CAN SOCIAL COMMUNICATION BE USED AS A STRATEGY TO ENHANCE TEACHING AND LEARNING OF LIFE SCIENCES? PERCEPTIONS OF STUDENT TEACHERS

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ABSTRACT

Social communication in the current context of an informational and technological society has become indispensable globally and in South Africa. This article examines how social communication can be used as a strategy to enhance teaching and learning of Life Sciences amongst student teachers at an institution of higher learning. Focus group discussions were held with senior Life Sciences student teachers, who were allowed an opportunity to tell their own stories of how they were able or unable to use social communication as it prevailed for them mediating the teaching and learning of Life Sciences. Social communication networks in education for example are increasingly used as a mode of delivery of education, but recently there have been some initiatives to establish how it can be used effectively in improving academic performance of students. Globally students are using social networks such as Twitter, MXit, Facebook, etc. although the majority of learners use this social means of communication for other purposes than education. The findings indicate that social communication enhances teaching and learning and regular usage thereof promotes learner interest in Life Sciences. Although there exists a strong desire to integrate social communication in the teaching of Life Sciences, there are many barriers. Accessibility, confidence and competence are critical components of technology; resources, effective professional development, and technical support need to be provided to student teachers.

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BACKGROUND

Social communication networks have become a common medium in both business and education for communicating ideas and messages that are beneficial to institutions. Modern technology offers many means of improving teaching and learning in the classroom (Lefebre, Deaudelin & Loiselle 2006). In support of this, Dawes (2001) argues that new technologies have the potential to support education across the curriculum, also providing better opportunities for effective communication between students and teachers. Communication is understanding and being understood by other humans, but this is about far more than just the words we speak. Collaboration is working together to achieve something. These two areas of human interaction are used in social communication, and they share many features that help make society constructive. A professional learning community encourages collaboration and dialogue access to colleagues' openness to challenge understandings. Yelland (2001) asserts that organisations that do not incorporate the use of new technologies in schools cannot seriously claim to prepare their students for life in the twenty-first century.

When communication and collaboration breaks down, the worst could be anticipated; violence and even war sometimes break out. If humans did not have effective communication and collaboration skills, the world would be a difficult place to live in. Networks such as Twitter and Facebook provide a platform where users can enter into dialogue, exchange ideas and find answers to questions. These networks are designed to foster collaboration and discussion.

In this study, senior Life Sciences student teachers at an institution of higher learning were allowed an opportunity to tell their own stories of how they were able or unable to use social communication in the teaching and learning of the subject. The idea was to obtain a snapshot of the reality of their social communication as it prevailed, and relate it to the way they used it, mediating the teaching and learning of Life Sciences.

PURPOSE OF THE STUDY

The purpose of this study was to investigate the extent to which social communication networks are used to enhance teaching and learning by Life Sciences students at an institution of higher learning. Identification of barriers to the use of social communication in teaching and learning could provide "guidance for ways to enhance technology integration" (Schoepp 2005) and encourage greater use thereof.

CHALLENGES TO THE USE OF SOCIAL COMMUNICATION

The student teachers who participated in this study originate from different backgrounds and had various levels of prior knowledge of Life Sciences when they first enrolled at the institution. A scientifically conceptual and contextual foundation in Life Sciences is of utmost importance. When teaching towards an understanding of major concepts in Life Sciences and achieving conceptual change for students, it is first necessary to understand students' prior knowledge, examine it, identify misconceptions, and then provide opportunities for old and new ideas to relate. Such an experience usually becomes very difficult to fulfil at higher education institutions considering the time allocated to accomplish plans (Al-Alwani 2005; Sicilia 2005; Gomes 2005) and for contact sessions with the students. According to Al-Alwani (2005), lack of time is an important factor affecting the application of new technology in science education.

At the institution involved in the study, the platform Blackboard, accessible through the university's intranet, is mainly used. Not all these students have access to Blackboard after hours. Information posted by the lecturer on Blackboard could only be accessed by some students when they arrive on campus the next day. Lack of access is one of the largest barriers to using ICT in teaching (Empirica 2006; Sicilia 2005). If there are urgent announcements regarding the class and the subject not all students can access this information timeously.

