ON THE DEMOCRATISATION OF SCIENCE EDUCATION THROUGH FACEBOOK: IMPLICATIONS FOR AUTONOMY, EQUALITY AND TEACHER EDUCATION AT UNIVERSITIES

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ABSTRACT

In this article I offer a defence for using educational technology to democratise classroom practices in relation to science education and teacher education at universities. My contention is that educational technology, more specifically using Facebook, can engender pedagogical action among learners and educators that resonates with democratic practices. In other words, using educational technology in science and teacher education can enhance learner autonomy and equality, so that critical, self-reflexive thinking and disruptive thought and action, respectively, can be cultivated through technology-assisted education.

Keywords: education, democracy, autonomy, equality and technology

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INTRODUCTION: IN DEFENCE OF TECHNOLOGY-ASSISTED EDUCATION

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 while still complying with sound pedagogical practices (McHaney 2011, 1). McHaney (2011, 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, 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, 51). Although many individuals in education hold the view that learners need to use traditional sources of knowledge, such as libraries, McHaney (2011, 51) suggests that it would be more beneficial for learners to be exposed to the wealth of knowledge, albeit of varying degrees of quality, which 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, 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, 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 the learners. It is this kind of imagination that can push aside obsolete teaching pedagogies to cultivate better pedagogical experiences for learners (McHaney 2011, 53).

There is much promise in the sense that technology can help to produce a fuller pedagogical experience for learners (McHaney 2011, xviii). Working towards a fuller pedagogical experience has been aided by the advent of many social computing and social media smartphone device applications to promote such an experience for learners (McHaney 2011, xviii). Various forms of technology thus have converged with one another. The convergence of technology is known as Web 2.0, and consists of five components, namely, social computing, social media, content sharing, filtering and web applications (McHaney 2011, 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, xviii). McHaney (2011, xviii) suggests that, when these components are integrated into classroom practices, there is a potential for richer knowledge delivery to the millennials than what we encounter in classrooms today. Moreover, Garrison and Anderson (2003, 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.

This article explores how the social media platform Facebook can be used to teach contentious issues in the grade 10 life sciences curriculum and the implications such a technology has on the democratisation of the classroom. It also accentuates the important role teacher educators at universities ought to enact in cultivating technology-assisted teaching and learning (science) classrooms for the reason that practices of student autonomy and equality are enhanced as enabling conditions for pedagogical change.

DEMOCRATISING SCIENCE EDUCATION

Science education in schools in most of the Western world has been widely perceived as comprising 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, 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, 3). Furthermore, over the past 50 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 works in small teams, pushing the boundaries of knowledge as part of an intellectual pursuit over which he or she has 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, multidisciplinary, significantly technologically linked, and often having significant community implications (Tytler 2007, 3).

In fact, the increasingly technological nature of contemporary society and the increasing need to manage resources and the effects of development carefully place new imperatives on the way the public needs to engage with and respond to science and its products. According to Bauer (2008, 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 PUS 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, 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, 4). There is widespread consensus that science education in schools under-emphasises 'the ability to analyse and present an argument based on data' (Association for Science Education 2006, 11) – skills and competencies required to address the aforementioned concerns about science education.

Science education in schools functions in contexts in which 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, 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' (Association for Science Education 2006, 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 and Collins 2001, 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 et al. 2003, 706–709). Thus, when teacher educators at universities endeavour to initiate student teachers into a discourse of technology-assisted and transformative science education, they have in mind the importance of cultivating student reflexivity and democracy – aspects of education that resonate with emerging approaches in science pedagogy in schools.

Furthermore, in defence of an inquiry-based approach to science education 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 wellbeing (Goodrum, Hackling and Rennie 2001, 6–9). In fact, much of the content knowledge I learnt at school and 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. 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, 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, 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, 126). And, when teacher educators at universities engender in student teachers a pedagogy of risk taking, they prepare them to cope with the changing demands of school contexts.

Secondly, the democratisation of science education is associated with engaging participants (learners and educators) in deliberation. Newton, Driver and Osborne (1999, 555) identify a shift in the position of science education in schools, from a view that grounds 'claims in truth 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, 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. This can only happen when university educators become more intent on preparing deliberative students for the school (science) classroom.

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, 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 and Osborne 2000, 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 for teacher educators in universities to embark on action research practices integrated with educational technology that can enhance the democratisation of science education in schools. 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 who can contribute to issues that have a scientific dimension, whether these issues are personal (relating to medication or diet) or political (relating to nuclear power, ozone depletion or DNA technologies) (Jenkins 1999, 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, which adds complexity to science communication (Bauer 2008, 117).

Following 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, 262) that hopefully will give science education in schools its democratic character. 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 and Lee 2003, 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, 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 wellbeing 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 wellbeing might not even have been discussed by learners exposed to health-undermining gases (Eisenhart, Finkel and Marion 1996, 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, 5).

