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The Effect of Alternative Assessments in Natural Science on Attitudes towards
Science in Grade 8 Girls in South Africa

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COMPULSORY DECLARATION

This work has not been previously submitted in whole, or in part, for the award of any degree. It is my own work. Each significant contribution to, and quotation in, this dissertation from the work, or works, of other people has been attributed, and has been cited and referenced.

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ABSTRACT

Attitudes towards science and school science have long been studied because of a desire to keep students in science-related subjects and science-related careers. In South Africa, little research has been done to identify what interventions would encourage students, especially girls, to continue in the sciences. This study focused on the implementation of an alternative assessment in Natural Science in Grade 8 at an all-girls independent school. Students were given an open-ended questionnaire at the beginning and end of the school year to determine their choices for their favourite and hardest parts of Natural Science. These choices acted as a proxy of their attitude towards science. They also completed three sections of the Relevance of Science Education (ROSE) questionnaire in June after the alternative assessment was completed. From this data, three conclusions were made. First, the students had a positive attitude toward the alternative assessment. Second, the students had a positive attitude toward science and showed evidence of the impact of alternative assessments on this attitude. Third, the alternative assessment did not show long term effects on the students' attitude toward science.

Keywords: Alternative Assessment; Attitudes; ROSE survey; Girls education; Science Education; Single-Sex Education

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Chapter 1

1.1 Introduction

This study investigated the relationship between alternative assessments in the Natural Science classroom and attitudes towards science and school science. There is a desire to increase the number of girls in the fields of science, and this formed the rationale behind investigating what efforts could encourage girls to remain in science subjects at school and beyond. Alternative assessments are a type of intervention which has become more common in classrooms around the world, and their efficacy and effect in the South African context has not yet been determined. This study will investigate their effect on attitudes towards science in Grade 8 girls.

1.2 Background and Rationale

1.2.1 *Why is it important to consider attitudes towards science?*

Attitudes towards a subject can affect the choices that individuals make. Some researchers argue that we should be concerned with attitudes towards science because the more people who engage with science, the more innovation and development nations will see. Below is an excerpt from a report by the National Science Board (NSB), which is a part of the National Science Foundation in the United States (2010).

The Nation needs “STEM¹ innovators”—those individuals who have developed the expertise to become leading STEM professionals and perhaps the creators of significant breakthroughs or advances in scientific and technological understanding. A key component of innovation is the development of new products, services, and processes essential to the Nation’s international leadership.”

¹ STEM: Science, Technology, Engineering, and Mathematics

(National Science Board, 2010, p.1)

In this report, the NSB purports that the best way to do this is to give students the best education possible and identify and foster talent from a young age. This would potentially lead to more individuals choosing studies and then careers in STEM areas.

South Africa is trying to improve the economy and increase the number of jobs available. President Jacob Zuma has said in his State of the Nation address year on year that there needs to be more effort to increase job opportunities in the country and details how and where in the economy this should be done (GCIS, 2011; GCIS, 2012). The areas mentioned in the last two speeches are in STEM related areas such as manufacturing and mining (GCIS, 2011; GCIS, 2012). Increasing the innovators within these sectors (a direct result of the fostering of innovation during their education) will increase jobs in these sectors.

1.2.2 Why girls?

There is an African proverb which says “if you educate a boy, you educate a man. If you educate a girl, you educate a family.” This proverb speaks about a basic education, but when looked at through the lens of science education for the informed citizen, it takes on a different meaning. In an increasingly technological world where individual members of society are called upon to engage with socio-scientific issues, it has become increasingly important to focus on science education (Kolsto, 2000), and through the lens of this proverb, it becomes even more important to focus on the science education of girls.

The problems within the science education of girls have long been documented (Acker & Oatley, 1993; Brotman & Moore, 2008; Carlone, 2003; Carlone, 2004; Jesse, 2006; Scantelbury & Baker, 2007; Thom, 2011). Acker and Oatley (1993) report on continued negative instances that girls must face while engaging with or trying to get into science or science-related fields, such as inequality with regards to textbook writing or bursaries for further study. Jesse (2006) states that often when boys are not achieving in science and math, the system is blamed, but when girls are not achieving in science and math, the girl is blamed.

Many, like the former Harvard President Lawrence Summers, believe that there is a biological difference between men and women that prevent women from actually succeeding in science-related fields (Holmgren & Basch, 2005). However, Jesse (2006) states that although

there is a difference in brain function between the sexes, there is no difference in problem-solving ability. Therefore what is creating the difference in job searches and subject choices?

Carlone (2003) argues that girls are often fighting against the “powerful sociocultural legacy of science” which is often enacted in the classroom without the teacher realizing it (p. 308). She shows through a discourse analysis of the teaching practices and interviews with a male physics teacher, that the male-dominated and elitist view of traditional physics is what is delivered, even though the course content is innovative and alternative (Carlone, 2003; Carlone, 2004). Aschbacher, Li & Roth (2010) also investigated the reasons that girls were dropping out of the “pipeline” of science, engineering and mathematics (SEM) courses in high school (p. 564). They found that these same male-dominated and elitist views were not only being enacted at school, but they were also being repeated at home. Female students who stayed in SEM courses had had an affirming relationship with something (zoo, aquarium, science centre, etc.) or someone (family member, teacher, researcher, etc.) which encouraged or enabled them to pursue this course.

