the fact that they are a clone and plots against the real one if you know what I mean, and if we clone humans we don't know what effects they might have, what if something goes wrong, there hasn't been enough research to prove that cloning is safe in any case
September 25 at 7:35pm via mobile · Unlike · 1

[redacted]ally dont think god has anything to do with this discussion because there are more good aspects to do with cloning than there are bad,cloning can solve lots of problems out there
September 25 at 7:38pm · Like

[redacted]uit and veg is the essential needs of a humans diet so it would need to be cloned so that with the amount of population in the world there is no shortage of it
September 25 at 7:39pm · Unlike · 2

Faiq Waghid We have to respect that people have different religious beliefs, I feel all the points made thus far are valid, but what if cloning can save many lives of people in drought stricken areas, wouldn't god want scientist to help these individuals?
September 25 at 7:41pm · Like · 1

[redacted]regard to human cloning the cons out weigh the pros but if you believe theres so many pros regarding human cloning then what are they?
September 25 at 7:41pm · Like

[redacted] i can say is that cloning has its goods and bads it can help with food shortages but it can cause over population in the world and as the world stands today it is already over populated
September 25 at 7:42pm · Unlike · 1

[redacted]hink you should google us the pro of cloning, lets add to this knowledge pool
September 25 at 7:43pm · Unlike · 1

[redacted]dvantages of cloning http://library.thinkquest.org/24355/data/reactions/pro.html
September 25 at 7:43pm · Unlike · 1

[redacted]oning food I agree on I mean that w help those people in need but I don't think people should be and animals cloned? I don't know about that, you don't need 'make' more animals

Participatory and collaborative learning. Critical construction in personal learning environments and societal awareness.

The nature of the Facebook comment feature is that it allows learners such as these to take note of others and consequently revise their initial conceptions.

Learners began to act critically by posting links supporting their thoughts regarding the topic.


facebook Search for people, places and things

September 25 at 7:42pm · Unlike · 1

Faiq Wagh[redacted]hink you should google us the pro of cloning, lets add to this knowledge pool
September 25 at 7:43pm · Unlike · 1

[redacted]vantages of cloning http://library.thinkquest.org/24355/data/reactions/pro.html
September 25 at 7:43pm · Unlike · 1

[redacted]loning food I agree on I mean that would help those people in need but I don't think people should be cloned and animals cloned? I don't know about that, you don't need cloning to 'make' more animals
September 25 at 7:44pm via mobile · Unlike · 2

Faiq Waghid Nice one jade, lets back post some more links and ideas of others, ask your classmates to join in this ongoing discussion.
September 25 at 7:45pm · Like · 1

[redacted]pically your ocean basket fish are [redacted]el knowing you are eating clones?
September 25 at 7:47pm · Like · 1

[redacted]tp://learn.genetics.utah.edu/content/tech/cloning/whatiscloning/
September 25 at 7:48pm · Like

Faiq Waghid nice jade now we getting somewhere
September 25 at 7:50pm · Like · 1

[redacted]hile all those pros are infact valid, one cannot dismiss ethics. Is it ethical to be cloning? As for fertilisation, in-vitro fertilisation may not be as effective as cloning but if that doesn't work, is their not too many orphaned children needing homes?
September 25 at 7:51pm · Like

[redacted]is is an article on both the pro's and con's and some interesting facts on the cloning process http://thefarnsworths.com/science/cloning.htm
September 25 at 7:51pm · Like

[redacted]hink I'd prefer not to know I'm eating a clone of a fish I mean we don't know what we can expect from animal clones, even in the video it took countless times to clone that goat or sheep and there's a reason for that, maybe it wasn't meant to happen and be
September 25 at 7:51pm via mobile · Unlike · 1

[redacted]od point fareeda but some people feel i think [redacted]y share DNA with offspring is in some way special
September 25 at 7:52pm · Like · 1

[redacted] my name has a "H" laaaaarl
September 25 at 7:53pm · Like

Faiq Waghid lol my bad
September 25 at 7:54pm · Like

Faiq Waghid what do you guys think about eating cl[...] what if you the the perfect apple, technically you coul[...] have the same perfect apple over and over.
September 25 at 7:55pm · Like · 1

Learners demonstrating societal awareness and critical thinking. They began a critical construction of their personal learning environment.

My role was as administrator was evidence for educator professionalism and equality.

facebook | Search for people, places and things

September 25 at 7:53pm · Like

Faiq Waghid lol my bad
September 25 at 7:54pm · Like

Faiq Waghid what do you guys think about eating cloned food? what if you the the perfect apple, technically you could clone it and have the same perfect apple over and over.
September 25 at 7:55pm · Like · 1

[redacted] you think about iy if that original apple (lets call it that) had not been cloned then apples would not have been in such an abundance
September 25 at 7:57pm · Like

Faiq Waghid yep, true story
September 25 at 7:58pm · Like

[redacted] hat is sharing DNA? It only means that person is gonna be as ugly as you, as fat as you and as stupid as you. Parenting a child is beyond the blood that runs through your veins. Also before you know it mense are ganna be walking around with "made in china" chappies on their necks. Anyways, I would like a perfect apple everyday. Whoop whoop for cloning crops:D
September 25 at 7:58pm · Unlike · 1

Learners demonstrating critical construction of personal learning contexts.

[redacted] basically cloning is helping with our in take of vitamins by making sure we do not run out of fruit and veg... I think that would be an advantage to cloning in organic foods
September 25 at 7:59pm · Unlike · 1

Learner building a new understanding after participating in the discussion and listening to the views of others.

Faiq Waghid good point fareeda with an h, DNA is simple a bunch of elements joined together
September 25 at 8:00pm · Like

[redacted] a, if it was cloned techically it wouldn't be organic.
September 25 at 8:00pm · Unlike · 1

[redacted] u are cloning organic foods thats what I mean
September 25 at 8:01pm · Unlike · 1

[redacted], its A "h", not an "h". "H" is not a vowel. hahaha
September 25 at 8:02pm · Unlike · 1

[redacted] most here believe cloning crops is ok and animals bad, what if it was more predictable, say you have a dog you really love and it dies, would you clone it?
September 25 at 8:03pm · Like · 1

[redacted] ost definitely
September 25 at 8:04pm · Unlike · 1

Faiq Waghid this discussion will continue untill the end of wednesday, feel free to leave your comments on here
September 25 at 8:06pm · Like

[redacted] oooo that dog wouldn't have the same memories as the `original dog` and knowing that its a clone doesn't make you feel the same
September 25 at 8:06pm via mobile · Like

Faiq Waghid Good point bianca, some breeders have cloned

At this stage of the discussion I managed to address the technical issue that was hindering learner participation.

Learners are able to construct their arguments in a more convincing manner. Razaan Abrahams is generally a quiet learner in the class, but through Facebook she was able to voice her opinions.

facebook

Search for people, places and things

[redacted] oooo that dog wouldn't have the same memories as the `original dog` and knowing that its a clone doesn't make you feel the same
September 25 at 8:06pm via mobile · Like

Faiq Waghid Good p [redacted] ome breeders have cloned championship winning horses, these clones are winning races much like the originals!
September 25 at 8:10pm · Like

Faiq Waghid For those having trouble joining the discussion from a BB, try using the FB mobile site and not the FB BB app
September 25 at 8:13pm · Like

[redacted], thats just weird. If you love that animal so much wouldn't you have the decency to respect that animal's passing?
September 25 at 8:18pm · Unlike · 1

[redacted] m AGAINST cloning
September 25 at 8:23pm · Like

[redacted] hat if you expect too much from the cloned animal and its not the same? How much does cloning a pet even cost?
September 25 at 8:24pm · Like

[redacted] hy?
September 25 at 8:24pm · Like

[redacted] n regular people afford to clone their pets?
September 25 at 8:25pm · Like

Faiq Waghid Razaan google us a price their
September 25 at 8:25pm · Like

Faiq Waghid it seems everyone here is against cloning, anyone for animal cloning?
September 25 at 8:26pm · Like

[redacted] use i don't think it's right.people have no right to clone other people or animals.
September 25 at 8:27pm · Like

Faiq Waghid Stemm cells can be used to grow organs, technically you can grow some one a new nose, what about using stem cells for this?
September 25 at 8:29pm · Like

[redacted] is really expensive to clone a human. It can cost anywhere from $1.7 million to $2.0 million.
September 25 at 8:31pm · Unlike · 1

[redacted] ell cloning animals for agricultural purposes is a lot different than cloning for personal things such as "I really liked that cat". I mean, for those of you who eat meat ethics doesn't really come into play. Whether or not that cow or sheep was cloned or naturally concieved the intention for it to be killed for food purposes is still the same.
September 25 at 8:31pm · Unlike · 1

[redacted] was mentioned that if you would clone a [redacted] lative or loved one if they died? I do not think I would do that because the whole idea of life is to live your life until the time comes for you to die and allow a new human being into the world... to me cloning humans has something to do with the theory of evolution that scientist

Learners regularly changed their ideas and perceptions throughout the deliberation. They therefore demonstrate the ability to construct personal learning contexts.

Learner demonstrating societal awareness.

Educational technologies such as Facebook allowed learners to come into contact with professionals in the field of the discussion topic.

Learners began to learn independently and no longer saw me as an exclusive source of information.

One of the problems that came to the fore as the discussion progressed was that, although the learners were not constrained by time, some of them were not in sync with the preceding comments. The deliberations on some of the arguments had already been completed by the time some learners added their comments.

Through the Facebook group the learners were able to make contact with a professional in the healthcare sector. Dr S Waghid was able to address some of the concerns of the learners through this Facebook group discussion.

Collaboration and engagement between learners.

The discussion initially progressed in a linear manner. This learner, however, demonstrated the autonomy to want to send the discussion on a different course – an indication that educational technology can assist in the construction of a personal learning context.

Here a learner demonstrates critical learning, as well as the construction of a personal learning context.

Through the learners' constant engagement and collaboration it is evident here that they had established friendships.

facebook

Search for people, places and things

pose potential health safety issues

September 26 at 9:28pm · Like

[redacted]!! u ddnt answer my question regarding Therapeutic cloning in the other comments?!? nd i dont see anything wrong with the cloned fish at ocean basket...no-one that ate ther is complaining about a brain tumor or having died because of eating there? s... See More

September 26 at 9:34pm · Like

Faiq Wagh[redacted] you elaborate on the therapeutic cloning?

September 26 at 9:45pm · Like

Write a comment...

[redacted]

Strange Fact regarding the ethics of cloning #Religous people are against cloning because they say that life begins at conception though Jewish people do not equate life with conception though some do question the wisdom of cloning, Orthodox Jews generally find no actual reason to object to cloning...

Like · Comment · Unfollow Post · September 26 at 8:44pm

2 people like this. Seen by 2

Faiq Waghid wow that new, anybody else have something like this to add?

September 26 at 9:16pm · Like · 1

Write a comment...