It is important to relate what is taught to students' everyday life experiences to make that content more meaningful because if students do not understand, they cannot learn. If topics such as cellular respiration, replication of DNA, and mitosis and meiosis are taught as a series of steps and not its significance within a context, then students will simply parrot names without any meaningful learning. Life Sciences teachers have to look for ways to include possibilities for genuine inquiry-based learning. Fundamentally, when there are new tools and approaches to teaching, teacher training is essential (Osborne & Hennessy 2003) if they are to integrate these into their teaching. Newhouse (2002) states that "teachers need not only be computer literate but they also need to develop skills in integrating computer use into their teaching/learning programmes". Pre-laboratory exercises, for example, could be put on a website to enable students to complete these at their own time. Life Sciences teachers should also take note that how they assess impact significantly on how and what students learn. They need to take heed of the fact that they should make use of assessment that will encourage deep thinking and learning.

Expensive hardware and software, as well as the high cost of communication and services, restrict access to social communication networks (Farrell 2007). Limited access, and inadequate technological infrastructure, such as a lack of hardware and software, limit individual and community access to ICT and

also pose a barrier to its integration with the school curriculum (Menda 2006; Janczewski 1992). Most of the students who participated in this study have indicated that they do not have access to the Internet after hours. They rely on the institution's facilities for access.

ATTEMPTS TOWARDS RESOLVING THESE CHALLENGES

At the higher education institution involved in the study, Blackboard is mainly used as a means of communication for academic purposes. The Life Sciences student teachers are gradually being exposed to the use of Twitter and YouTube for notices, pre-laboratory exercises and simulated experiments as a supplement to Blackboard.

In teaching towards understanding of major concepts in biology and achieving conceptual change for students, it is first necessary to understand students' prior knowledge. Social communication allows a lecturer to add his thoughts, and allows students to continue working through the day (Yelland 2001; Brandsford, Brown & Cocking 2000) using, for example, YouTube, Twitter, etc. These platforms allow discussions to flow and new knowledge to be created despite the geographical location and time, and as such enable Life Sciences students to overcome barriers in conceptual understanding and improve on their thinking; that is, they will learn, uncover and discover.

The type of Life Sciences teachers that institutions of higher learning produce should be lifelong learners who are not only competent in knowledge and skills in Life Sciences, but also competent to make decisions and participate in public debates on the subject and other socio-scientific issues. This can only be achieved through active student-centred methods of school work (Michael 2006), including class discussions, excursions, field work, problem-solving, and laboratory work as flagship (Hofstein & Lunnetta 2004; Hofstein & Mamlok-Naaman 2007); also, inquiry and problem-based methods and approaches (Hmelo-Silver 2004). Through social communication platforms such as Twitter and YouTube students are able to engage in problem-solving, information-sharing and discussions with classmates, preparation for laboratory work, and laboratory work through viewing simulated experiments anywhere at any time (Chaka & Ngesi 2010).

THEORETICAL FRAMEWORK

According to Lim (2002), the use of social communication networks in education is based on activity theory. This allows for the study of a combination of variables such as events, activities, and contents within an activity setting in which ICT is situated (Lim & Hang 2003).

> Learning is no longer studied in the light of students learning in isolation with only their minds to guide them: instead, the emphasis is on students learning with a variety of tools and participants in the learning environment that mediate their goal oriented activities (Vygotsky 1978, in Lim & Chai 2003).

Social communication is the latest of the artefacts finding their way into the education arena for use in teaching and learning, as well as expanding pedagogical resources available to science teachers (Al-Alwani 2005). It has found its way into the classroom where teachers and students were traditionally using the chalkboard and textbooks. Life Sciences teaching and learning have more sophisticated mediation tools; the so-called "science apparatus" housed in purpose-built science laboratories. As social communication networks enter the arena of the existing culture of "material and social resources" (McCown, Driscoll & Roop 1995), teachers may have to rethink their lesson objectives, learn new skills and work with a new set of tools. Students alike may have to learn new skills.