Economically, there is a strong argument for encouraging girls to stay in and pursue careers in STEM fields. One in every two households in South Africa is headed by a single parent, and 50% of these households are headed by women (Ellis & Adams, 2009). The alarming part of the statistics regarding women-headed households is that they are on the rise in South Africa. In 1998, they formed only 42% of the households in South Africa, whereas in 2008 they formed greater than 52% of all households (Ellis & Adams, 2009, p. 13). Many of these heads will be less likely to have a job, more likely to have less education, and more likely will struggle to feed their children due to unemployment or low wages (Ellis & Adams, 2009, p. 14; Kinyondo & Mabugu, 2009).

As markets shift and productivity in the work place changes, women will need to be resistant and resilient to these changes. Kinyondo & Mabugu (2009) reflect on the realization that women with the same skill set are often passed over for their male counterparts for semi-skilled and skilled positions. These women are then required to take a position which is considered unskilled or one with a lower salary as a result. It is the jobs in STEM sectors which are historically more stable and have a higher wage (Kinyondo & Mabugu, 2009). The authors, therefore, suggest that by improving the education of women in the science and math related

fields they would increase their chances for employment in STEM sectors (Kinyondo & Mabugu, 2009).

The same trends are seen on an international scale as well. Lopez-Claros & Zahidi (2005) investigated the gender gap in 58 countries based on 5 criteria, including economic participation and economic opportunity. With regards to economic participation, they found that women earn less than 78% of what equally qualified men earn (p. 3). The economic opportunities that women have are generally in low skill and low wage areas or are in sectors deemed “female” such as nursing or teaching (Lopez-Claros & Zahidi, 2005, p.3). These jobs often do not have movement up in terms of administration or opportunities. The opportunities that do exist for women often do not offer them “family-friendly” benefits such as maternity leave. As a possible result, Lopez-Claros & Zahidi (2005) found “49% of high-achieving women to be childless, as compared with only 19% of their male counterparts” (p. 4).

With regards to education, Lopez-Claros & Zahidi (2005) called it “the most fundamental prerequisite for empowering women” (p.5). Education within South Africa has been a long contested system. Morrell (2000) outlined the findings of the South African Gender Equity Task Team with regards to the education of girls and the plea for more single-sex schools within South Africa. He stated that girls were often not provided with a safe environment in which they could learn. This was with regards to both academic performance and general emotional safety. In a single-sex school, he argued that girls will often take more “boys” subjects and perform better (*ibid*, p. 225). He also stated that girls-only schools have less sexual harassment and have more positive female role models for the students (*ibid*, p. 225-6). Therefore, girls within a co-educational school are having to struggle with issues far greater than their subject choice, and may therefore choose easier subjects or less “boys” subjects as a result.

Regardless of Morrell’s (2000) case for opening more girls-only schools, South Africa currently has a higher percentage of girls matriculating from high school (60%) than many other African countries (Ellis & Adams, 2009). The Further Education and Training (FET) phase and tertiary sector of education have had higher percentages of women since 2007 (CHE, 2009; Molebatsi, 2009). And yet in the STEM courses at universities (especially in the advanced degrees),

women are consistently under-represented. Therefore, it is important to determine the points in the secondary education of girls where they are encouraged or discouraged to continue in the sciences.

1.2.3 Why innovate?

Innovation stems from the need for change within a system. In the educational system, it can be sparked by a number of different emergent factors, such as technology (Dooley, 1999), philosophy of education (Singh, 2002), or pedagogical theories (Montessori, 1912). Innovation can also be sparked by internal factors, such as high stakes testing results or participation in a subject (Couling, 2011). Hannan, English & Silver (1999) reviewed the reasons that higher education institutions were innovating and discovered that some educators are forced by the management of the school into innovative teaching practices while others will try new methods to improve their students' learning willingly and independently. Regardless of its source or *raison d'être*, innovation is a way that teachers and academics are attempting to change the outcome of one part of the pedagogy in a schooling system and improve the education of the students (Wilkes & Bligh, 1999).

Within this context, there is a drive to increase the number of girls in STEM courses and careers. This is happening globally, from educational to corporate to government interventions (OSTP, 2011). These interventions seek to increase access for girls to interact with scientists (Nagaraja, 2012), change the focus of assessments to be more gender-neutral (Chilisa, 2000), and improve attitudes of girls through curriculum changes (Carlone, 2003).

1.2.4 Why educational innovation?

Dooley (1999) quoted Rogers' (1995) definition of innovation – “an idea, practice, or object that is perceived as new by an individual or other unit of adoption” (1999, p. 36). This meaning is broad and can be applied to many different points in Bernstein's “Pedagogic Device” (Singh, 2002) of education. It is important to recognize where in this process the innovation is taking place as this will determine who will be responsible for the evaluation of the effect of the innovation.

Innovation is only useful when evaluated in light of the criteria or outcomes desired. Who is evaluating the innovation will also determine the evaluation criteria (Wilkes & Bligh, 1999).

For example, if the question is about student performance, the results on summative assessments would most likely be collected to determine the effectiveness of the course. The evaluation criteria can be very broad or rather narrow (Wilkes & Bligh, 1999). However, it is through the evaluation process that innovations may be adopted, changed or discarded. Without this step, innovations often fall away as being too difficult (Dooley, 1999).

However, it is within the evaluation and assessment process of innovation teaching and learning methods that skeptics raise issues. The evaluation process often fails to take into account the entire situation of the student (the whole programme or social environment of the student). When asked to evaluate a number of innovative medical curricula, Friedman, de Blik, Greer, Mennin, Norman, Sheps, Swanson, & Woodward (1990) noted that it is difficult to determine how one aspect of a programme can be credited with the changes in knowledge, skills or behaviour of the candidates. It is important to view the effect of the entire programme on the candidate, and this also requires a long-term view (potentially up to 10 years with medical students) (1990, p. 11). Therefore, when reviewing educational innovation within one institution or classroom, it is also important to view the whole picture of the student, rather than take a narrow focus on one innovative aspect.