[redacted] honestly thort that cloning humans was wen u go in one end of a machine nd it scans you, then an exact replica come out on the other side 8o lmAo!!...this is what Phineas and Ferb (Cartoons) does to a person! lol

Like · Comment · Unfollow Post · September 26 at 8:51pm

[redacted]es this. Seen by 2

[redacted]ll only be taybah, haha. but no, alot of work and time goes into it. its not <WHOOSH> theres a clone lol

September 26 at 8:53pm · Like

[redacted]hnk u've been spending to0 much time watchn phineas & ferb 8o lol

September 26 at 8:53pm via mobile · Like

[redacted]l i know ryt 8o hehe...i really ddnt know that they still had 2 grow lmk

September 26 at 8:59pm · Like

Faiq Waghid lol yes taybah,you should check youtube, it is quite a procedure yes

September 26 at 9:14pm · Like

It was evident even at this late stage of the discussion that the technology afforded the learners the opportunity to go back and rethink their initial ideas.

facebook Search for people, places and things

[redacted]

Cloning is a highly controversial topic these days. Many scientists consider cloning a vital step in the advancement of medicine. And then there are many others that are opposed to cloning because of the moral ramifications.

The real reason that cloning is explored is because of the possibility of using organs from clones to give to other people that desperately need it. This idea is known to some as "organ farming". This is one of the reasons that cloning should not be explored. Humans will be created for the sole purpose of using their organs for other people who need them. This creates an "inferior race" and shows the clones as nothing more than tools for society.

If people could clone and have their offspring look exactly like them, then many would choose this instead taking a chance...

See More

Unlike · Comment · Unfollow Post · September 26 at 10:14pm via mobile

You and [redacted] e this. Seen by 2

Faiq Waghid You should refer t [redacted] ost too, thanks for the post
September 26 at 10:16pm · Like

Write a comment...

[redacted] against cloning unless it becomes safe, because there are many health problems that come with it at this stage

Like · Comment · Unfollow Post · September 26 at 9:47pm via BlackBerry

Seen by 2

Faiq Waghid well according to the video there are no problems regarding safety, unless you can prove otherwise??
September 26 at 9:48pm · Like

Write a comment...

[redacted]

What is the main purpose of cloning

Like · Comment · Unfollow Post · September 26 at 9:41pm via mobile

Seen by 2

Faiq Waghid there are many applications, google for us the pros for cloning and post us some info there :)
September 26 at 9:46pm · Like

Learners were exposed to a wealth of resources; however, they did not seem to be able to filter this information effectively. As can be seen here, some simply copied and pasted information from a website.

Another indication that some learners' comments are not on the same level due to them joining the discussion later than others.

facebook

Search for people, places and things

This learner demonstrated autonomy to drive her learning and that of her fellow learners by summarising the findings of the discussion. An opinion poll was created, allowing learners to poll their opinions, thus concluding the discussion.

[redacted]

There are three Primary types of cloning (1) DNA cloning (2) Reproductive cloning, and (3) Therapeutic cloning...Having an open mind, which type of cloning would u prefer??...

- [x] Therapeutic cloning (Used 2 grow organs seperatley and not harvested 4rm clones) ...
- [ ] DNA cloning (The creation of superior clones using specific desired DNA)
- [ ] Reproductive cloning (When identical clones are made using asexual reproduction)

+ Add an answer...

Like · Comment · Follow Post · September 26 at 11:12pm

Seen by 2

Write a comment...

As the discussion was concluding, the learners became progressively innovative as they became comfortable with Facebook as a medium for learning.

[redacted]

haha, so this is not what a normal cow is supposed to look like! this is a cloned cow thet has been fed an abnormal diet of grain ,antibiotics and hormones

Unlike · Comment · Unfollow Post · September 26 at 10:58pm

You like this. Seen by 2

Faiq Waghid are you sure thats a clone?

September 26 at 11:00pm · Like

Cycle II:

In this cycle, instead of posing multiple questions I opted to pose only one question on the topic in order to avoid the linear discussion that was observed in the first action research cycle. In this way the learners were able to direct the discussion in the direction they desired and an opportunity for different ideas to be raised would hopefully come to the fore.

As in the first action research cycle, YouTube clips were uploaded to serve as an introduction to the two schools of thought with regard to global warming.


facebook
Search for people, places and things
[redacted]
I'm 100% against global warming and believe that it does exist,scientist have proven this over again.I think that factories should close down coz people should start thinking about the future and environment and not jst themselves,so REDUSE,REUSE nd RECYCLE
Like · Comment · Follow Post · September 27 at 12:44pm via mobile
[redacted] es this.
Seen by 2
Write a comment...
[redacted]
I support global warming because there is evidence in the videos , that it does have an effect in nature...
Like · Comment · Follow Post · September 27 at 12:41pm via BlackBerry
Seen by 2
Write a comment...
[redacted]
I am against global warming.
There are way more negative aspects of global warming, than possitive aspects.
Disadvantages of Global Warming:
...
See More
Like · Comment · Follow Post · September 27 at 12:38pm
[redacted] es this.
Seen by 2
Write a comment...
[redacted]
m against global warming. There is evidence that the temperature increases dramatically all over the world and there are many deaths from heat strokes now already. many people don't take note of the increase in temperatures because it doesn't affect them just yet, and also that's a reason why some say global warming is fiction. I say we shouldn't take the risk and rather do something about it now. Decrease the amount and rate of pollution yo.
Unlike · Comment · Follow Post · September 27 at 10:23am via mobile
Technical difficulties preventing learners from participating in the first discussion were resolved. Learners were able to communicate with each other across different platforms, i.e. BlackBerry or desktop computer.

The first action research cycle acclimatised learners to seeing Facebook as a new means of supporting learning. The learners' confidence that was built up in the first cycle was carried over into this second action research cycle. To that end there generally was enhanced participation.

facebook | Search for people, places and things

Faiq Waghid interesting take on the matter, but where there is smoke, there tend to be fire
September 27 at 5:07pm · Like

Write a comment...

[redacted]

Everyone is saying that we should close down factories and things uhrm NewsFlash we close down that and we destroy peoples lives, do you really want to fire people and ruin their lives, what about their families and come on now, imagine all the things that we won't be able to get, where you you think we get electricity and basic essentials so we need those factories, and yes it may be killing animals and maybe it is destroying the world but who ever said we were suppose to last forever maybe there is a plan for us and this is part of the plan so I'm actually neutral when it comes to Global Warming
Unlike · Comment · Unfollow Post · September 27 at 2:48pm via mobile

You and 4 others like this. Seen by 2

Faiq Waghid interesting take, have you done some research into what would happen if we stop all CO2 levels today?
September 27 at 5:05pm · Like

Write a comment...

In the first action research cycle, using the questions resulted in a linear discussion. I refrained from using questions in this cycle to allow learners greater autonomy. As can be seen here, the learners approached the discussion from different vantage points.

Faiq Waghid

What about other sources of energy?
Like · Comment · Unfollow Post · September 27 at 5:03pm near Claremont

Seen by 2

Write a comment...

[redacted]

If evry1 stopd wasting n resources were shared equally ther would be no need 2 over produce
Like · Comment · Unfollow Post · September 27 at 3:37pm via mobile

Seen by 2

Faiq Waghid Greed is a problem
September 27 at 5:02pm · Like

Write a comment...

[redacted]

I'm against global warming... If each of us just does a small bit 2 combat

As the learners became increasingly adept at using the educational technology's capabilities, they began substantiating their claims with images such as these. In this way the learners were able to express their viewpoints in a visual way.

Learner constructing personal learning context.


facebook

Search for people, places and things

are you going to stop breathing out?
September 27 at 5:44pm via mobile · Like

Write a comment...

[redacted] I am against global warming fully because u can see clearly that the effects of global warming are deteriorating and that's not normal...so u can exactly say its part of life. Us as human beings are the main cause so I agree with Kayla Adams post and we should close down all factories and other places and stuff that are giving off greenhouse gases so that our children and our childrens children will be able to live in a safe and healthy environment

Like · Comment · Unfollow Post · September 27 at 12:38pm via mobile

3 people like this. Seen by 2

[redacted] gree that global warming is a problem. However, closing down factories is just going to cause an economic crisis. Instead of shutting down factories, people should find a way to make it environmentally friendly , and keep green house gasses to a minimum
September 27 at 12:46pm via mobile · Like · 1

[redacted] es actually jamie that makes more sense...so making like solar powered things and recycling stuff will be a much better option:)...but isn't green house gases like already high or sumtn? Can it even reduce? Lol
September 27 at 12:48pm via mobile · Like

Faiq Waghid do some research for us on how we can reduce it
September 27 at 5:06pm · Like

[redacted] ound something:D...Delay childbearing or have fewer children. The biggest change you can make is to reduce the number of children who will grow up to drive, use water, heat their homes, etc. If you are affluent and live in a modernized country, this is especially importa
September 27 at 5:23pm via mobile · Like

Faiq Waghid but what about poor countries?
September 27 at 5:24pm · Like

[redacted] idnnt know they make greenhouse gases!!...maybe that's the governments fault..for not giving them houses so they are actually forced to make fires which is burning holes into the o-zone layer...so ja its jacob zumas fault that the worlds ending
September 27 at 5:27pm via mobile · Unlike · 2

Write a comment...

[redacted] dded photos to September 27, 2012.

The Earth's Greenhouse Effect
SUN
Only a small amount of the heat energy emitted from the surface passes through the atmosphere

Posts such as these indicate the potential for learners to engage in critical thinking whereby they subject their viewpoints to the scrutiny of others.

My role as an educator became less instructional and more motivational, as I encouraged the learners to use the technology to do further research.

facebook Search for people, places and things

[redacted]

I am not against Global warming. Its part of peoples lives. Global warming is nothing we are not going to die ,there are going to be no species that get extinct ,the temperature uprising has got to do with everyday life. All people on earth contributed to this ,the temperature uprising. If people want to stop global warming they can't expect businesses to close down factories to stop pollution. There are people who work at the factories who need the money otherwise they will have nothing,so people can't expect factories to close down just because off what some scientist are saying. Global warming cannot stop everyday life for people that depend on factory work. Sprays also contribute to global warming. So you can't tell people not to use spray or buy other types of sprays.