The question that this study sought to address is to what extent social communication is used by Life Sciences student teachers, with reservation or with enthusiasm, in enhancing teaching and learning of their subject in particular. Social communication expands the course offerings of a school, which is very significant. The courses can be taken by whole groups, or just one interested student. According to a study conducted by Adeogun (2001), research conducted in South Africa indicated that the condition(s) of the schools may have an effect on poor learner performance if teaching materials are inadequate, whereas when using social communication networks learners understand faster than when they are taught in class.

Most of the students who participated in this study have access to cellphones, whereas they may not have computers with Internet access at home. The available literature also confirms that in South Africa, as is the case in other African countries, the national electricity grid is limited to commercially viable areas, with often poorly serviced rural areas. Lack of electricity in some homes, together with frequent power breakdowns and power cuts, has increased the cost of owning social communication networks infrastructure (Farrell 2007), and thus make it almost impossible for people residing in rural areas to access and use ICT in education; clear evidence of the digital divide.

PARADIGM

Life Sciences, or biology, is about life. It is both a domain of knowledge and process of investigation. People learn best when they are actively involved

rather than being passive listeners. Constructivism elevates the importance of processes, especially the knowledge construction process. As advocated by Piaget (1981) and Bruner (1990, in Williams 2000), an individual's constructs are developed through discovery. Through this process, students are therefore given an opportunity to manipulate ideas, and to generate and test hypotheses (Skaife & Wellington 1993).

Education works best when it concentrates on thinking and understanding, rather than on rote memorisation. Constructivism concentrates on learning how to think and understand. Referring to Vygotskian Social Constructivism, which pays attention to the context of knowledge construction, social communication is useful as a tool mediating among learners, parents and teachers. The role of the Life Sciences teacher in this case is to provide scaffolds in the learning process, and to guide and coach the students who are actively engaged in constructing knowledge individually and socially. The students then learn through carefully scaffolded projects where expert behaviour is modelled and mediated through peer interaction. Social communication as such plays the mediation role, providing informative tools, communication tools, constructive tools, and co-constructive tools (Williams 2000). Social Constructivism includes situated learning; similarly, in Life Sciences students engage in activities directly relevant and applicable to the concepts and context in which the learning will be applied.

Life Sciences teachers have to take heed of the fact that learning is a social activity where learners construct their understanding not only through interaction with the material, but also through collaboratively constructing new knowledge with their peers. By means of this collaborative learning process, the learners' cognitive development is supported through the interaction and coordination of different perspectives amongst peers (Bearison & Dorval 2002), and plays out in pedagogical terms as Social Constructivism.

The collaborative, communicative and interrelated nature of social communication makes it an ideal tool for supporting Social Constructivism in teaching and learning. Powerful teaching and learning attributes of quizzes and simulations can be enhanced when it occur online, in a networked fashion any time anywhere.

VALUE OF THE STUDY

While social communication may not provide a panacea to the problems hindering Life Sciences teaching and learning, the findings could provide the Life Sciences teachers with some examples of best practice on what he or she can do with social communication in the practice of teaching. Pertinent to this study is the networking component where student teachers were to communicate using platforms such as Twitter, Facebook and YouTube.

METHODOLOGY

The research methodology used is qualitative and the design is descriptive. Descriptive research is concerned with conditions or relationships that exist, practices that prevail, beliefs, points of view, or attitudes that are held, processes that are ongoing, effects that are being felt, or trends that are developing (White 2005). Focus group discussions were held with 48 senior Life Sciences student teachers at a university of technology.

Population and sampling

For purposes of this research study, the size of the accessible population was determined by using a method suggested by Cohen, Manion and Morrison (2011) which states that, "for a small population (with fewer than 100 people or other units), there is little point in sampling, survey the entire population". In this study the population comprises of 48 senior Life Sciences student teachers at a university of technology. They all participated in the study through four focus group discussions.

Research question

This study aimed to address the following research question: To what extent can and are social communication networks used to enhance teaching and learning and also promote students' interest in Life Sciences?