1.2.5 What are alternative assessments?

Alternative assessments have been characterised by Herman, Aschbacher & Winters (1992). These types of assessments have 5 basic characteristics in common. They are the following:

- (1) asking students to perform, create, produce, or do something;
- (2) tapping higher-level thinking and problem-solving skills;
- (3) using tasks that represent meaningful instructional activities;
- (4) involving real world applications;
- (5) using human judgment to do the scoring.

(as quoted in Corcoran, Dershimer, & Tichenor, 2004, p. 213).

These assessments often provide a more holistic view of a student's progress or understanding (Century, 2002). Lawrenz, Huffman & Welch (2001) presented their findings that these alternative assessments can also be fairer to lower-achieving students, therefore giving a teacher a more realistic picture of what all the students in the class understand. This definition of alternative assessment fits into the understanding of assessment for learning

instead of assessment of learning. This view of assessment is alternative in itself as it brings the assessment into the middle of the learning process instead of being removed from the learning process altogether.

1.2.6 21st century skills and alternative assessments

A new buzz phrase in education is 21st century skills. Many educators and policy makers are promoting the idea that education needs to take another angle in this “knowledge economy.” Since the knowledge (content) that the students need is often at their fingertips now via the Internet, teaching and learning has become less about a transfer of knowledge and more about an evaluation and synthesis of knowledge, which are classified as more higher-order thinking skills. The work place of the next generation will not look like it does today, and the question often asked is how will we educate students for a world of work that we don’t recognize? The answer many educators now give is through skills. The Partnership for 21st Century Skills (www.p21.org) has developed a framework for the skills necessary for expected success in the workplace. The 4Cs for learning and innovation are collaboration, communication, critical thinking and creativity (in no particular order) (P21, 2011).

Science is an extremely collaborative subject. Just a quick glance at *Science Daily* (an internet based science news site) will show a large percentage of collaborative projects. A short conversation with academics at any university will reveal that many projects are done with a variety of people, all of whom bring a different skill set to the table and without whom the project would not have been a success. Therefore, it begs the question – why are we not promoting this kind of collaboration at a school level?

Innovation and creativity are seen as the key to an improvement in the global economy as well as independent country economies. In the USA, there is a move to identify and support young people (and through them educators) who are showing innovative talents. These talented young people need to be nurtured and developed to become the next innovators (as discussed above). It is through these alternative assessments in classroom settings at a young age that these talented young people will be inspired to continue with STEM courses.

1.3 Problem Statement

In any country, girls are needed to increase the human capacity of innovators, engineers, researchers, and developers, so that the economy can continue to positively grow. Therefore, we need to address the early attitudes of girls towards STEM courses and careers. Within the secondary school education of girls in South Africa, there is a need for innovative practices in the science subjects to encourage girls to remain in these subjects. Alternative assessments may be the tool used in schools to affect girls' attitudes towards STEM courses and careers.

1.4 Research Question

Can alternative assessment methods in Natural Science change attitudes towards science in girls in Grade 8?

1.5 Aims and Objectives

The aim of this study was to determine the effect that an alternative assessment in Natural Science can have on the attitudes of girls in Grade 8 towards science.

1.6 Significance of the Study

In South Africa, with the rising number of female-headed households, it is important to improve the chances that women have in the market for stable, high paying jobs. These jobs are most commonly found in STEM sectors. However, in order for women to enter these sectors they have to be given equal opportunities in their education, which often does not happen. Because females are not seen to have the same capabilities of their male

counterparts, this can lead to deterioration in their attitude towards STEM subjects, removing them from the “pipeline.”

From the literature in South Africa, it is not commonly known what factors influence the attitudes of girls with regards to STEM courses. A look through the theses and research repositories at four of the largest universities in South Africa (University of the Western Cape, Stellenbosch University, University of Pretoria, and University of Johannesburg) reveals that much of the research done in South Africa is with FET students or first year varsity students. There has been limited research in this field looking at biology specific classes and attitudes of boys and girls (Cherian & Shumba, 2011), but there is no study which focuses on the attitudes of girls. Therefore, this study will add to the body of knowledge which focuses on how alternative assessment approaches may influence their attitudes.

This study used a small sample of girls in a specific setting to describe their attitudes after engaging with Natural Science through an alternative assessment task. Grade 8 is a significant year to study as it is the first year in high school (although technically the middle year in a phase) and many different schools feed into the same Grade 8 class at this particular school. Therefore, the students came from many different primary school backgrounds with regards to their prior experience in Natural Science.

By looking at their attitudes at such an early stage in their high school career, the findings of this study will inform the teaching and learning practices of the teachers at this school so that we can try to increase the numbers of girls who take STEM courses in the FET phase. It can also lead to further longitudinal studies of attitudes of girls as they continue through high school, which would give a clearer understanding of the point at which girls are determining that they want to leave the pipeline. It is important to understand when this happens so that interventions can take place beforehand and more girls can be encouraged to remain in STEM courses.

This study also describes the attitudes and practices of girls in a highly motivated and functional setting. Its findings cannot therefore be extrapolated to include all girls in school-level education in South Africa, but can hope to provide feedback for other schools in similar situations, so that top schools can continue to offer South Africa’s girls the best possible

education, thereby increasing the number of top achievers into STEM courses in tertiary education.

1.7 Clarification of Terms

Grade 8 - students who are in the middle of the Senior Phase of the General Education and Training (GET) band of secondary education; they are on average 14 years old and at this school have entered high school for the first time.