Unlike · Comment · Unfollow Post · September 27 at 10:34am via mobile

You ar [redacted] this. Seen by 2

Faiq Waghid Great poi [redacted] k'- but what if results ten years from now indicate it is getting worse what will your opinion be then?
September 27 at 10:38am · Like

Faiq Waghid Great poin [redacted] k'- but what if results ten years from now indicate it is getting worse what will your opinion be then?
September 27 at 10:38am · Like

[redacted] e u are right but how can u not be against it, [redacted] nerations, possibly ur children that will suFfer oneday because we didn't put a stop to global warming before it gets out of hand
September 27 at 10:42am · Unlike · 1

[redacted] r Waghid ,we don't know how the [redacted] ut we can't stop everything that contributes to global warming ,if a tree huger says we must stop factories for the pollution ,are they going to stop driving cars and tell everyone to stop driving also.
Nina I'm not against global warming I'm against more the scientific information because we cannot stop still ,stop the whole world for it because its impossible.
September 27 at 10:50am via mobile · Like

[redacted] lee don't be dom, scientific info says we going [redacted] !!
September 27 at 10:55am · Like

[redacted] e all going to die eventually we just don't know how and when. Everyday life contributes to global warming ohk. How would you like to prevent it?
September 27 at 11:06am via mobile · Like

[redacted] doesn't mean u don't need to take preventative measures to live while u are alive rather than suffer global warming. Plus u only thinking of urself, what about the future? Its little things that count. Re-use. Reduce, recycle nigguh
September 27 at 11:12am · Like

[redacted] t the moment you are probably sitting at a table made from wood that a tree was cut down for so I don't see you preventing global warming

In the first action research cycle the learners' posts were quite sporadic. However, in this cycle the learners' comments appeared to be better researched and better articulated than in the first action research cycle.

As these discussion posts indicate, although learner participation was now maximised, the learners approached the discussion topic as a debate, trying to impose their ideas on each other rather than seeing the discussion as an opportunity for deliberative action through which their views could be adapted through exchanges.

Each Facebook post became a forum for a different discussion on a particular aspect the learner was interested in.

My role as an educator became more motivational.

Many learners started posting diagrams to the Facebook group wall, which helped to facilitate the learning process. Diagrams such as these were helpful for learners who had joined the discussion late, as they summed up the different points of view already highlighted in the discussion – i.e. learners constructing personal learning contexts.

As this post indicates, some learners were still making sporadic, generalised posts. This was realised by this learner, who asked for some elaboration.

Learners constructing personal learning contexts as well demonstrating societal awareness.

As a result of the Facebook discussion, the learners began searching the Internet for information sources. As the learners started posting links to websites to substantiate their claims they began to learn how to filter information sources, and links to websites consequently were of a higher quality.

My role was again reduced from instructional to motivational educator.

Personal construction of learning contexts as well as societal awareness on the part of learners.

In this Facebook discussion there was more engaged participation by the learners, primarily due to all learners being able to use their own technology to participate, as pointed out here.

facebook

Search for people, places and things

Write a comment...

[redacted]

If you think about it people are trying to slow down global warming but by doing that they still contributing to it for example electric powered cars are being made to stop air pollution from cars but to make these cars it takes mining for the materials found in the battery and it takes a factory to make the body and engine parts this all contributes to global warming. So basically we really have to think critically about slowing down global warming

Unlike · Comment · Unfollow Post · September 27 at 7:14pm

You like this. Seen by 2

Faiq Waghid did you see that in topgear?
September 27 at 9:05pm · Like · 1

Faiq Waghid thought so lol
September 27 at 9:07pm · Like

[redacted] but its true
September 27 at 9:11pm via mobile · Like

Faiq Waghid yes it [redacted] so made the point that these cars need to be charged, where does the electricity come from then hey
September 27 at 9:13pm · Like

Write a comment...

[redacted]

i am against global warming because its killing me and my family and friends and i have already lost dinosaurs to global warming so thats why i hate it!

Like · Comment · Follow Post · September 27 at 12:50pm

8 people like this. Seen by 2

[redacted] bimp are u then dying huh
September 27 at 3:39pm · Like

[redacted] ah, coz the dinosaurs totally became extinct [redacted] they were all super-intelligent and advanced, and towards the end, many stegosaurus and tricerotops (they were the creators) had developed complicated forms of transport which consum... See More
September 27 at 7:33pm via mobile · Like

Write a comment...

[redacted]

In this post the learners demonstrated critical thinking. Although many of the learners proposed that we should reduce all emissions, some looked at the implications of having to reduce emissions in a critical manner.

Although the learners demonstrated that they were passionate about the environment, and the discussion consequently had a serious tone, there were some instances of light-heartedness in which they were humorous.

facebook

Search for people, places and things

[redacted] I am against global warming because there is no solid evidence that global warming really does exsist and that it really is global warming affecting the temperatures of the world it could just be natural climate change. People cannot also afford to lose their jobs because of global warming. If we stop factories from working people lose their jobs and families suffer. Another thing said was that Carbon Dioxide affects global warming if that is true then we will have to stop exhaling to help stop global warming which would be stupid

Like · Comment · Unfollow Post · September 27 at 3:52pm

Seen by 2

[redacted]gree wit[redacted]h this too though. But you can't say that there isn't global warming? Nobodies sure? So why pollute the air more than we already are?
September 27 at 4:59pm · Like

[redacted]e earth has been heating and cooling since the beginning so global warming is inevitable
September 27 at 8:31pm · Like

[redacted]ou are "for" global warming.. then you have no problem with temperatures above 40 degrees in summer? or temperatures below 5 degrees in winter?
September 27 at 8:54pm · Like

[redacted]e have pools and blankets so its ohk 🙂
September 27 at 8:58pm · Like

[redacted] then what about the homeless people on the streets? Sure a pool can cool you down, but for how long? Its not like you can stay in the pool for the whole summer and just come out when its winter.
September 27 at 9:02pm · Unlike · 1

[redacted]may be inevitable, but atleast we can do our bit to reduce the effects and buy the world some time.
September 27 at 9:06pm · Like

[redacted]i[redacted]s a point, we should consider others.
September 27 at 9:06pm · Like · 1

[redacted]good point but dont you think its too late?even if we all start going green wont the global warming situation still be beyond repair?
September 27 at 9:08pm · Like

[redacted]en though it seems pointless, we should consider going green. Its a healthier alternative for all life on the planet and the more people and companies to go green, the better. Maybe if one person on earth goes green, it wont really make a difference. but if a large group goes green and large countries promote a green initiative, then the impact would be greater
September 27 at 9:14pm · Unlike · 2

[redacted], so maybe we wont be able to reverse the [redacted]ng or repair it, but we should atleast be willing to take the initiative to try.
September 27 at 9:18pm · Unlike · 2

In this Facebook post this learner demonstrated societal awareness by looking at the social implications of reducing emissions. In addition, the learner was able to construct a personal learning context in a critical manner.

Societal awareness is illustrated by a learner.

As can be seen in these discussion posts, it was evident that the learners were demonstrating problem-solving skills in trying to devise a plan to address the environmental and societal issues that need to be taken into consideration with regard to global warming.

facebook

Search for people, places and things

[redacted]

For those against Global Warming*
Carbon dioxide (CO2) is a powerful greenhouse gas. In the atmosphere it captures the sun's heat and warms the planet.
So those who say Global Warming exists*.How would you like 2prevent C02?? Should we all stop breathing out???
Like · Comment · Unfollow Post · September 27 at 5:52pm via mobile

Seen by 2

> In the initial stages of the discussion, the emphasis was on the learners gaining understanding of the various concepts relating to global warming. However, the discussion later progressed towards learners demonstrating problem-solving skills in relation to taking action.

[redacted] e co2 in the atmosphere isn't mainly from us [redacted]
September 27 at 6:04pm via mobile · Like

[redacted] bviously not, but we can try and keep CO2 [redacted]
September 27 at 6:11pm via mobile · Like

[redacted] t we contribute to it.
And Cars? They pollute the air so? You going to tell every1 to stop driving also?
September 27 at 6:41pm via mobile · Like

> There were instances when the learners thought autonomously by coming up with practical suggestions to reduce carbon emissions.

[redacted] . But there are ways to reduce it. Lift clubs, [redacted] etc. Not only, is it environmentally friendly, but also cost effective.
September 27 at 6:49pm via mobile · Unlike · 1

[redacted] ats true, it will be hard though cause the people today want everything to be easier,we all think about ourselves and not our planet. it time we start working together, cause if theres no planet, theres no us. we might not be able to prevent global warming completely but there are ways that we can reduce the effects.
September 27 at 6:54pm · Like · 2

Faiq Waghid electric cars too, but is said that to mine such resources for the car is often more damaging to the environment.
September 27 at 6:55pm · Like · 1

> Unlike in the first action research cycle, there now appeared to be a more engaged discussion between the learners. Despite the engaged participation, the learners still lacked the skill to deliberate with one another effectively and seemed to approach the discussion as a debate, trying to impose their viewpoints.

[redacted] Don't electric cars have to charge? So it uses electricity and its made in factories also. There is no way around global warming for our lives ,people just have to face it
September 27 at 9:10pm via mobile · Unlike · 1

> Again my role as an educator was less instructional and more advisory.

Faiq Waghid Yes, it seems any change we are willing to make is proving to be too expensive and not very practical
September 27 at 9:12pm · Like · 1

[redacted] amie lift clubs aren't help full it just [redacted] are always going to be cars on the road ,public transport pollutes also. Trains won't pollute but it uses Electricity and I doubt every1 will cycle everywhere.
#Fact. Show me you go to Canal walk in this holiday by a bicycle
September 27 at 9:14pm via mobile · Unlike · 2

[redacted] , but less cars on the road = less green house gas emissions #fact
September 27 at 9:15pm · Unlike · 1

[redacted] We not only talking about here in Cape Town ,All people don't want to travel by lift clubs. There are millions and millions of cars in the world ,people won't trade it in just for global warming

In this action research cycle it was evident that the discussion was not directed by me. As a moderator and consultant to the learners, I merely provided them with some insight at particular stages to stimulate the discussion.

Learners demonstrating increasingly more societal awareness and critical thinking.

During the second cycle it was evident that the learners were increasingly more comfortable with using educational technology to do research and reveal to classmates what they had researched via the Facebook group.

facebook

Search for people, places and things

Faiq Waghid

The USA made the point that it would not adhere to the Kyoto Protocol as it valued the livelihoods of its citizens over that of the environment. It is one of the largest producers of greenhouse gases in the world, any responses from you learners?

