

Using Visual Media to Enhance Science Teaching and Learning in Historically Disadvantaged Secondary Schools

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Abstract. Science education in South Africa is ineffective, since significant numbers of secondary school students perform poorly. Only 30 % of Grade 12 students passed science in 2011 and 85% of secondary schools lack laboratories. To combat this problem, the author issued twenty science teachers of 10 historically disadvantaged schools with a science Digital Versatile Disk (DVD) that visualises all science experiments that are prescribed in the Grade 8 and 9 science curricula.

The research was based on qualitative data gathered from an open-ended questionnaire that was completed by participants. Analysis of the data indicated the advantages and challenges that participants experienced when using media to visualise science experiments to their students.

This study highlighted the following advantages when students visualise science DVD recorded experiments: teachers had more time to facilitate students' learning activities as they did not have to plan and execute experiments, students were provided with images to understand new concepts, students who experienced a language barrier were more clear on new science concepts and visual media can be replayed to reinforce complex concepts. Challenges that science teachers emphasised included poverty (lack of electricity and electronic devices) and the deprivation of students to conduct experiments. Regardless of the challenges participants experienced the science DVD as a crutch to assist them in improving their students' science education.

Keywords: Visual Media; DVD; Science; Secondary Education; Teaching, Experiments, Laboratory,

1. Introduction

For several years science, mathematics and technology education has been a national priority. Nevertheless, the current science education situation may be described as a crisis as only 30 % of Grade 12 students passed science in 2011 (Department of Education, 2012). Internationally, South African science students came last in a group of 50 participating countries in the trends in mathematics and science study (TIMSS) in 2001 and 2003 (Howie 2001, 2003). This poor performance of science students could be caused by a lack of infrastructure and inadequately trained teachers which may not provide in the needs of all students (Kriek & Grayson, 2009). Statistics indicate that of the 84% science teachers only 42% are qualified in science and 85% of the 24 717 secondary schools in South Africa lack laboratories to conduct experiments (EduSource Data News, 2012). The growing student numbers in historically disadvantaged secondary schools causes the student-teacher ratio to increase to 45 students per class (EduSource Data News, 2012). Because of the growing population, financial constraints of the Department of Education, it may not be possible to address the lack of laboratory facilities in the foreseeable future. Muwanga-Zake (1998) on the other hand, states that many teachers do have laboratories but are not able to use them, due to their workload and a lack of training.

The importance of a laboratory to execute practical investigations and experiments in science education cannot be ignored. According to the Department of Education (2005), science education aims to allow students to investigate physical and chemical phenomena through scientific inquiry and the application of scientific models, theories and laws in order to explain and predict events. Scientific and technological knowledge is important to address the challenges facing society.

A laboratory must not be seen as the only source to execute scientific investigations and experimentation. Teachers should be encouraged to be creative and find alternative ways to do practical work. One way of doing this, is to use visual media when a laboratory is not available. For example, students can visualise science experiments on a science Digital Versatile Disc (DVD).

The theoretical framework of this article is based on research findings claiming that visual media have a strong impact on students' understanding and retaining of new concepts. Often teachers ask themselves the

question: “Why do my students remember everything that is on television and forget what I teach them in class?” According to Willingham (2007) the answer is, bring the television to the classroom.

Previous researchers indicated that visual media can be used to complement traditional approaches when teaching and learning and improve student performances. Salomon (1979) proved that students learn new abstracts and novel concepts in both verbal and visual form. Cowen (1984) states that visual media make concepts more accessible to students and enhance lateral recall of information, while Pinker (1997) emphasises that visual media can support students to retain and apply new concepts to real life situations. Bransford, Browning and Cocking (1999) emphasise the importance of media in the creation of a learning environment where students can be involved in interactive learning, such as group discussions or the solving of a case study. Cavanaugh (2009), Pinker (1997) and Schwartz and Bransford (1998) point out that educational television programs can positively influence students’ knowledge of science, which enables them to provide more complete and complex explanations of scientific concepts, and could generate scientific ideas that can be applied in the industry.

Motivated by previous research findings, the research of this article identified some of the advantages and challenges when using a DVD to visualise science experiments in class.

2. Research Design and Method

The research was based on qualitative data gathered from 20 secondary school science teachers from 10 historically disadvantaged schools in the Gauteng Province of South Africa. Participating teachers were issued with a science DVD (which was recorded by The Department of Education) containing experiments that are prescribed in the Grade 8 and 9 curricula at the beginning of the academic year. They showed the DVD to their students whenever they had to conduct a prescribed science experiment in class.