Attitudes – An individual’s prevailing tendency to respond favorably or unfavorably to an object, person, or group of people, institution or event (Century, 2002)

Alternative Assessments – Assessments which conform to the following characteristics:

(1) asking students to perform, create, produce, or do something; (2) tapping higher-level thinking and problem-solving skills; (3) using tasks that represent meaningful instructional activities; (4) involving real world applications; and (5) using human judgment to do the scoring.

(Herman, Aschbacher, & Winters (1992) as quoted in Corcoran, Dershimer, & Tichenor, 2004, p. 213).

1.8 Methodology

1.8.1 Overview of research

A quasi-experimental design was used to try to identify a change in attitudes in the sample. Specifically, an equivalent time-samples design was used (Tuckman, 1994). This allowed for a qualitative questionnaire at the beginning of the year to determine a baseline for attitudes towards Natural Science, followed by the alternative assessment, followed by another qualitative questionnaire mid-year, followed by a final qualitative questionnaire at the end of the school year. Additionally, there was a quantitative questionnaire completed concurrently at the mid-year point. This was determined by the sequentially exploratory design (mixed

methods approach) described by Creswell (2009). The beginning of year questionnaire highlighted themes that were used to determine the sections of the Relevance of Science Education (ROSE) questionnaire used. The purpose of the ROSE questionnaire was to use an internationally recognized and validated attitude survey in which to compare students in this study's sample.

1.8.2 Qualitative approach

The questions asked at the three different times of the year were open-ended. This kind of questioning allows the subjects to create their own answers. This allows for specific themes to emerge naturally and improves the validity of the participating girls' answers because they are not guided by the question itself (Creswell, 2009, p. 15-6). The beginning and end of year questionnaires contained two questions which were open-ended in which to identify their favourite and hardest part of Natural Science.

The mid-year questionnaire was slightly different, but also open-ended. The difference in the question structure allowed for a more detailed response and gave clarity to their favourite part of Natural Science. This question guided their answer to provide more detail. This question was also used again at the end of the year to determine if their detail had changed over the course of the year. (See Appendix E)

1.8.3 Quantitative approach

The statements given in the ROSE questionnaire were closed questions. This kind of question identifies that kind of information or answers that the researcher is interested in collecting (Creswell, 2009, p. 15-6). These statements covered two different topics – Science, Technology and Me, and Me and my Science Classes. These all included statements which the students had to rank using a Likert scale in terms of agreement (from Strongly Disagree to Strongly Agree). These sections were chosen from the ROSE questionnaire because of the themes which emerged from the beginning of the year questionnaire and because they linked the closest to measuring attitudes towards science and school science.

1.8.4 Mixed methods

By using the qualitative questions and the quantitative questionnaire, the analysis highlighted links between their chosen answers and what they rank as important with regards to science.

1.9 Chapter Outlines

Chapter one provides the background to the purpose of the study. The situation of women in the economy is unpacked alongside the purpose of innovation in education. This chapter also outlines the entire study.

Chapter two provides a more in-depth literature review of current models of assessment and literature on the intersection of how girls learn and assessment practices. Innovation is a key to this review.

Chapter three reviews the methodology used in this research. This includes the development of the alternative assessment, the implementation of the assessment, the development of the questionnaires, the rationale behind the ROSE questionnaire and the development of the analysis tools.

Chapter four contains a summary of the findings from each of the surveys conducted. It contains both qualitative references to the actual responses from the students and the quantitative view of their total response.

Chapter five contains a discussion of the results. In this chapter, the link between this alternative assessment practice and the attitudes of girls over a calendar year in Grade 8 is made clear. Implications for the findings are unpacked and analyzed alongside the results. Suggestions for further research are given.

Chapter Two

Background and Rationale

2.1 Introduction

In this chapter, the conceptual framework will be discussed. This is the intersection of attitudes, alternative assessments, and the learning styles of girls. Each will be discussed with regards to their working definition for this study as well as current literature about each topic. However, it is the intersection of these three constructs which formed the central theme to this study. The following diagram (*Figure 1*) shows the intersection of these three concepts.

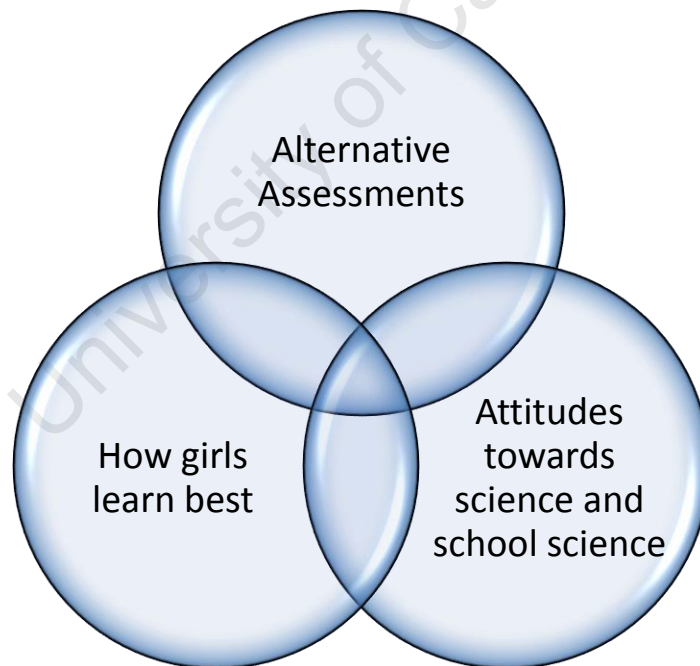


Figure 1: Framework showing the intersection between attitudes towards science, learning styles and alternative assessments