Like · Comment · Unfollow Post · September 27 at 9:20pm

Seen by 2

[redacted] because of large countries and companies like this that the whole world has to face global warming. Sure the livelihood of citizens is important, but who in the future is giong to want to live with the extreme conditions of global warming?
September 27 at 9:26pm · Unlike · 2

[redacted] s understandable that they would not want to have the protocol rattified as it affects their citizens, but whats the point if in 50 years from now there wont even be people left coz of global warming? they should just work at trying to become as eco-friendly as possible.
September 27 at 9:29pm · Unlike · 1

[redacted] e might be able to cope with global warming now, but what about the future generations? They should also be considered. Conditions of global warming can only get worst over time. there isnt really a way to repair the o-zone layer, but there are many ways to reduce the negative impact of global warming on our planet.
September 27 at 9:30pm · Unlike · 3

[redacted] hat we do now has an effect on the future. i personally believe that it is our (as the human race)'s responsibility to look after the planet. rattifying the protocol would be much easier than living with sweltering heat or extreme coldness coz of global warming.
September 27 at 9:35pm · Unlike · 1

[redacted] gree w [redacted] e dont know for sure just how bad global warming will affect people years from now. Thats why its best to preserve what we have
September 27 at 9:37pm · Unlike · 1

[redacted] unny that America seems to be hit a lot by hurricanes and tornadoes
September 27 at 9:37pm · Like

[redacted] e US emits the second most green house gasses. China is first
September 27 at 9:42pm · Like

[redacted] oth refuse to sign
September 27 at 9:43pm · Like

[redacted] e U.S experiences all climate extremes because of its sheer size and topography. basically convection, high humidity and wind-shear can create a steady state storm. tornadoes are most likely to form in unstable conditions with wind-shear present.
September 27 at 9:48pm · Unlike · 1

[redacted] euss thats coz majority of thing are manufactured in china. if they adhere to the protocol,that means that their factories will not be in work? and i doubt anyone will boycott china coz of thier CO2 emissions
September 27 at 9:49pm · Unlike · 2

Write a comment...

As this post indicates, educational technology afforded the learners the opportunity to participate in the discussion at any time.

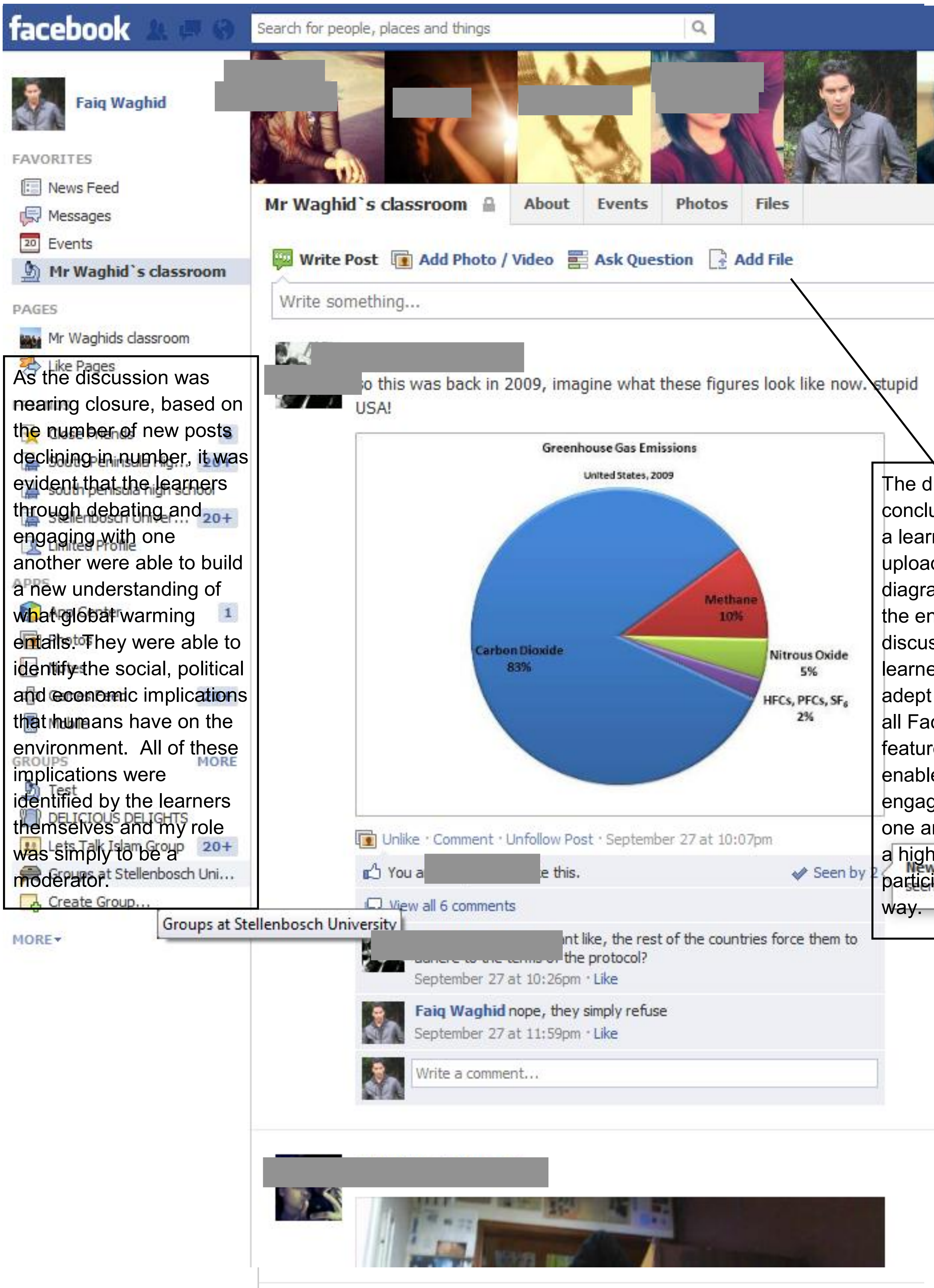
Facebook as an educational technology allowed learners to express their viewpoints and also receive verification from other learners. In this way the learners supported one another's learning.

Learners who are generally not vocal in class were afforded the opportunity to engage with fellow learners through Facebook as medium.

Although educational technology serves as a sphere for engaged participation, a problem posed by technology is that rhetoric and the tone of the posts cannot be established by the learners and me. As a result it might appear that learners are rude even when they are not.

The learners continued to show personal construction of their learning contexts, as well as critical thinking.

It is evident from these screenshots that my role as an educator was minimal and that the learners drove the discussion.



As the discussion was nearing closure, based on the number of new posts declining in number, it was evident that the learners through debating and engaging with one another were able to build a new understanding of what global warming entails. They were able to identify the social, political and economic implications that humans have on the environment. All of these implications were identified by the learners themselves and my role was simply to be a moderator.

The discussion concluded with a learner uploading a diagram. By the end of the discussion the learners were adept at using all Facebook's features to enable them to engage with one another in a highly participatory way.

Cycle III:

In this cycle the learners were again able to demonstrate their ability to construct their own personal learning contexts.

Facebook allowed the learners to follow posts that they had an interest in to keep them up to date with the discussion on a constant basis.

Due to the sensitivity of the topic it was important for learners to deliberate rather than debate.

Engaged participation was again observed, with learners making use of Facebook's full range of capabilities to liaise with one another.

After the first two cycles, a new feature was introduced by Facebook that allowed users to track how group members have seen their posts.

Critical thinking and learners' willingness to participate were foregrounded.

facebook Search for people, places and things

October 29 at 7:12pm · Like

Write a comment...

Learners show a willingness to challenge own beliefs.

[redacted]

I think that the evolution does make sense due to its scientific discovery yet I still believe in God and believe that He is our creator. That's just how I was raised and I adapted to that way of belief

Like · Comment · Unfollow Post · October 29 at 6:52pm via mobile

Seen by 66

Although not all learners commentated on the wall posts, it is highlighted that the learners are indeed viewing their peers' posts.

Faiq Waghid So you are saying you yourself are evolving in that way, interesting

October 29 at 7:01pm · Like

[redacted] vas also raised to believe in God and so we are taught that God created each thing seperately But i do think that micro evolution could be possible because we do change and adapt to things that just natural, but dont agree with macro evolution which says we come from apes and everything evolves and changes into something else.

October 29 at 7:11pm via mobile · Unlike · 1

Many learners opened up their initial perceptions and ideas with regard to evolution to revision.

Write a comment...

[redacted]

Creationism does not have to be incompatible with evolution. There are many who believe in a creater (God) and who also accept evolution. But you do get those believers who believe in God, and judge science by the bible and not the other way around! "we walk by faith, not by sight" (1 Corinthians 5:7) I do belive in God! But there is evolutionary theories that evolution might have been the start of life on earth!

Like · Comment · Unfollow Post · October 29 at 6:47pm via mobile

A learner demonstrates critical thinking. The use of educational technology allows learners the time to reflect on their own beliefs on the theory of evolution.

Seen by 66

Faiq Waghid thanks for your input

October 29 at 7:05pm · Like

Write a comment...

My role, reduced from instructor to motivator.

[redacted]

http://news.nationalgeographic.com/news/2004/10/1018_041018_science_religion.html

Like · Comment · Follow Post · October 29 at 6:40pm

[redacted] es this. Seen by 66

Write a comment...

Learners took responsibility for their own learning by doing research on the topic under discussion on the Internet and then consulting with peers and me.

facebook Search for people, places and things

Write a comment...

[redacted]

With regard to the lesson we had today I still don't believe in evolution• I strongly believe in my religion and I don't think we come from apes, I mean why aren't apes evolving into humans anymore and God made us in his own way, by saying we came from apes totally throws away all our beliefs and it actually tells us that the Bible is wrong and a lie, I also don't believe that animals all have a common ancestor because it says in the Bible "Then God commanded, "Let the earth produce all kinds of animal life: domestic and wild large and small:"-and it was done" which clearly shows that animals were made perfect, not from a single organism

Because this topic is so sensative to me when I go to Father [The Priest] for my interview I'll ask him for permission to ask about his views and beliefs and post it here to perhaps "back up" future comments if that's okay with you Mr Waghid

Unlike · Comment · Unfollow Post · October 29 at 5:28pm via mobile

You and 5 others like this. Seen by 66

Initially the learners were dogmatic in their thinking; they indicated their willingness to do further research into the topic by interviewing religious leaders.

Faiq Waghid yes I would encourage th [redacted]
October 29 at 6:03pm · Like

[redacted] strongly agree with bianca also because [redacted]
October 29 at 7:30pm via mobile · Unlike · 2

I performed a motivational role.

Write a comment...

Some learners expressed thoughts that could coexist with previously held thoughts; thus room was created to think about issues.

[redacted]

I am a believer of creationism but I also take the theory of evolution into thought because if you really think about it that organism that the scientist say created everything else on this eath was not just put there by nobody.. God put it there and used it to evolove evrything else in the world.. A good example would be that when God created Adam and Eve he used a rib of Adam to create Eve and till this day men have one rib less than woman.. If thats a true fact then scientist should include it in their theory so that they can actually prove to people that there is a God out there as well

Like · Comment · Unfollow Post · October 29 at 6:36pm

Seen by 66

Faiq Waghid is there scientific evidence that relates to your belief then?
October 29 at 7:12pm · Like

My role as an educator in this discussion was not to question the learners, but to spark an interest in them to use educational technology in order to take responsibility for their own learning.