Limitations of the study

The study limited participants to the Life Sciences senior student teachers. On reflection it became clear that other student teachers and lecturers could have contributed significantly. Secondly, the time spent with these student teachers was rather short. Spending more time with them could have been more revealing as to the reasons for the observed apathetic use of social communication in their learning.

Ethical considerations

As Goddard and Melville (2006) observe, "collecting data from people raises ethical concerns". Bynard (2007) asserts "it is therefore important to avoid hurting people and to treat them with appropriate respect as individual human beings". People have to be informed about what will be done with the results of the study and why their opinions or help is sought (McMillan & Schumacher 2006). In this study, participants were informed of the nature and purpose of the research as well as its benefits, and the fact that they must consent to participate without coercion. Participants were made aware that their participation is voluntary and that they were free to withdraw from the study at any time.

Data collection and analysis

According to Hancock (2002), qualitative approaches to data collection usually involve direct interaction with individuals on a one-to-one basis or in a group setting. It is for this reason that the main method of data collection, namely focus group discussions, was employed with the aim of describing the experiences of Life Sciences student teachers on the use of social communication in teaching and learning. The researcher was primarily concerned with the nature and degree of the existing situation. All 48 participants had mobile phones. Research has proven that mobile phones can be used to support teaching and learning (Van Rooyen 2010), and for collaborative learning (SAIDE 2009).

It is important to note that the social communication strategy employed by the institution where the study was conducted is mainly Blackboard and SMS. The institution has control over the content as it is monitored.

When asked about access to the Internet, and Blackboard in particular, two of the respondents responded as follows:

> *I come from an impoverished area. We have no computer at home and there is no internet shop; the only place where I can access internet is here at the University. During the weekends I have serious problems because I can only see what has been posted on Blackboard when I arrive at the institution the next Monday.*
>
> *I have tried using the internet cafe at my home town which is 70 km away from my university and always have difficulty in accessing Blackboard from there*.

It is evident that not everyone had access to a computer, not to mention Internet facilities. However, all respondents indicated that they have cellular phones from which they could access social media platforms such as Twitter, Facebook, MXit, and YouTube.

One respondent argued:

> *It was very difficult for me to make sense of the process of DNA replication, for example, and this had always posed a problem for me regarding Teaching Practice and micro-teaching. My problem was how am I going to explain this process to learners at a school where I will be practicing when I cannot make sense of the whole thing? But after referring to the web page that was posted on YouTube by our laboratory technician, the simulations I saw cleared the confusion I had*.

It is important to note that social communication in this regard can help a teacher to enhance his or her pedagogical practice and also assist students in their learning. In support, Grabe and Grabe (2007) state that technologies can play a role in student skills, motivation and knowledge. They are of the opinion that

social communication can be used to present information to students and help them complete learning tasks.

A respondent indicated that:

> *It can be better if we can have assignments posted not only on Blackboard but communicated to us by the lecturer through Twitter, Facebook and the like, then this message will be available to all of us in the Life Sciences class at anytime and I can also consult with my classmates and other people who know the subject.*

Another respondent stated that:

> *I usually use Facebook and Twitter to chat about social stuff with my friends and not for school work. If I can get communication regarding any of my courses through these networks I can assure you that I won't miss it at all because I always chat on my phone whenever I am not busy*.

Because there is no control and monitoring over what content goes onto, for example, Twitter and Facebook, most lecturers still prefer to use social communication platforms such as Blackboard because of the control that is provided over content. However, a lecturer could create a group on Facebook for a specific lesson where he or she has control over the content as administrator of the group. Farrell (2007) asserts that while technicians can be employed to fix and maintain computers, teachers and educators must know how to exploit ICT for what it does best, namely opening learners up to the world of knowledge.

As clearly articulated by one of the respondents:

> *Information that we share through Facebook, Twitter provides us with an opportunity to work together, share ideas, discuss, and learn from each other. Before I write my assignment, also in preparing for laboratory work, I do thorough consultation and networking on the topic through Facebook and Twitter. Once I am sure that I have gathered enough information, then I start writing up*.