2.2 Attitudes towards Science

2.2.1 *What is an attitude?*

Mager (1968) defines an attitude as “a word used to refer to a general tendency of an individual to act in a certain way under certain circumstances” (p. 14). Century (2002) defined it as an individual’s prevailing tendency to respond favorably or unfavorably to an object, person, or group of people, institution or event. Attitudes can be changed over time (Eagly & Chaiken, 1993; Mager, 1968) and are influenced by everything around the individual – teachers, media, classmates, parents, family members, or friends (Mager, 1968). It can be as easy as a teacher reflecting on one’s own school experiences and determine points which lead one into a specific field or, conversely, away from a specific field. This is also true for many adults. Bauer (2002) identified specific things that college level chemistry students remembered about their high school chemistry classes, such as the frequency of practicals or demonstrations, how well the teacher could explain challenging concepts, and how well the teacher could relate the subject of chemistry to everyday life (p. 54-55). Eagly & Chaiken (1993) identified the three components of an attitude as being cognitive, affective and behavioural (p. 10). These three aspects can be seen as responses of an attitude or as influences towards an attitude.

The affective aspects of an attitude are the emotions that a person would attach to the thing or idea (Eagly & Chaiken, 1993, p. 10-11). When a student is asked if science is fun or hard or challenging, these words are helping a researcher to construct the emotions that students have around the construct of science. An emotive response might be as simple as feeling angry or happy when presented with the subject in any form. Some students have commented that they feel happiest when they see science is next on their timetable. Other students are excited about the time when they can “give up” science after Grade 9 (the point in a South African student’s education after which science classes become an elective subject). This emotive response will lead to different kinds of behavioural responses, another aspect of a student’s attitude. Behavioural responses are the seen effect of the student’s attitude toward an attitude object (Eagly & Chaiken, 1993, p. 12-13). If students have a positive attitude towards science, they are more likely to choose science-related subjects or

books or television shows. These “moving toward” responses (Mager, 1968) would indicate that the student in question is choosing these things based on a positive attitude towards science. Cognitive aspect of attitude refers to the individual’s belief about the subject or thing (Eagly & Chaiken, 1993). An individual’s interaction with a subject will lead to specific beliefs about it, such as a belief that they are good at the subject or that the subject has inherent value.

The purpose of studying student attitudes towards science is the effect it will ultimately have on their choices, specifically academic and career choices. As stated before, there is a large need for students to continue to study STEM courses in South Africa for economic, social and academic reasons. If students maintain a positive attitude towards science, they may be more likely to continue in a science-related field past Grade 9 and into tertiary education. Cherian & Shumba (2011) investigated the attitudes towards science in a sample population of Grade 12 Northern Sotho students in the Limpopo province of South Africa. In their findings, boys exhibited a more positive attitude toward science than girls, and their findings showed a small effect with regards to age (the older girls (>20) had less of a positive attitude than those under 20) (p. 293). George (2006) looked at the change of attitudes in high school students over a 5-year period to determine the trend in attitude change over high school. While there was a strong correlation between a positive attitude towards science and a positive attitude toward the utility of science (defined as the usefulness of science for society), students had a general decline in attitude towards science over the five years (p. 585). It is important to determine what is causing the change in attitudes within a schooling system and potentially what can be done to continue to maintain a more positive attitude towards science, regardless of their future field of study.

2.2.2 How have attitudes towards science been measured before?

Student attitudes towards science, school science, and assessment have long been studied (Osborne, Simon & Collins, 2003). It is important to differentiate between attitudes towards science, attitudes towards school science and scientific attitudes (Osborne et al., 2003). The first is science as a construct in society, the larger idea that is science. The second refers to science as a subject at school level. The last idea refers to specific behaviours and characteristics which would define a scientific person (Osborne et al., 2003, p. 6). In this study,

attitudes towards science and school science will be discussed and investigated. Students will be asked about a potential future for themselves in science, but this will not be regarded as “scientific attitudes” as Osborne et al. (2003) referred to, but it will be used as a proxy to discuss the relationship between their attitudes and school science.

Since attitudes have been studied for more than 30 years, many tests have been designed to this end. The following are examples of the kinds of tests developed. The final one was the test used in this study.

The Test for Science Related Attitudes (TOSRA) was developed by Fraser in 1978 to assess high school student attitudes in Australia (Welch, 2010). It contained 7 dimensions of attitudes towards science originally discussed by Klopfer in 1971 (Welch, 2010). Fraser developed 10 statements for each dimension and used a 5-point Likert scale as the method for answering. This questionnaire investigated affective, cognitive and behavioural aspects of attitudes towards science, seen as “enjoyment of science lessons” to “normality of scientists” to “leisure interest in science” (Welch, 2010, p. 188). The sections could stand alone or could be used together to get individual or whole pictures of a student’s attitude towards science. TOSRA has been subsequently used for attitude research world-wide, across age groups and intervention types (Farenga & Joyce, 1999; Khalili, 1987; Lyons & Quinn, 2010; Ouyang & Hayden 2010).

Simpson and Troost designed an attitude questionnaire in 1982 (STAQ), with the first look at a rising drop-out from science-related subjects at school (Owen, Toepperwein, Marshall, Lichtenstein, Blalock, Liu, Pruski & Grimes, 2008). This test consisted of statements that participants had to rank on a 5-point Likert scale and investigated the relationship between attitudes towards science and specific influences like peer groups and family groups. Their questionnaire has been used a number of times in the last 30 years to determine the attitudes of certain populations towards science (Nasr & Soltani, 2011; Owen et al., 2008).