Write a comment...

facebook Search for people, places and things

[redacted]

I have nothing against people that believe in evolution but I strongly believe in GOD and that he created live on earth because if you read genesis 2 v 24-28 it tells us about the way god created the earth and everything living on it

Unlike · Comment · Follow Post · October 29 at 7:20pm via mobile

You like this. Seen by 66

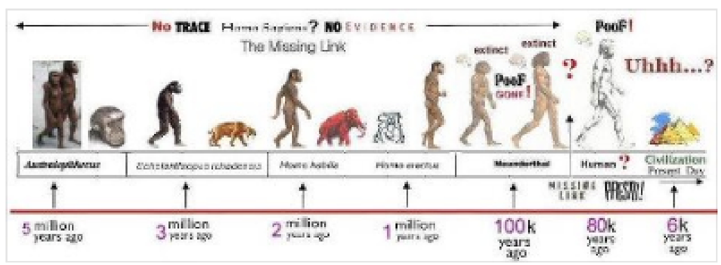
[redacted]ue! But their are many other different versions of the bible! And the stories are completely different! So how do you know if its the truth or not??
I too believe in God! bUt until today i am two minded! Evolution vs. Creationism!
October 29 at 7:45pm via mobile · Like

Write a comment...

Learners' willingness to think autonomously.

[redacted]

This diagram shows that "missing link" thing we discussed in class today Mr Faiq Waghid?



Unlike · Comment · Unfollow Post · October 29 at 7:32pm

You like this. Seen by 66

View all 3 comments

[redacted]illustrated above, we have thousands of animals and Homo Erectus species documented in the 5 million year time span but no trace of humans were ever found.
October 29 at 7:33pm · Like

[redacted]s hope so 🙂
October 29 at 7:34pm · Like

Write a comment...

Not only did the learners demonstrate critical thinking through comments on the discussion topic, but many of them explored the Internet in search of different information, as can be seen here in the form of diagrams such as this one, which serves as an indication of learner autonomy and rhizomatic thinking.

Learner demonstrating critical thinking and not just accepting researchers' hypotheses regarding the theory of evolution.

[redacted]

With regard to the lesson we had today I still don't believe in evolution•
I strongly believe in my religion and I don't think we come from apes, I mean why aren't apes evolving into humans anymore and God made us in

Learners' willingness to think autonomously so that they can contribute in an informed way.

Although some learners did not demonstrate critical thinking and were simply unwilling to re-look their viewpoints, they did show rhizomatic thinking by examining ideas more deeply.

Although this learner did not demonstrate critical thinking or rhizomatic thinking, nor acted autonomously, the use of educational technology did encourage her to participate. Learners who otherwise would not voice their opinion in class are still afforded the opportunity to participate in this democratic sphere.

facebook

Search for people, places and things

[redacted]

I believe that we were created by God and that the theory of evolution is not entirely despite that fact that they have scientific back-up.

Unlike · Comment · Unfollow Post · October 29 at 6:10pm via BlackBerry

You like this. Seen by 67

Faiq Waghid How would you persuade others to confer with you?
October 29 at 6:11pm · Like

[redacted]agree w[redacted] believe that God created ALL life on earth. If human evolution were to be entirely true, then why haven't we evolved into creatures that can walk, aswell as fly? We have to make use of "man-made" inventions or technologies for transportation and various other purposes. If we had wings for example; then it would make it easier for us to get to places. We could have evolved into creatures suitable for transportaition, because people have been inventing and trying to improve on transport systems since 3500 BC, more than a thousand years ago. And this is just one example that we can consider.
October 29 at 6:43pm · Unlike · 1

Faiq Waghid [redacted]entist have come up with examples of evolution in humans today, maybe you can look at those examples takings into consideration your point of view.
October 29 at 6:52pm · Like

[redacted]hat if humans are the final stage of evolution? Technology undergoes changes constantly - they are evolving... http://www.scientificamerican.com/article.cfm?id=the-future-of-man
October 29 at 6:54pm · Unlike · 1

[redacted]can see that Humans are constantly adapting [redacted]nge (climate, etc). But that doesn't show or prove that ALL life originated from a single organism.
October 29 at 7:07pm · Unlike · 1

[redacted]hat article that you posted a linked to indicates that we are indeed showing evolutionary changes, that would therefore contradict your post.
October 29 at 7:07pm · Like

[redacted]you believe in a form of [redacted]
October 29 at 7:09pm · Unlike · 3

[redacted]ell physically we do not see humans evolving [redacted]nano level
October 29 at 7:14pm via mobile · Like

[redacted] so first of all evolution is based on natural [redacted]n means methods of survival. Which renders your arguement invalid. If we needed to fly due to us being prey to another species our bodies would have adapted to fly. but istead our minds have evolved in order for us to create man made, either weapons (for defensive purposes) or cars, busses, planes for our own convienience.
October 29 at 7:19pm · Like

Faiq Waghid Natural selection is the gradual, non-random process by which biological traits become either more or less common in a population as a function of differential reproduction of their bearers. It is a key mechanism of evolution. The term "natural selection" was popularized by Charles Darwin who intended it to be compared with

Although the learners were dogmatic, there are indications of learner autonomy. This learner demonstrated rhizomatic thinking by wondering about the future of human evolution. Although there is very little scientific basis for the learner's comments, it is interesting to note how this learner's thinking has progressed in a rhizomatic manner.

As an educator it was not my intention in this discussion to direct or guide it along specific lines. Rather, my role in this discussion was to serve as a scientific consultant, ensuring that learning was directed towards achieving the learning outcomes.

This learner demonstrated rhizomatic thinking by first reading the comments of peers, researching the Internet autonomously and then posting a comment that was different to the initial chain of thought in the discussion.

Although not all the learners participated in every single wall post discussion, Facebook at least shows that they viewed the comments posted.

By consulting me, the learners were encouraged to do further research in order to address the questions that their peers posed in the discussion.

facebook

Search for people, places and things

Some learners were still dictated to by religious authority and not always prepared to wonder, i.e. to think autonomously. However, through the use of Facebook as a medium of learning, the learners were able to revise their initial viewpoints that saw evolution as a threat to their religious beliefs.

[redacted]

I spoke t[redacted]d he told me that The Church is not against evolution but there are limits to what scientist think are true• He also told me that in the Bible where they speak about how Earth was made is more of a poem that envokes the mysterious of God
He told me that some Catholics are much more strict and can't really grasp this concept but our church believes in some parts of evolution buut that humans were made in an image of God [so I guess we don't agree with the whole apes bit]

Unlike · Comment · Unfollow Post · October 29 at 8:08pm via mobile

You [redacted] this. Seen by 66

Faiq Waghid did you go to church specifically to ask your father?
October 29 at 8:13pm · Like

[redacted]at if God created one organism as a basis for all [redacted]ngled cell organism) and intended for Humans to evolve from that.
October 29 at 8:13pm · Like · 1

The learners demonstrating critical thinking, and a willingness to listen and question in a respectful manner.

[redacted]onfused] like what parts of evolution does the church believe in??
October 29 at 8:14pm via mobile · Like

Faiq Waghid thats what evolutionist agree on, however in the picture Razaan uploaded there seems to be a missing link.
October 29 at 8:16pm · Like

[redacted]dah
Because of my beliefs I believe we were made perfect In the image of God and in the Bible it says "Then the Lord God took some oil from the ground and formed man out of it; he breathed life-giving breath into his nostrils and the man began to ... See More
October 29 at 8:22pm via mobile · Unlike · 3

Write a comment...

This learner demonstrated rhizomatic thinking by stating indirectly that viewpoints on the topic of evolution have been dictated by religion and that greater rhizomatic thinking could possibly be attained free from religious doctrine.

[redacted]

[redacted]I'm against evolution .however I believe that if we were nt brought up to believe in christianity n islam teachings and beliefs that we would have a different outlook on the topic.

Unlike · Comment · Follow Post · October 29 at 8:10pm via mobile

You like this. Seen by 66

Write a comment...

[redacted]

I believe that we were created by God and that the theory of evolution is not entirely despite that fact that they have scientific back-up.

Unlike · Comment · Unfollow Post · October 29 at 6:10pm via BlackBerry

facebook | Search for people, places and things

Learners who joined the discussion late still appear to be dogmatic in there thinking and were referred to the posts of peers. Learners were therefore responsible for their learning and that of others.

[redacted]
In this modern society why then has man not evolved himself yet? Thus, i remain resolute in my belief that God is the Creator of all things not man.
Like · Comment · Unfollow Post · October 29 at 8:50pm via mobile

2 people like this. Seen by 67

Faiq Waghid Garin try reading some of the comments already posted, it may allow you to understand the topic in relation to life sciences better.
October 29 at 8:52pm · Like

Write a comment...

[redacted]
After further research about creationism and evolution that are connected. I believe that evolution may have occurred, but only by the divine guidance of God.

بِسْمِ ٱللَّهِ ٱلرَّحْمَٰنِ ٱلرَّحِيمِ

In the name of Allah, the Most Compassionate, the Most Merciful
...
See More

Creation and Evolution in the Holy Qur'an By Hassan El-Najjar
www.aljazeerah.info
Al-JazeerahIslam: A Brief Introduction 2.Performing Islamic Prayers 4.The Scientific Evidence That God Exists and the

Like · Comment · Unfollow Post · Share · October 29 at 8:40pm

3 people like this. Seen by 66

By using educational technology the learners were able to re-evaluate their initial perceptions of evolution. Through exploring the Internet they were able to think rhizomatically and consequently were able to build a new understanding of the topic of evolution.

Faiq Waghid So thus far you have changed your initial take on evolution and that now indeed has a place in your belief?
October 29 at 8:43pm · Like

[redacted]. I haven't done proper research on the subject and didn't quite understand many things, but I now see how creationism and evolution could go hand-in-hand.
October 29 at 8:46pm · Unlike · 2

Faiq Waghid thanks for your input.
October 29 at 8:47pm · Like

Write a comment...

[redacted]
[redacted] spoke to Father Shaun and he told me that The Church is not against evolution but there are limits to what scientist think are true• He also told me that in the Bible where they speak about how Earth was made is

facebook   Search for people, places and things

[redacted]

My opinion is that Humans were not evolved from anything. But however, both the Noble Quran and Science claim that animals were sent down to earth from space, and then developed into many physical shapes and forms. The idea of Evolution came from Charles Darwin, an English atheist scientist who lived in the 1800's.His parents were Christians. He believed that humans were originally animals; more closer to monkeys and Apes, then we developed and became more intelligent and formed the "human" race. He also had other theories that dealt with reproduction and other human-animal related topics.

I won't comment much on Darwin's theories, because I don't know enough about it. But it is quite clear that the theory of Evolution has no support in Islam. Let us look at the proof:

Allah Almighty created the first man of Mankind on Earth from scratch. He didn't evolve him from any other GOD's creation: "Behold, thy Lord said to the Angels: 'I will create a vicegerent on earth.'...(The Noble Quran, 2:34)"

One comment I have to Darwin's Scientific Theories and Facts, and that is: Allah Almighty created humans and animals from Earth's dust: "From the (earth) did We Create you, and into it Shall We return you, And from it shall We Bring you out once again. (The Noble Quran, 20:55)" It is normal to find similarities in our Physiological Systems.