Other respondents indicated that:

> *I have developed the skill of searching for information through social communication networks. As a result it is easy for me to search for information whenever I have a project to do and also to get other people's opinions.*

> *Some topics that were treated during lecture time make more sense to me now after seeing simulated experiments on YouTube. I was able to watch them over and over again at home.*

Constructivism promotes social and communication skills by creating a classroom environment that emphasises collaboration and exchange of ideas. Students learn how to articulate their ideas clearly as well as to collaborate on

tasks effectively by sharing in group projects. Through the exchange of ideas they also learn to negotiate with others and to evaluate their contributions in a socially acceptable manner. This is essential to success in the real world, since they will always be exposed to a variety of experiences in which they will have to cooperate and navigate among the ideas of others. As indicated by one of the respondents, through social communication the lecturer was able to assist the students in searching for information rather than receiving facts, doing research by themselves, and this in away could "increase their awareness of the importance of the world around them, of citizenship and of scientifically literate community" (Pickersgill 2003).

Another respondent asserts:

> *I really like using my cell phone to chat but when it comes to school work I'm not so sure about that. I need guidance, I am so used to face to face communication with my lecturers and feel not very confident to do my work alone and follow prompts on YouTube or Twitter. If I were to use the same for my learners during teaching practice I would be in serious trouble. We need to be properly trained on how to use such media for teaching and learning.*

It is evident from the statement above that the respondent lacked confidence in the use of social communication. According to Dawes (2001), lack of confidence in teaching using ICT is a contextual factor which can act as a barrier. This makes student teachers anxious about using social media in their teaching (Balanskat, Blamire & Kefala 2006; Osborne & Hennessy 2003). Proper training has to be provided for the student teachers by their lecturers to enable them to gain experience in dealing with new devices, modern technologies and new pedagogical approaches.

FINDINGS AND DISCUSSION

Social communication platforms such as Twitter, Blackboard, etc. demonstrate their ability to be excellent tools for supporting Social Constructivism in the Life Sciences classroom, not only through the real-time interaction amongst classmates around the technology, but also those synchronous and asynchronous interactions that occur virtually with classmates and other peer learners. It provides a good way for the lecturer, students and peers to stay in touch. It can also be used by both students and the lecturer to get feedback on the tasks immediately, or to ask questions and get answers quickly. All concerned can have an opportunity to learn about diversity and get exposure to multiple points of view anytime anywhere (Chaka & Ngesi 2010). Ultimately, this exposure helps students to learn to look at things from different angles, and to be more tolerant of other people's opinions.

Social communication may be just what a Life Sciences student teacher needs to sustain his or her interest in the subject. In support, Osborne and Collins (2000) argue that technology may help increase student motivation. New technology can be used in science education (Skinner & Preece 2003), in particular Life Sciences, as tools for enhancing teaching and learning in schools through, amongst others, multimedia software for simulations and computer-controlled microscopes (Osborne & Hennessy 2003) and to enable students to collect science information and interact with resources such as images and videos and also to encourage communication and collaboration (Gillespie 2006; Murphy 2006). By grounding learning activities in an authentic, real-world context, the student's learning and engagement could be stimulated and enhanced. Students could then be encouraged to learn to question things and to apply their natural curiosity to the world.

In as much as social communication is significant and offers a deeper understanding of principles and concepts of science, it cannot replace face-to-face classroom experiences (Kelleher 2000), and it does not offer enough hands-on experience, particularly in the instance of laboratory work. However, lecturers can always send supplementary lab materials or maybe request students to collect and send in specimens. Still, it is crucial to question whether these extensions constitute a full laboratory experience since the students may miss out on the ongoing, personal feedback that someone would normally receive in a regular laboratory course.

Relevance and generalisability

The study offers important baseline information necessary to support the use of social communication in an effort to enhance effective teaching and learning in Life Sciences. Although the sample size was small, it comprised all senior Life Sciences students enrolled for Life Sciences as a subject.