The Relevance of Science Education (ROSE) questionnaire was developed by Schreiner and Sjøberg (2004) to investigate what students want to study as well as how they relate to specific areas of science (such as technology or the environment). The questionnaire, like the two above, consists mainly of statements that participants responded to using a 4-point Likert scale. There was also the inclusion of one open-ended question where student voice could be

heard as the responses were individual and personal. Unlike other surveys, the ROSE questionnaire was developed to be cross-cultural. The panel that developed the questions represented 10 countries with languages and educational systems very different from each other (Schreiner & Sjøberg, 2004). As a result, there is a high degree of validity when using the test in different cultures which has led to many researchers using it (more than 20 full texts available at http://roseproject.no/?page_id=39).

Regardless of the tool used, the trend has been that girls exhibit less positive attitudes towards science (whether school science or science as a whole) than boys (Bennett, Lubben & Hogarth, 2006; Farenga & Joyce, 1998; Smith & Matthew, 2000; Weinburgh, 1995) and that on the whole, attitudes towards school science and science as a whole decline through the middle school and high school years (George, 2006; Morrell & Lederman, 1998; Sorge, 2007). For this reason, it has become necessary to examine different populations of students around the world with regard to the relationship between different variables (assessments, other subjects, teachers, parents, age, ethnicity, etc.) and attitudes towards school science and science as a whole.

2.2.3 Intersection of attitudes and alternative assessments

While many studies look to investigate the intersection of attitudes with specific criteria (such as peer group influence, non-classroom science interventions, achievement, or family interactions), only recently have people looked at the interaction of alternative assessments and attitudes towards science.

Bennett, Lubben, and Hogarth (2006) conducted a meta-analysis of studies which linked attitudes towards science and specific types of alternative assessments. These assessments were classified as context-based or science-technology-society (STS) approaches. Their research concluded that while these approaches improved attitudes towards school science, it did not conclusively translate into an improvement of attitudes towards science.

Smith & Matthews (2000) were able to see an improvement in 15 year old girls' attitudes towards science as a result of similar Science, Technology and Society (STS) approaches in the classroom. They were also able to see a shift in their subject choices after the intervention of

STS teaching. Students also showed a change in their rationale behind choosing specific subjects, showing more interest in a subject rather than a need to study it for a career.

Kirikkaya & Vurkaya (2011) were able to set up a control versus experimental group within three schools in Turkey. In this study, attitudes and academic achievement were monitored pre- and post-assessment during a unit on “Electricity in our Lives.” There was a more positive attitude towards science post-assessment in all schools, indicating that the alternative assessment was the cause of the change in attitude. It was also seen that in all three schools, there was a significant difference between the achievements of students in the experimental groups versus the control groups. This would indicate that the assessment method was the reason for this improvement in their marks (p. 1001). This study was a small sample size, but gives a good comparison between experimental and control groups within the same setting (same school).

2.3 Alternative Assessments

2.3.1 What is an alternative assessment?

Within a study that focuses on alternative assessments, it is also important to distinguish these from traditional assessments since this underpins any inferences from this study. Traditional assessments are generally one-time measures where the questions asked have one correct answer. They are generally a paper-and-pencil test, worksheet or comprehension activity where a specific body of knowledge, removed from a real-world context, is recontextualized for the purpose of determining a student’s performance in a determined amount of time. These assessments tend to be culturally separated from many of the students that take the assessments because the teachers are not consulted in the construction of these tests. Traditional assessments are designed for large-scale use, national reporting, or statistical analysis (SEDL, 2012; State of New Jersey, 2010). All of these points are in opposition to the five characteristics of alternative assessment tasks described in Chapter 1 (State of New Jersey, 2010).

Alternative assessments are designed to engage a student’s higher-order thinking skills as well as engage them in real-world contexts, lending themselves to problem-solving. The scoring of

these tasks depends on the immediate teacher's judgment which can bring in cultural context and situational bias. Alternative assessments are also underpinned by a constructivist theory of learning. Students have freedom of choice within the context of the assessment which leads to ownership of the ideas created and social interaction to create the ideas and products (Janich, Liu, & Akrofi, 2007). These assessments are often received in a positive manner, with students being able to reflect not only on the subject matter but also how they have approached the assessment (Janich, Liu, & Amma, 2007). Waters, Smeaton, & Burns (2004) found other positive effects of alternative assessments like collegiality and creativity within the classroom, with a decrease in off-task behaviours (p .96-97). Researchers and teachers alike have seen the benefits of using alternative assessments to improve both achievement and attitudes in students (Kirikkaya & Vurkaya, 2011).

2.3.2 Previous research in and of alternative assessments

In order to understand alternative assessments, it is necessary to review some of the current literature as the topic is considered highly contextual. Each of the studies below highlights different reasons for the alternative assessments and the effect that it had on the context. It is important to note that in many cases, there was a positive relationship between the implementation of the alternative assessment and the improvement of attitudes in the students towards that subject.

Couling (2011) conducted action research with her General Chemistry students in Grade 10 to investigate how to curb cheating on homework and improve results on solo tests. She did this through a three-cycle approach to research, in which each cycle contained an intervention and an evaluation. Through each cycle, she monitored cheating on homework and recorded solo test results. Collaborative units tended to decrease cheating on homework as it allowed the students to set their own and mark their own homework assignments. This led to improvements on solo tests, which is very relevant to the South African framework of high-stakes testing. Without intending to, Couling also noted a change in their attitudes towards Chemistry as a result of the interventions. The attitudes of most students had improved as a result with more of them saying "I can do Chemistry."

Archer, Dewitt, Osborne, Dillon, Willis, & Wong (2010) created a five-year longitudinal study in which they studied students in five different schools in the London area. The sample

represented a large diversity of schools and students, since their question was based on the identity the students were creating for themselves. The main question that the researchers were trying to answer was the link between “doing science” and wanting to “(be) a scientist” in the eyes of middle school and high school students. They reviewed student interviews for clues about the enjoyment of “doing science” and learned that many of the students enjoyed participating in science at school level. They concluded that “doing science” in elementary school does not equate to students wanting to “be a scientist” after high school.