My question to all of the Darwinists out there is: If your belief is true, then how come humans didn't develop into something more intelligent and physically different than us today?

I know that we are much more technologically advanced and more knowledgeable than the humans that existed 3,000 years ago for instance. But if we originated from Apes and Monkeys, then what will be the advanced stage for us? Perhaps being born without fathers as it is done in cloning?

This still doesn't prove that humans came from animals or vise versa. We are far more intelligent than animals. We co-existed with animals for thousands of years, and they have not changed a bit. In fact, many of them have already been extinct.

Also spiritually, only humans on earth have Allah Almighty's Spirit in them. No where in the Noble Quran do we see Allah Almighty giving spirits to Animals:

"Behold! thy Lord said To the angels: 'I am about To create man, from sounding clay From mud moulded into shape; 'When I have fashioned him (In due proportion) and breathed Into him of My spirit, Fall ye down in obeisance Unto him.' (The Noble Quran, 15:28-29)"

Unlike · Comment · Follow Post · October 29 at 9:35pm

You and 2 others like this.   Seen by 64

Write a comment...

Although this learner did not demonstrate critical thinking, autonomy or rhizomatic thinking, she had clearly been exposed to a wealth of different information sources through the use of educational technology, and this can only be regarded as beneficial. It was evident in this action research cycle that the learners were better able to filter the vast array of information available on the Internet.

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[redacted]

Science and religion don't mix well, evolution being based on purely scientific facts and creationism based on faith.. There is no room for beliefs in science as they lead to bias results, however this does not mean a scientist must not have a religion.. As for my opinion I believe in both.

Unlike · Comment · Follow Post · October 29 at 10:09pm via mobile

You [redacted] e this. Seen by 64

Write a comment...

Faiq Waghid

What do you learners think about archeopteryx and the coelacanth in relation to evolution?

Like · Comment · Unfollow Post · October 29 at 8:54pm

Seen by 67

[redacted] he coelacanth has existed largely unchanged for the past 3 million years. its only recently that a new sub-species (the rebellatrix) was discovered. the rebellatrix has undergone a significant evolutionary in its ancestry

October 29 at 9:12pm · Edited · Like

[redacted] the coelacanth the fish that can breathe on land and in water

And is the archeopteryx the birds that were once reptiles

For the whole fish I think that that's one of the many beautiful animals God created

And for the reptile I really don't know what to make of it• Like is there proof that those animals were once reptiles

October 29 at 9:07pm via mobile · Like

[redacted] coelacanth is considered a living fossil

October 29 at 9:08pm · Like

[redacted] coelacanth is proof of the evolutionary process

[redacted] · Like · 1

[redacted] y have fossil evidence to support the theory

October 29 at 9:14pm · Like · 1

[redacted] Vell even though they do have and they maybe prove evolution is like real one day but I will still believe in my religion because since small we've been practicing our religion\faith and I don't think they would have made up religion so I still believe in my religion no matter what•

I'm not against evolution entirely but there's a fine line between the two and I believe in religion over everything

October 29 at 9:21pm via mobile · Like

Faiq Waghid Read Igshaq take on evolution then

October 29 at 9:27pm · Like

[redacted] ere is manyy thoughts and believes but i fully believe that my god is the creator and in what world can we come from a monkey like where is the facts like there has not be a monkeey with a

Learners expressed their independent voices.

Enhanced participation and equal expression of ideas occurred.

Learners took responsibility for their own learning and that of their peers. Learners also acted autonomously by doing research on archaeopteryx and coming up with different information sources, resulting in rhizomatic thinking being practised.

Although learners from different denominations initially were unwilling to entertain any ideas that were in conflict with their faith, they were now open and willing to listen to the ideas of others as the discussion progressed.

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[redacted] believe that God created us and that people cannot be linked as they say in evolution because how can that one organism create all of us, then who created that organism??? And the fact that evolution facts or theories are not permanent, they change all the time

Unlike · Comment · Follow Post · October 29 at 10:26pm via BlackBerry

You like this. Seen by 63

[redacted] stand 100% behind [redacted]
October 29 at 10:31pm · Unlike · 1

[redacted] nd Bible facts are permanent, and it clearly states that God wants us to have a relationship with him and that is through faith which we should all have faith
October 29 at 10:39pm via mobile · Unlike · 1

Write a comment...

[redacted]

[redacted] his is proof that god created life http://www.creationism.org/heinze/SciEvidGodLife.htm

Unlike · Comment · Follow Post · October 29 at 10:34pm

You and Baden Pelston like this. Seen by 63

Write a comment...

[redacted]

[redacted] m a christian and true believer of God and belive that He created all living,and 100% against evolution however still respect other people who are are pro-evolution

Like · Comment · Follow Post · October 29 at 10:29pm

Seen by 63

Write a comment...

[redacted]

i believe in creationism because evolution is too far fetched. with regards to the archeopteryx and coelacanth: sounds like adaptation, some thing God uses to make life easier for beings.

Unlike · Comment · Unfollow Post · October 29 at 10:11pm

You like this. Seen by 64

Faiq Waghid thanks for your input.
October 29 at 10:21pm · Like

[redacted] agree wi [redacted] 00%
October 29 at 10:24pm · Unlike · 1

Some learners may seem to be trapped in religious doctrine, although there is a greater indication that these learners were simply unaware of the theories in evolution that could coexist with their beliefs. This is primarily due to them joining in on the discussion much later as is evident from the time and date.

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Write a comment...

[redacted] If God doesn't exist then why do we have religions?..I believe in God and that he is our creator.

Unlike · Comment · Unfollow Post · October 29 at 11:06pm via mobile

You a [redacted] this. Seen by 63

Faiq Waghid we are not questioning that God exists, we are looking at the theory of evolution in relation to the life sciences curriculum, check the previous posts

October 29 at 11:22pm · Like

Write a comment...

> Some of the learners began to see the topic as evolution versus creationism due to the contentious nature of the discussion topic. This is why I had to remind the learners that it was actually a life sciences discussion.

[redacted] kinda confused,people say that they belief in evolution but the how can they call themselves christians,muslims,jewish or whatever religions there are if they dont truely belief that God created Earth

Like · Comment · Unfollow Post · October 29 at 10:37pm

6 people like this. Seen by 64

Faiq Waghid If you refer to some of the earlier posts you will learn that the two can coexist. Read some of them and let us know what you think?

October 29 at 10:40pm · Like

Faiq Wagh[redacted]

Creation and Evolution could possibly be the same thing, it's just that creation was written in a time when people didn't have the ability to understand something like evolution and how long it took to reach the stage we are now. God created the world in 6 days and rested on the 7th, but how long is one of God's days compared to ours? One of God's days could be a million years to us or more. As for the parts of the old testament that speaks of what God has said or done: such as Genesis; had to be bestowed on the authors of the old testament from a higher power, because they had no way of knowing. If it said God created the world, and then all the animals in it as well as humans by starting with single celled organisms and making us evolve into marine life, then land walking mammals would have confused people in those days. Basically we weren't ready for that knowledge. Evolution is just a perfect method to make us earn our existence in this physical world God has made for us.Like · · Unfollow Post · 2 hours ago near Cape Town

October 29 at 10:41pm · Like

> Due to the learners joining the discussion at a late stage, many of them missed out on the important points highlighted earlier in the discussion. Fortunately I was able to copy and paste earlier comments so that these learners were not excluded from the initial discussion.

[redacted] I spoke to Father Shaun and he told me that The Church is not against evolution but there are limits to what scientist think are true• He also told me that in the Bible where they speak about how Earth was made is more of a poem that envokes the mysterious of God

He told me that some Catholics are much more strict and can't really grasp this concept but our church believes in some parts of evolution buut that humans were made in an image of God [so I guess we don't agree with the whole apes bit]Unlike · · Unfollow Post · 2 hours ago via mobile

As the discussion progressed the learners demonstrated rhizomatic thinking by coming up with different takes on the topic.

Another instance where learners demonstrated rhizomatic thinking. Through exploring the Internet with the use of educational technology, the learners came up with different ideas on the evolution versus creationism argument.

Enhanced participation by learners and interaction between them occurred – another instance of Facebook as a medium for deliberation.

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[redacted]

I believe in evolution. Both adaptation and religion have no solid back up and religion is based more on faith that facts which I respect. But to me evolution and the single stem cell makes more sense and has more proof, although who is too say its not the way God planned for it to be.

Like · Comment · Follow Post · October 30 at 9:03am via BlackBerry

Seen by 61

Write a comment...

[redacted]

Creation and Evolution could possibly be the same thing, it's just that creation was written in a time when people didn't have the ability to understand something like evolution and how long it took to reach the stage we are now. God created the world in 6 days and rested on the 7th, but how long is one of God's days compared to ours? One of God's days could be a million years to us or more. As for the parts of the old testament that speaks of what God has said or done: such as Genesis; had to be bestowed on the authors of the old testament from a higher power, because they had no way of knowing. If it said God created the world, and then all the animals in it as well as humans by starting with single celled organisms and making us evolve into marine life, then land walking mammals would have confused people in those days. Basically we weren't ready for that knowledge. Evolution is just a perfect method to make us earn our existence in this physical world God has made for us.

Like · Comment · Unfollow Post · October 29 at 8:37pm near Cape Town

3 people like this. Seen by 67

Faiq Waghid interesting take on the topic, thanks
October 29 at 8:38pm · Like

[redacted]e!:) definitly interesting!!
October 29 at 8:53pm via mobile · Like

[redacted])I strongly believe that God made us all...science doesn't have accurate proof and this whole thing bout evolution changes everytime,either scientist discover something new and then their idea they had at first has to change.In histor... See More
October 30 at 8:58am · Unlike · 2

Write a comment...

[redacted]

I am a firm believer in God and in my faith and I don't doubt it at all.. BUT I am not against evolution. Because of various theories that prove how evolution came about I respect that there was something that happened a billion yrs ago. God might have had a hand in it

facebook

Search for people, places and things

[redacted]

I believe thaT gOd cREatEd mAn, plants and EarTh I rEalY don't bliEve thAt wE evolved frOm apEs...sum bEliEve tht wE dId bT ThtS oNlY BasEd oN facTs anD thE iNtErNet, buT thE thE BIBLE sAyS thT gOd created Man :)

Unlike · Comment · Follow Post · October 30 at 6:15pm via BlackBerry

You and 2 others like this. Seen by 61

Write a comment...

[redacted]

I believe in creationism, simply because I grew up with the bible telling me this is how it is :) but then again? Evolution happens, God might work through evolution. Creationists need to get over the fact that science is here (not to confound us, but to inspire us). God works in mysterious ways and gee, maybe science is one of them?