CONCLUSION

Social communication, when used in a professional context, provides valuable information. For example, a question could be posted on Twitter, and one could readily get access to experts in the field who are willing to share information. Also, one has access to classmates' comments. Lastly, social communication is advantageous since ideas rather than appearances govern online. Students who are commonly marginalised or silenced may feel more comfortable voicing their opinions. This means that people from many different locations and backgrounds can come together and learn from each other. Barriers such as access to resources and lack of confidence have been found to be critical components for technology integration in enhancing the teaching and learning of Life Sciences. Effective professional development through training, time and access to resources need to be provided to ensure the desired enhanced teaching and learning environment for Life Sciences student teachers through social communication.

REFERENCES

Adeogun, A.A. 2001. The principal and the financial management of public secondary schools in Osun State. *Journal of education system and development* 5(1): 1-10.

Al-Alwani, A. 2005. *Barriers to integrating information technology in Saudi Arabia Science Education*. Unpublished doctoral thesis. University of Kansa, Kansas, USA. [Online]. Available at: http://adsabs.havard.edu/abs/2005PhDT.....64A [Accessed on 04 August 2012].

Balanskat, A., Blamire, R. & Kefala, S. 2006. *A review of studies of ICT impact on schools in Europe.* European Schoolnet.

Bearison, D. & Dorval, B. 2002. Constructive features of collaborative cognition. In Bearison, D. & Dorval, B. (eds). *Collaborative cognition: Children negotiating ways of knowing*, pp. 117-121. USA: Preager.

Brandsford, J., Brown, A.L. & Cocking, R.R. 2000. *How people learn: Brain, mind, experience and school*. (Second edition). Washington, D.C.: National Academy Press.

Bynard, P.A. 2007. *Introduction to research in management-related fields.* (Second edition). Pretoria: Van Schaik.

Chaka, C. & Ngesi, N. 2010. Mobile writing: Using SMSs to write short paragraphs in English. In Guy, R. *Mobile learning: Pilot projects and initiatives.* Santa Rosa, CA: Informing Science Press.

Cohen, L., Manion, L. & Morrison, K. 2011. *Research methods in education.* (Seventh edition). London: RoutledgeFalmer.

Dawes, L. 2001. What stops teachers using new technology? In Leaks, M. (ed.). *Issues in teaching using ICT*, pp. 61-79. London: Routledge.

Empirica. 2006. *Benchmarking access and use of ICT in European schools 2006: Final report from Head Teacher and classroom teacher surveys in 27 European countries.* Germany: European Commission. [Online]. Available at: http://www.elearningpapers.eu [Accessed on 06 July 2012].

Farrell, G. 2007. *Survey of ICT in Education in Uganda.* Washington, D.C.*:* infoDev/World Bank.

Gillespie, H. 2006. *Unlocking learning and teaching with ICT: Identifying and overcoming barriers.* London: David Fulton.

Goddard, W. & Melville, S. 2006. *Research methodology: An introduction.* (Seventh edition). Landsdowne: Juta.

Gomes, C. 2005. *Integration of ICT in science teaching: A study performed in Azores, Portugal.* Recent research developments in learning technologies. [Online]. Available at: http://cat.upatras.gr/en/biblio [Accessed on 05 August 2012].

Grabe, M. & Grabe, C. 2007. *Integrating technology for meaningful learning*. (Fifth edition). Boston, New York: Houghton Mifflin.

Hancock. B. 2002. *Trent focus for research and development in primary health care: An introduction to qualitative research*. Notingham: Trent Focus Group.

Hmelo-Silver, C.E. 2004. Problem-based learning: What and how do students learn? *Educational Psychology Review* 16: 235-266.

Hofstein, A. & Mamlok-Naaman, R. 2007. The laboratory in science education: The state of the art. *Chemistry education research and practice* 8: 105-107.

Hofstein, A. & Lunnetta, V.N. 2004. The laboratory in science education: Foundations for the twenty-first century. *Science Education* 88: 28-54.