Carlone (2004) researched the effect that an innovative teaching method had on the attitudes and achievement of the students in the class. The class of Active Physics students at Sunnyglen High included both boys and girls and was taught by a male teacher. The teacher employed a problem-based learning approach to the subject of Physics based on a national curriculum called Active Physics. Carlone found that even though the method of instruction was innovative and alternative to the regular (or traditional) Physics class at the same high school, the students had the same attitudes towards Physics and science at the end of the investigation. She witnessed instances within the enacted curriculum that historical views of women in science were portrayed by the male teacher. Traditional values of science and scientists were the norm, even though the curriculum was innovative. Girls were never seen as naturally-gifted, whereas boys in the class were. As a result, fewer girls had a positive attitude towards Physics at the end of the investigation. This is important as it denotes the importance of the teacher in the benefits of alternative and innovative education.

Since alternative assessments are considered contextual, as effort was made to investigate other research into alternative assessments in South Africa, but no formal research was found. However, from discussions with other teachers at this school and others, a few vignettes were noted about the effects that alternative assessments can have on attitudes towards school subjects and alternative assessments.

In the Grade 4 class at this school, the teachers were told that the incoming class did not enjoy reading and could not work together. Therefore, the teachers designed a unit around a set book which incorporated different kinds of group work as the assessments throughout the unit. The assessments involved creating new story lines for the main character, drawing these stories, narrating them into a movie, creating new buildings within the fantasy land of the

book, and teaching others about the story. The qualitative feedback from the students after the unit was finished was that they enjoyed reading more and felt that they had accomplished a lot through this project. The feedback from the teachers was that the students were more capable collaborators and could solve group problems better. They also commented that the reading logs of these classes had increased by the end of the project. They were able to compare these results to a traditional assessment in the following term. The individual marks were lower on average and the students did not respond with the same enthusiasm for the assessment.

From these examples, one can determine that alternative assessments can have a positive effect on the attitudes of the students towards science and school science as well as their achievement within these subjects.

2.4 How girls learn best

If one reviews the definition that Herman, Aschbacher & Winters (1992) given in Corcoran, Dershimer & Tichenor (2004) about alternative assessments (Chapter 1, p. 13), it is clear that these points would fit within the paradigm of how girls learn best. The following is a discussion about the optimal learning conditions for girls.

Problem-solving skills are noted as one of the characteristics of alternative assessments. In order to develop this skill, students need to be able to understand the complexity of problems and develop solutions. They also need to be able to express their ideas in a common language to the group. According to Gurian & Stevens (2004), girls develop the “verbal-emotive functioning” parts of their brain more than boys at a similar age (p. 22). A girl’s brain is more likely to revert to using these aspects of her brain than the “spatial-mechanical functioning” that boys have (p. 23). This could indicate that girls will more likely use their ability to dialogue with each other in order to find solutions to problems rather than independently create solutions. Therefore, they will want to work together.

Thom (2001) discusses the differences between boys and girls with regards to their optimal learning environments. She states that girls will generally benefit from working collaboratively, whereas boys will work better independently and competitively. Brotman &

Moore (2008) quoted previous research which indicated that girls were more collaborative and less competitive than boys (p. 982). Honigsfeld & Dunn (2003) investigated the relationship between learning styles in high school students across eight different countries. Within their results, they were able to highlight a few characteristics of how girls learn versus boys. Across cultures, girls learned better in a system which allowed for varied sociological mixtures, such as independently, in pairs, in groups or even with the teacher (p. 204), as compared to classrooms which focused on one style of mixing students (such as often in pairs or often independently). Bonomo (2010) stated that girls can work better in groups because they are more able to multitask and can listen and differentiate sounds better.

Since Gurian & Stevens (2004) say that “children will naturally gravitate toward activities that their brains experience as pleasurable” (p. 22) one can infer that girls will gravitate towards situations in which they are able to discuss possible solutions in a common language, usually one that includes everyday words rather than complex scientific terminology. This conclusion would indicate that for girls, group work and problem-solving should be significant factors when designing assessments.

For both alternative assessments and girls’ preferences in learning, real-world context and everyday language have appeared in many studies. In a German Physics classroom, Stadler, Duit & Benke (2000) investigated the differences between how boys and girls responded to a practical investigation of the limited predictability of a chaotic system. Within the co-ed group, girls were more likely to use discussion as a way to reach an answer (p. 421). Girls were more prone to using everyday language to express their ideas as well as trying to relate the concepts to daily contexts (p. 421). This is consistent with the alternative assessments being those which are placed in a real-world context and represent meaningful instructional activity. Girls should respond more positively to assessments which give a connection to their daily lives or assessments which allow them to make these connections.

With these concepts in mind, it was predicted that girls’ attitudes towards science would improve if they are provided with opportunities to learn through problem-solving and real world contexts and given assessment tasks which allow them independence and compared to projects which encourage regurgitation of facts or comprehension based questions.

2.5 This study

This study investigated the intersection of three aspects of research – how girls learn, the effect of alternative assessments, and student attitudes towards science. If students are given situations where they are placed in optimal learning environments, they will presumably have a more positive attitude toward that subject. If a student has a more positive attitude toward that subject, it may lead to further choices in science and science-related fields (“moving toward” responses (Mager, 1968)). Thus it is hypothesized that with the presence of an alternative assessment within a curricular year, students would show a positive attitude toward the subject matter by choosing to continue studying it past high school in a theoretical context as well as an overall positive attitude toward science.