Like · Comment · Follow Post · October 29 at 8:34pm via mobile

4 people like this. Seen by 68

[redacted] y)woah it's good to see how interesting this topic is,evolution and creationism is something one really should think about.It has an important outlook on life.People have their own opinion and ideas,I respect that...but Creationism has the Bible which states how God made man and the earth.

October 30 at 9:11am · Like

[redacted] gree that god works in mysterious ways, but i dont believe that macro evolution could happen and that we all branch from different species, like humans coming from apes.

October 30 at 10:27am via mobile · Like

Write a comment...

[redacted]

I believe in evolution. Both adaptation and religion have no solid back up and religion is based more on faith that facts which I respect. But to me evolution and the single stem cell makes more sense and has more proof, although who is too say its not the way God planned for it to be.

Like · Comment · Follow Post · October 30 at 9:03am via BlackBerry

Seen by 61

Write a comment...

[redacted]

Creation and Evolution could possibly be the same thing, it's just that creation was written in a time when people didn't have the ability to understand something like evolution and how long it took to reach the

Through the use of educational technology, the learners were able to communicate in the way they feel most comfortable. In this instance the learner is able to convey her viewpoint through the use of different characters.

Another instance of a learner demonstrating critical thinking, being open to new ideas and being willing to listen to others. Learners also demonstrated rhizomatic thinking by coming up with different ideas beyond the normal creationism versus evolution argument.

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[redacted] I dont intend on criticizing anyone's religion and I respect everyone's personal beliefs,
BUT
There is no proof that God created human beings and all other forms of life, as a matter of fact their is no proof of an existing God at all, yet people simply believe in the mysteries because that's the way they were raised.
But in my opinion, life started as 1 DNA cell and is a non stop evolution/ adaptation process

> This learner not only demonstrated autonomous learning, but also rhizomatic thinking, by disrupting the deliberation, in this case controversially.

Like · Comment · Unfollow Post · October 29 at 9:53pm via BlackBerry

2 people like this. Seen by 66

Faiq Waghid thank you for your input
October 29 at 9:55pm · Like

[redacted] re so you don't believe that you were created by god ? (super confused face)
October 29 at 10:01pm · Like · 3

[redacted] then explain to me why did the process stop???,are you saying that a 100years from now we will be deformed into something else?
October 29 at 10:13pm · Like

> Due to the disruption on the part of the learner the discussion was driven in a different direction – towards the learners' understanding of the proof for human evolution. In this way the disruption served to stimulate the learners' learning beyond the initial confines they learners seemed to impose on the discussion.

Faiq Waghid Nina is putting her thoughts out here people, let's not demand explanations from her. Stephan why don't you do some research into evolution in humans in our time?
October 29 at 10:21pm · Like

[redacted] r Faiq Waghid, is there any SOLID proof of human evolution? Or was it just something scientists pasted on over time?
October 29 at 10:26pm · Like

Faiq Waghid http://listverse.com/2009/01/05/top-10-signs-of-evolution-in-modern-man/
October 29 at 10:30pm · Like

Faiq Waghid Razaan Abrahams I have posted a link to a website that may answer your question.
October 29 at 10:31pm · Like · 1

> As a consultant in the discussion I was able to address the concerns of many learners.

[redacted] ank you sir:)
[redacted] Like

[redacted] we believe in God,we shouldn't have to question him..I believe in God and that his is our creator
October 29 at 11:04pm via mobile · Like

[redacted] w do u know with alll the global warming humans won't start to evolve to adapt to the new climates, obviously it will take years and we wont be around to see it. A am I christian and I do believe in God but there is no proof that he created me
October 30 at 8:13am · Like

> Learners realised the sensitive nature of the discussion and were consequently respectful of peers in the deliberation.

[redacted] understand that we all have I own opinion on evolution-- but I don't understand how it could be said that you believe in God but not that he created us. Doesn't it say in the bible that God created Adam And Eve. So Isn't that evidence enough that he created humans. Not trying to argue on your beliefs but I don't agrue against what's said in the bible
October 30 at 10:51am via mobile · Like

Learners made full use of Facebook's features, such as uploading pictures and links to websites to help facilitate the learning process.

Although many learners participated in the discussion, it was evident from this post that some learners merely saw Facebook as a means to voice their ideas without deliberating with their peers. In previous posts, many learners were able to revise their initial understandings, allowing them to see creationism and the theory of evolution coexisting.

facebook

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[redacted]

I strongly believe in creationism.. in Islam evolution is not accepted. I believe that God created us . As a child i was taught not to ask too many questions regarding our religion. God's power is so strong that no human brain can be able to handle without slowly heading into insanity. So in my point, as Rehana has said, how was life created if not by God, as humans developed technology developed we began to become curious about everything, asking questions then falling back on science, hence evolution for answers because we fear the unknown and lack faith. Many miracles have happened to people so there is definitely a higher power and to this day humans are still discovering different things that God placed on earth. It is a test of faith....where animals and humans come in my answer is adaptation we humans are the cause too with global warming, climate change and there is animal mating. Things were put on this world by God things not even in the Quraan are explain in detail..so who are we to question?

Unlike · Comment · Follow Post · October 30 at 10:26pm

Y[redacted] Seen by 56

Write a comment...

[redacted]

I believe in God aand that he created us beautifuul human beings:).In my point of view evolution has not been proven properly too us for us too see,unlike in creationism has greater facts too back it up with.

Unlike · Comment · Unfollow Post · October 30 at 7:18pm via mobile

You like this. Seen by 59

[redacted]eater facts does it have to back it up though?
October 30 at 7:49pm · Like

Faiq Waghid ?
October 30 at 8:30pm · Like

[redacted]elieve in creationism too, the Bible says that God created the Earth, but, what greater facts are you talking about? Scientists have proven that things and some say everything was formed by DNA, which is true but doesn't entirely prove evolution. Th... See More
October 30 at 9:01pm via mobile · Like

[redacted]hink that evolution does have enough facts but we were brought up believing in God..so that's just how we would think it would be.
October 30 at 10:05pm · Like

Write a comment...

By the end of the discussion it was evident that learners who participated in the discussion had a better understanding of the theory of evolution and were able to assist their peers.

`

facebook Search for people, places and things

[redacted]

I believe in creationism because I am a muslim
"It is Allah who created the heavens and the earth and whatever is between them in six ayums". Qur'an, Surah 32:4

4. ^ Say: Is it that ye deny Him Who created the earth in two days?....and measured therein all things to give them nourishment in due proportion, in four days....So He completed them as seven firmaments in two days, and He assigned to each heaven its duty and command. (For a total of eight days of creation: Qur'an 41:9-

Islamic views on evolution are diverse, ranging from theistic evolution to creationism. Muslims believe in a God as the Creator, as explained in the Qur'an. Throughout history some Muslim thinkers have proposed and accepted elements of the theory of evolution, while believing in the supremacy of God in the process. In modern times, some Muslims have rejected evolution, and teaching it is banned in some countries. The main schism between Islam and evolution is in the Adamic descent of human beings, a concept which modern biological anthropology rejects as mythology, supported by fossil evidence.

Very often, it seems as though evolution and religion must be locked in a desperate struggle of life and death - and, for some religious beliefs, perhaps that impression is reasonably accurate. However, the fact that some religions and some religious dogmas are not entirely compatible with evolutionary biology does not mean that the same must be true for all religions or religion generally.

Unlike · Comment · Follow Post · October 31 at 3:12pm via mobile

You and 2 others like this. Seen by 56

[redacted]ree wit[redacted] 100% I totally agree...I believe that micro-evolution totally existz 😐...because it is literally proven everyday...but macro-evolution is a bit harder 2 grasp especially because it is mostly proposed theories and does not have totally un-deniable proof in every case...
October 31 at 8:23pm via mobile · Like · 1

[redacted],9%
October 31 at 10:41pm · Like

Write a comment...

[redacted]s a firm believer of creationism I do not in anyway discriminate against anyones beliefs and religions... I am open to the opinion of everyone and I do not in anyway judge what one may say.... I was brought up to believe that the earth was created by God and If my parentz didn't teach me that im positive that I wud have still been a believer...the following website provides sum versus in the bible stating factz abwt God and his creationz.... www.earthcareonline.org....then in bible verses.... So yeah I do believe that we were created by the almighty...:)

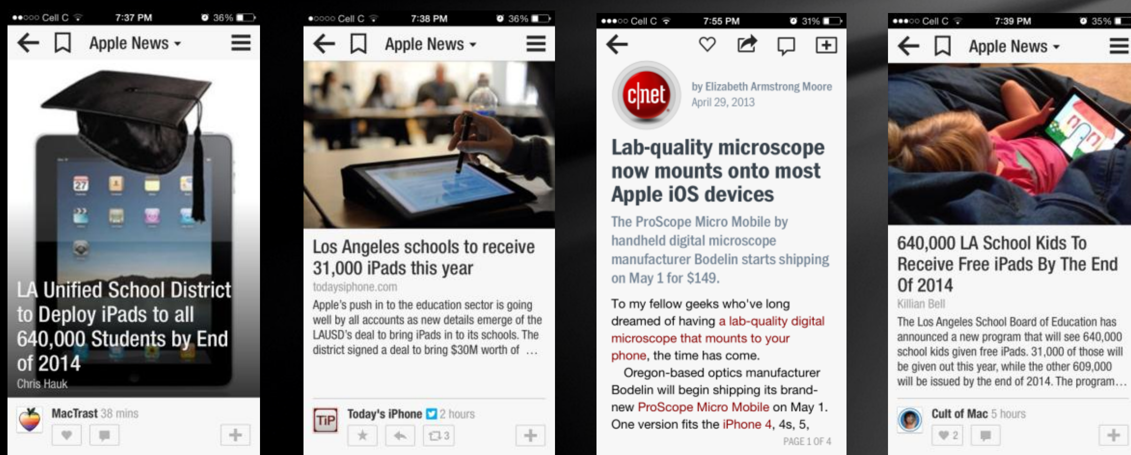
The final wall post aptly summed up the contentious nature of the discussion topic. Through Facebook as an educational technology the learners were able to demonstrate autonomy and rhizomatic thinking, moving them beyond their initial understanding of the topic of evolution and making them wonder about it.

Because the learners acted autonomously by doing their own research, they were able to think differently, rather than adhering to norms when there is a discussion on evolution. By using Facebook and other technologies as medium, the learners were able to think rhizomatically and consequently changed their initial perceptions of the discussion topic. They began to wonder.


PhD Presentation
Faculty of Education
Stellenbosch University
Towards the democratisation of senior phase school science through the application of educational technology
Faiq Waghid
2013

Main Research Question

Does the use of educational technology contribute to the democratisation of teaching and learning?