At the end of the academic year participants reflected their experiences by completing the following open-ended questions on a questionnaire:

- *What are the advantages of a DVD that visualises science experiments?*
- *What are the challenges of using only a DVD as a medium to conduct experiments?*
- *If you had access to a fully equipped laboratory at your school, will you still use a DVD to visualise experiments to students or would you rather want to conduct the experiments with the help of your students?*

The reflections of participants enabled the author to determine the advantages and challenges when using a DVD to visualise science experiments in class.

3. Analysis of Data

The most frequent answers for each question were selected and quoted verbatim.

Question 1: What are the advantages of a DVD that visualizes science experiments?

‘Since, our school does not have a laboratory, the DVD was absolutely a ‘wonder from heaven’ for me, as I had more time to facilitate and assess my students.

Many of the respondents indicated that the DVD enabled them to spend more time on the completion of their administrative duties, assessment of students’ assignments and facilitating and guiding of students. The DVD removed extra pressure from teachers, as they do not need to set up and execute experiments.

‘Students’ interest increased in discussed topics and their term test’s results reflected improvement’.

Research of Girardi (2008) and Raehsler (2009) support this statement that using media as an introduction to new concepts makes the subject more interesting and relevant to students, increases class attendance, promotes cognitive reasoning and increases examination results.

‘The experiment could be replayed, step by step for students that did not understand the new concept the first time’.

When observing visual science experiments, students become interested and motivated in the topic. Images that media create enable students to recall difficult concepts and unclear concepts can be clarified by replaying certain parts of the DVD to the class. Schwartz and Bransford (1998) recommended that media can

be used to reinforce complex concepts and should be shown before the topic is discussed in class so that students are provided with an image that can be used to compare the topic under discussion.

'I could pause the DVD every time I asked them to do a specific task in class, for example: formulate a hypotheses, predict what will the outcome of the experiment be, formulate your own conclusions from what you have learned from the experiment, etc. Every time I stopped the DVD, they completed the task and then I continued playing the DVD so that they can correct their wrong answers. This immediate feedback on their tasks enabled them to learn from their mistakes and encouraged them to start thinking critically like scientists do'.

Students can develop process skills while completing their assignments. Visual media can also be used as a brief introduction before learning the concept. After learning the concept, media can be shown allowing students to use their analytical skills when applying what they have learned in real life situations (Cavanaugh, 2009). Students can replay the DVD during school-breaks and after school to clarify unclear concepts and to develop the process skills they need to complete assigned tasks. Students are not bound to a specific period to master knowledge.

'Many of my students are struggling to learn with English as their second language. The visual connectivity with English explanations on the science DVD assisted them to understand difficult concepts'

Henderson and Wellington (1998), state that one of the major challenges to learning science is students' language barrier. South Africa's science curricula are taught mainly in languages, English or Afrikaans, causing many students to be taught in a second language which they are not always familiar with. Using the science DVD as a media to visualize new concepts can address students' language barrier.

'I cannot teach without the science DVD, it supports my teaching with real life applications'.

Media contain controversial and socially relevant real world issues to engage students in learning. Not only do media assist students to improve their content knowledge and higher order thinking skills, but also motivate them and stimulate their interest. Students are motivated to investigate the application of new concepts in real life situations and discuss it with their peers (Klosterman & Sadler, 2010).

'Neighbouring schools requested the use of our school's science DVD so that they can also visualise the experiments to their students'.

Teachers' collaboration is to the advantage of science education where they can discuss 'bad' and 'good' practice ideas with one another.

Question 2: 'What are the challenges of using only a DVD as media to conduct experiments?'

'Because of regular power failures and the school not able to pay its electricity bill, I encountered numerous problems when I planned a lesson where the science DVD's experiments were part of my lesson'.

'When students are used to be taught with media they expect all lessons to be taught with media, or else they lose interest in the lesson'.

'Our school was burgled and the TV and DVD player stolen. I relied mainly on the DVD to explain the experiments to the students and had to fall back to the textbook, as I did not have a laboratory, this had a major influence on my students' performance'.

'Because we only have one TV and DVD player that must be shared between 30 teachers, I could not use the DVD that often as I wanted to'.

'My classes consist of 50 and more students per class. The TV screen was too small for all my students to observe at once. Therefore, I divided my class in two and repeated the video twice. While the first group was watching the DVD the second group completed an assignment based on the experiment'.