Janczewski, L.J. 1992. Factors of information technology implementation in underdeveloped countries: Example of the West African nations. In Palvia, S., Palvia, P. & Zigli, R.M. (eds). *The global issues of information technology management*, pp. 187-212). London: Idea Group Publishing.

Kelleher, P. 2000. Review of recent development in the use of Information Communication Technologies (ICT) in the science classrooms. *Australian Science Teachers' Journal* 46(1): 33-38.

Lefebre, S., Deaudelin, D. & Loiselle, J. 2006. *ICT implementation stages of primary school teachers: The practices and conceptions of teaching and learning.* Paper presented at the Australian Association for Research in Education National Conference, Adelaide, Australia. 27-30 November.

Lim, C.P. 2002. A theoretical framework for the study of ICT in schools: A proposal. *British Journal of Educational Technology* 33(4): 411-421.

Lim, C.P. & Chai, C.S. 2004. An activity-theoretical approach to research of ICT integration in Singapore schools: Orienting activities and learner autonomy. *Computers & Education* 43: 215-236.

Lim, C.P. & Hang, D. 2003. An activity theory approach to research of ICT integration in Singapore schools. *Computers & Education* 41: 49-63.

McCown, R., Driscoll, N. & Roop, P.G. 1995. *Educational psychology. A learning-centred approach to classroom practice*. Boston: Allyn & Bacon.

McMillan, J. & Schumacher, S. 2006. *Research in education. A conceptual introduction*. Boston: Allyn & Bacon.

Menda, A. 2006. *ICT in education: Content issues as Kiswahili reigns*. [Online]. Available at: www.iConnect-Online.org. [Accessed on 05 August 2012].

Michael, J. 2006. Where's the evidence that active learning works? *Advances in Physiology Education* 30: 159-167.

Murphy, C. 2006. The impact of ICT on primary science. In Warwick, P., Wilson, E. & Winterbottom, M. (eds). *Teaching and learning primary science with ICT*, pp. 13-32. Berkshire, England: Open University Press.

Newhouse, P. 2002. *Literature review*: *The impact of ICT on learning and teaching*. Perth, Western Australia: Department of Education.

Osborne, J. & Collins, S. 2000. *Pupils' and parents' news of school science curriculum*. London: King's College London.

Osborne, J. & Hennessy, S. 2003. *Literature review in science education and the role of ICT: Promise, problems and future directions.* London: Futurelab.

Pickersgill, D. 2003. Effective use of the Internet in science teaching. *School of Science Review* 84(309): 77-86.

SAIDE. 2009. *Using mobile technology for learner Open Schooling*. [Online]. Available at: http://www.col.org/SiteCollectionDocuments/Mobile%20Technology-Final%20Report.pdf [Accessed on 05 August 2012].

Schoepp, K. 2005. Barriers to technology integration in a technology-rich environment. *Learning and teaching in higher education: Gulf perspectives* 2(1): 1-24.

Sicilia, C. 2005. *The challenges and benefits to teachers' practices in Constructivist Learning Environments supported by technology.* Unpublished master's dissertation. McGill University, Montreal, Canada. [Online]. Available at: http://www.tact.fse.ulavai.ca/papers/Bracewell-aera [Accessed on 05 August 2012].

Skaife, J. & Wellington, J. 1993. *Information Technology in Science and Technology Education.* Open University Press: Buckingham.

Skinner, N.C & Preece, P.F.W. 2003. The use of information and communication technology to support the teaching of science in primary schools. *International Journal of Science Education* 25(2): 205-219.

Van Rooyen, A.A. 2010. Effective integration of SMS communication into a distance education accounting module. *Meditari accountancy research* 18(1): 47-57.

White, C.J. 2005. *Research: A practical guide*. Pretoria: Ithuthuko Investments.

Williams, M.D. (ed.). 2000. *Integrating technology into teaching and learning. Concepts and applications: An Asia-Pacific Perspective.* Singapore: Prentice Hall.

Yelland, N. 2001. *Teaching and learning with information and communication technologies (ICT) for numeracy in the early childhood and primary years of schooling*. Australia: Department of Education, Training and Youth Affairs.