Wolff-Michael and Lee (2003, 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, which implies 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, 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, 189). One view is that an effective workforce in society requires scientific and technologically literate persons (Hazen and Trefil 1991, 3). Wolff-Michael and Lee (2003, 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, 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 individuals. This is contrary to the notion of science for all or, more specifically, democratic science education. This traditional, individualistic approach to science therefore has marginalised diverse audiences (Wolff-Michael and Lee 2003, 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 and Wynne 1996). Everyday science is not unproblematic, objective and coherent (Roth and Desautels 2004, 37). On the contrary, science is uncertain and contentious, and it provides insufficient solutions to individuals' everyday lives (Jenkins 1999, 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, 6). Wolff-Michael and Lee (2003, 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 (Bauer 2008, 115; Jenkins 1999, 703). 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, 5). Teaching this form of science hopefully will ensure that learners are competent in their everyday lives (Wolff-Michael and Lee

2003, 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, 261) furthermore suggest that there should be a move in emphasis from science education focusing 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, 262). Wolff-Michael and Lee (2003, 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 homogeneous group (Wolff-Michael and Lee 2003, 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 and Lee 2003, 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 and Lee 2003, 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 and Lee 2003, 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 and Lee 2003, 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.

This brings me to a discussion of how science education can be democratised with the use of Facebook – a practice that possibly could encourage university educators of science education students to engender forms of learner participation that will potentially enhance autonomy and equality.

FACEBOOK AS EDUCATIONAL TECHNOLOGY: USING SCREENSHOTS TO ANALYSE DATA

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, and using Facebook, my initial assumptions regarding Facebook as a potential teaching tool were 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.

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 and Munoz 2011, 35). Facebook had humble origins, having 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 1.23 billion active users (McHaney 2011, 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 lives, not only as a communication tool but for electronic socialisation (Towner and Munoz 2011, 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 users 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. Users on Facebook can also join groups which 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, 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.

A group can be used as a teaching tool where, for example, learners are able to communicate with friends or friends of friends to gain insight when writing reports or preparing for examinations (McHaney 2011, 80). This form of social interaction among learners who form part of this community facilitates knowledge creation (McHaney 2011, 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 in, 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 ensure 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 users' '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, 82).

Moreover, many connected individuals all contributing to knowledge production seem 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, 613).

As Facebook's popularity has increased, educators and learners have come into contact as they share the same social space (Towner and Munoz 2011, 36). Mazer, Murphey and Simonds (2009, 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, 147), that is, a matter of democratising classroom practices. The privacy concerns, in that there is an erosion of the professional boundaries between learners and educators, are often scrutinised (Towner and Munoz 2011, 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 the learners (Towner and Munoz 2011, 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 and Munoz 2011, 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 and Pitts 2009, 175). It allows learners the facility to communicate with educators when time constraints do not permit face-to-face interaction (Li and Pitts 2009, 175). This is in consonance with the perceptions of learners using Facebook, namely that it is more a learning tool than a means of instruction for educators (Towner and Munoz 2011, 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 and Munoz 2011, 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 and Munoz 2011, 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 and Munoz 2011, 51).

Research indicates, however, that some learners are less accepting of using Facebook as either an informal or a formal teaching tool (Towner and Munoz 2011, 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 and Munoz 2011, 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, 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.

McHaney (2011, 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. Smartphones are becoming increasingly more powerful and their capabilities are parallel to those of laptops or desktop computers, allowing Facebook to work on mobile phones. Phones can access Facebook via their integrated web browsers, or through specially written Facebook applications. The convergence of smartphone and Facebook consequently allows these technologies to have a pedagogical potential. 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. To illustrate the pedagogical potential that Facebook holds, screenshots of the Facebook group site were used as a form of data collection. An illustration of how the analysis was conducted can be seen in the screenshot in Figure 1:

Figure 1: A screenshot of the Facebook group site

TOWARDS THE CULTIVATION OF STUDENT AUTONOMY AND EQUALITY

By far one of the most important findings of the aforementioned approach to technology-assisted pedagogy is 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, alluded to earlier, 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, 496). 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, 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 they previously engaged in pedagogical spaces to think and act critically, they have now been stimulated through educational technology to act 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. For instance, after having completed research on the contentious issues and posted it on the Facebook group page, they not only have learnt to deliberate, but also to take autonomous decisions. 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, 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.'

Equal democratic relationships (following Rancière 1992) 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, 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, 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.'

In conclusion, through the use of educational technology, especially Facebook, learners were initiated into democratic practices through which they were provoked to act more autonomously and equally. That is, their autonomy has been enhanced because, on the one hand, they took initiative in and throughout pedagogical activities. On the other hand, they could equally articulate their views about their learning, which suggests they have actually come to speech. And, considering that democratic education is considered as a way in which people can deal with the contentious challenges in a transforming society, it seems plausible for university educators to become more attentive to the use of educational technology as they prepare future teachers and citizens for participation in a global democracy.

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