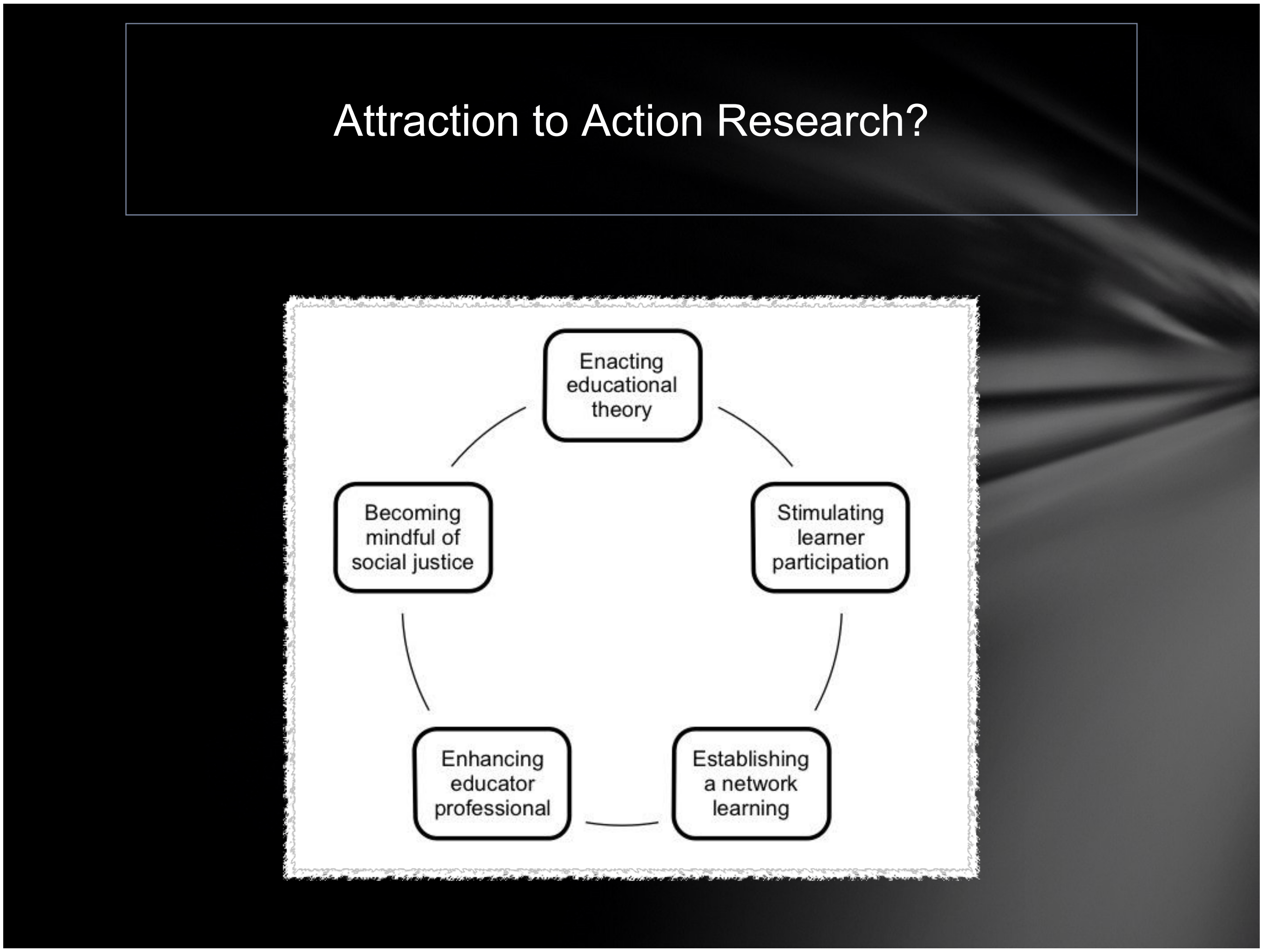


Educational Research Design: Action Research

To embark on pedagogical practices that can improve my professional practice

To reflect more on my teaching and to experiment with new ideas in science classrooms

Stimulate and provoke learners to use technology (Facebook) as to enhance understanding and practice and to become mindful of issues of social justice


Attraction to Action Research?
Enacting educational theory
Stimulating learner participation
Establishing a network learning
Enhancing educator professional
Becoming mindful of social justice

Democracy and Education

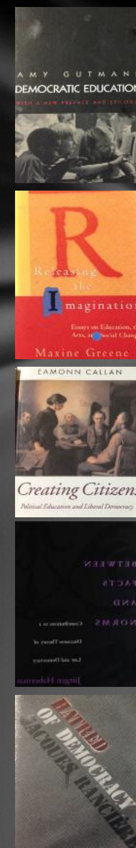
Amy Gutmann (1987) - education is political; learmers need to influence education which in turn influences their values, attitudes, and modes of behavior as future citizens and deliberative inquirers

Maxine Greene (1995) – education involves connecting with others to transform what is inhumane and unjust

Eamonn Callan (1987) – education involves encouraging learners to speak their minds, provoking deliberation, and initiating learners to become just and to change undesirable situations

Jűrgen Habermas (1995) – education is inclusive, argumentative and encourages learners to be reasonably persuasive (searching for the better argument).

Jacques Ranciére (2006) – education is about inclusion of learners through allowing them equal equality to exercise their voices and to disrupt the conversations.



Democracy and Science Education

Wolff-Michael and Lee (2003) science education in schools ought to gain a democratic character . What does it involve?

(1) Not all citizens should be scientifically orientated

(2) Science should not necessarily be biased, and should accommodate differences

(3) Science education should promote participation in community life

Educational Technology and Democratic Science Education

Emerging educational technology holds the key to improving education (Gimbert & Cristol, 2004)

Educational technology can enable new ways of thinking (Burbules, 2007)

Educational technology can provide educators with pedagogical support, in particular teaching and learning (Selwyn, 2011)

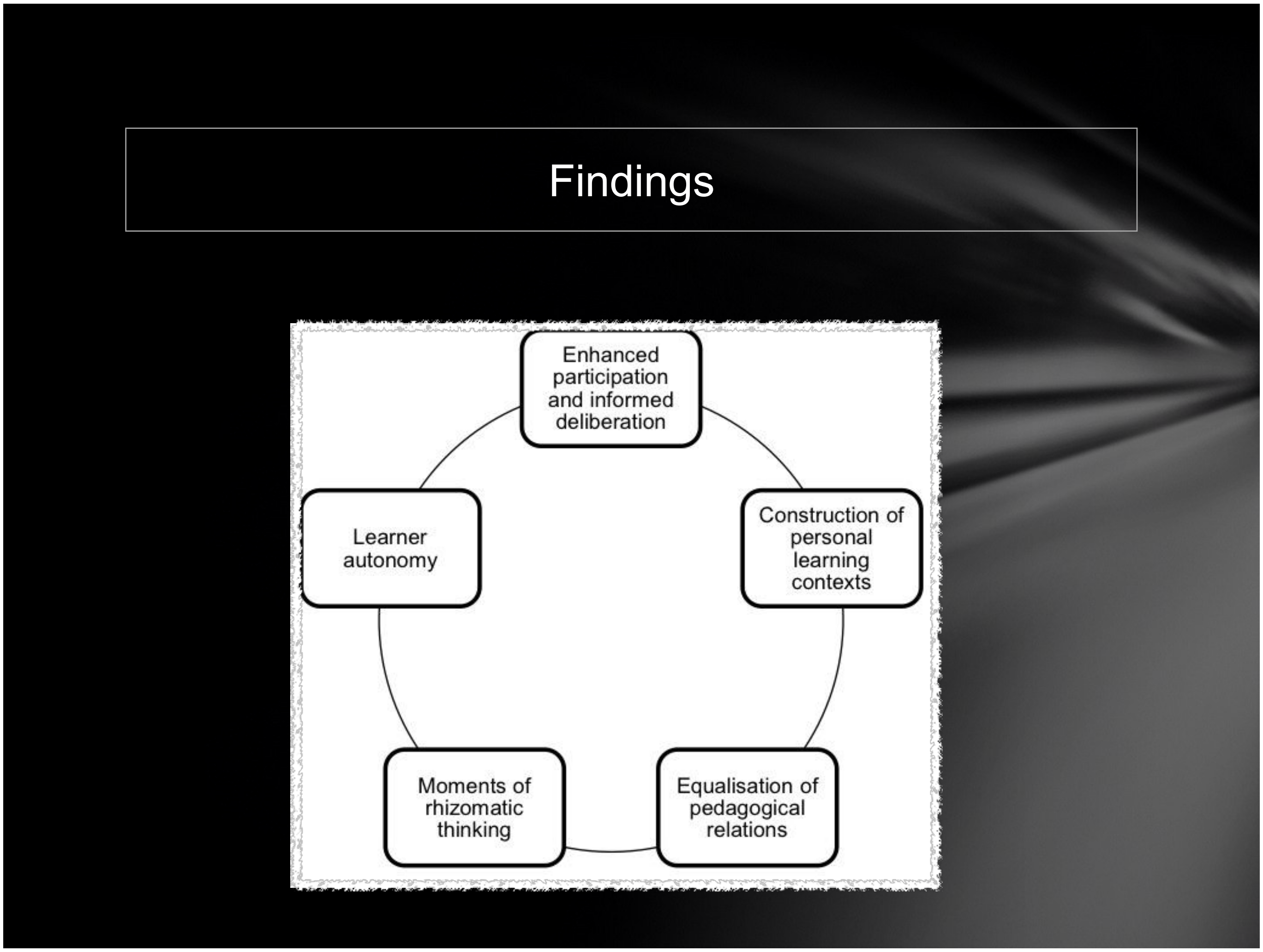
Educational technology can also give rise to autonomous / rhizomatic learning creating opportunities for learners to embark on new lines of flight or vectors of escape in order to become deterritorialised and reterritorialised (Deleuze & Guattari, 1987) – that is, establishing new connections and possibilities

Three Action Research Cycles

(1)Cycle I: Learners experienced technical difficulties and hence their participation was minimal

(2)Cycle 2: Learners became confident in using Facebook, however, despite the technical improvements, there still was a lack of engaged participation although critical thinking was evident – my role was that of stimulant (linear discussions unfolded)

(3)Cycle 3: Unrestricted openness that brought a flood of ideas in quite haphazard and at times chaotic fashion – emergence of rhizomatic thinking – that is, learners can wonder and think beyond their limitations (Deleuze & Guattari, 1987)


Findings
Enhanced participation and informed deliberation
Construction of personal learning contexts
Equalisation of pedagogical relations
Moments of rhizomatic thinking
Learner autonomy

Elaboration of Findings

With educational technology the following happened:

Debates, discussions and deliberations confirm that the use of educational technology gave rise to opportunities for learning to become democratised (enhanced participation)

Learners trusted the responsibility to decide for themselves (individual autonomy)

Learning was without limit and enclosure (personal learning contexts)

Learners were able to speak, understand, share and construct their opinions in collaboration with other learners (equalisation of relationships)

Learners' thoughts were scattered and then scrambled together to form new assemblages of knowledge (rhizomatic learning)