When using media for large class sizes, it is important that the screen size should be large enough for clear visibility. The advantage of students watching the DVD in large classes is that most of them experience the same emotions, laugh and cry at the same time, gasp when they are shocked and cry when they feel empathy. This collective experience of the class that media evokes, can be very powerful in learning and teaching new concepts in science.

The comments above, state that poverty played a major role in science education. Schools were often disrupted by power failures due to financial constraints and burgled, leaving the school without electronics equipment. Teachers had to be innovative to find solutions, such as using their neighbouring school's facilities.

'Certain process skills needed by a scientist do not develop while watching a DVD. Students are deprived of opportunities to actually do experiments themselves'.

The Department of Education (2003) demands active involvement of science students in hands-on experiences, where they can formulate hypotheses, make inferences and draw conclusions.

Question 3: If you had access to a fully equipped laboratory at your school, will you still use a DVD to visualise experiments to students or would you rather want to conduct the experiments with the help of your students?

'Even if I have a fully equipped laboratory, my workload is too much to plan difficult experiments by myself. If the school appointed a laboratory assistant who can set up the experiments and save time, only then would I use the laboratory'.

'The curriculum has changed so many times the past fifteen years that I am not always able to conduct certain experiments in classes.

'I wish to attend a course on how to conduct the prescribed experiments'.

'I am afraid of the reaction that certain chemicals might cause. I prefer, for safety sake, to show the DVD rather than conducting the experiments myself'.

The answers that frequently appeared above indicated that teachers are not properly trained to use laboratory equipment. Poor teacher training could account for the poor science results (Kriek & Grayson, 2009). According to Sanders and Khanyane (2002) most students in historically disadvantaged schools have never experienced practical experiments. Therefore, the science DVD is regarded by most of the participants as a crutch to assist them to improve their students' science education.

4. Recommendations

Effective and successful science education requires qualified science teachers that are creative and able to apply different teaching techniques, media and strategies to clear abstract concepts to students. If teachers use interesting visual media to teach science, most students would be able to apply these concepts in real world situations.

Other visual media that teachers can use to improve science education are: cartoons, virtual laboratories, newspapers, Facebook, Wikis and Blogs:

- Historically disadvantaged schools will find that cartoons are more affordable and can be used as stimuli to create interest in a concept, accommodate different learning styles and develop critical thinking and reflective skills in Science. The visual impact of the cartoon is abrupt and affects all students regardless of their age or cultural background (Van Wyk, 2011). A cartoon can visualize a contemporary science problem that can be used as a strategy to motivate students to collaborate in group discussions and find solutions to this problem.
- Virtual laboratories that simulate experiments on a computer can also work well, but once again, computers are needed.
- Students can be encouraged to create their own media which will contribute to collaboration, creativity, accountability and mastery of ideas and concepts.
- Social media such as Facebook, MySpace, Wikis and Blogs can be used. They provide students with a sense of belonging and create an affective bond between them and their peers. They can blog about their experiences and this can lead to an increase in collaboration between students all over the world.
- Newspaper articles can be used as relevant and current news to analyse quantitative comparisons and graphical analyses.

5. Conclusion

The qualitative research in historically disadvantaged secondary schools indicated that participating science teachers ($n=20$) welcomed the science DVD as a replacement for laboratory experiments. They indicated that they have more time at hand to assess and facilitate students and to complete administrative duties. The advantages of the science DVD are that teachers are able to replay experiments where concepts are still not clear to students and class activities could still be centered on the development of students' science process skills. The students enjoyed the DVD as a teaching media and showed more interest in the shown topics, even students experiencing a language barrier understood complex concepts. The visualisation of experiments on the DVD not only cleared abstract concepts to students, but enabled them to apply newly learned concepts to everyday learning situations. Despite the advantages of a science DVD, one major challenge was identified namely, poverty. Poverty results in schools not always being able to visualise the science DVD, because of a lack of electricity and electronic devices. Some schools can only afford small television screens, preventing all students from observing the experiments at once. The visualisation of experiments deprives students of opportunities to conduct experiments themselves and develop scientific skills as real scientists do.

Some teachers do have laboratories at school, but are also not willing to conduct experiments because of their workload and insufficient training. As only 42% of science teachers are qualified to teach science, many of the historically disadvantaged school teachers do not know how to conduct science experiments.

6. References

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