University of Cape Town

Chapter 3

Research Methodology

3.1 Research design

There are a variety of ways in which researchers can mix their qualitative and quantitative methods, mainly based on their desired outcomes (Creswell, 2009). Through an investigation into these desired outcomes, the mixed methodology often emerges. This study has used a number of methods for reasons which are explored below.

A quasi-experimental design was used to try to identify a change in attitudes in the sample. Specifically, an equivalent time-samples design was used (Tuckman, 1994). This allowed for a qualitative questionnaire at the beginning of the year to determine a baseline for attitudes towards Natural Science, followed by the alternative assessment, followed by another qualitative questionnaire mid-year, and a final qualitative questionnaire at the end of the school year. Additionally, there was a quantitative questionnaire completed concurrently at the mid-year point. This was determined by the sequentially exploratory design (mixed methods approach) described by Creswell (2009). The beginning of year questionnaire highlighted themes that were used to determine the sections of the ROSE questionnaire used. The purpose of the ROSE questionnaire was to use an internationally recognized and validated attitude survey to which to compare these students.

3.1.1 Qualitative approach

The questions asked at the three different times of the year were open-ended. This kind of questioning allows the subjects to create their own answers. This allows for specific themes to emerge naturally and improves the validity of their answers because they are not guided by the question itself (Creswell, 2009, p. 15-6).

The January (beginning of the year) and December (end of the year) questionnaires contained two questions that were open-ended in order to identify their favourite and hardest parts of Natural Science. Bennett, Lubben & Hogarth (2006) stated that “subject choices... and/or

career aspirations are important indicators of attitude to the subject” (p. 363). By identifying these, students were indicating their attitudes towards specific parts of the subject of science by classifying their answers under the headings of *favourite* and *hardest* part.

In June (mid-year) and December (end of the year), the open-ended questions was slightly different. The final question from the ROSE questionnaire asked the students to think about the future and assume that they had become a scientist. They were then asked to identify what they would study and give a reason why they would study this area of science. Continuing with the rationale given by Bennett et al (2006) one can determine the attitudes of the students towards the subject of science based on their career aspirations. This question guided their answer to provide more detail about their career aspirations. It also included their rationale for choosing a specific topic. This gave insight into how and why the students responded as they did. This question was used twice to determine if their career aspiration or rationale had changed over the second half of the year.

3.1.2 Quantitative approach

Quantitative data was also collected mid-year for purposes of identifying larger patterns within the attitudes of this non-random sample of students towards science. The addition of this survey of attitudes was in line with a “sequential exploratory design” as described by Creswell (2009, p. 209). In this design, the qualitative data collection and analysis informed the choices of the quantitative data collection method. A total analysis of the data followed at the end. Within this study, however, the data analysis has included all the qualitative data collected and the quantitative data collected, as they have informed each other.

The statements given in the ROSE questionnaire were closed questions. This kind of question identifies that kind of information or answers that the researcher is interested in collecting (Creswell, 2009, p. 15-6). These statements covered two different topics – Science, Technology and Me, and Me and my Science Classes. These all included statements which the students had to rank using a Likert scale in terms of importance to them (from Not Important to Very Important) or in terms of agreement (from Strongly Disagree to Strongly Agree). These sections were chosen from the ROSE questionnaire because of the themes which emerged from the beginning of the year questionnaire. These two sections also allowed for the measurement of attitudes towards science and school science. There were 6 other sections

of the ROSE questionnaire which were not used. Three of these sections dealt with topics that students may want to learn about. One section dealt with experiences that students have out of school, another with the number of books in a student's household. The last two sections were concerned with the kind of job the students want in the future and how they relate to environmental challenges (Schreiner & Sjøberg, 2004). These sections were not used because they did not fit with the purpose of the study, as they did not relate directly to attitudes towards science or did not allow the analysis to link back to alternative assessments.

3.2 Sampling Method

The Grade 8 class of the school was chosen for this study. The reason that Grade 8 was chosen as a year of study was three-fold: there are new girls introduced into the school at this stage, so that the histories of the students with regards to Natural Science were all different; this is the first year in the high school within this school; and it is the grade in the middle of a phase within the GET, which gave a good historical point at which to collect this kind of data. A non-random sample was chosen for this study. This was in line with the quasi-experimental design. Since there were only 68 students in the grade and this number was large enough to assess and large enough to use as an appropriate sample size, all the students were chosen to receive the alternative assessment. The number of students in the sample was therefore regulated by the total number of students in the Grade 8 class at this school.

This "critical case sampling" (Palys, 2008) was chosen to give insight into the attitudes of girls in a privileged environment. The privilege indicated that the school (and by association, the students) did not have any barriers towards learning taking place (for example, all girls were well-fed and had equal access to computers, desks, books, etc. at school).

3.3 Research Participants

The school in which this study has taken place is an all-girls, Anglican school from grades 00 – 12. The school is over 140 years old and maintains many traditions, both religious and secular. The school is a member of the Anglican Church of South Africa, and the girls are exposed to regular religious instruction and ceremonies. The school is also a part of the Round Square conference of schools. This organization, founded by Kurt Hahn, is underpinned by six IDEALS – Internationalism, Democracy, Environmentalism, Adventure, Leadership, and Service. These themes are expressed inside and outside of the classroom environment. Recently the school was chosen to be a super-mentor school for Microsoft® Partners in Learning. This international programme strives to recognize educators and schools who value and embrace innovation in education through the incorporation of 21st century skills within their classrooms and school environment. This is a testament to the innovative teaching and learning practices that are at work within all sections of the school.

The classrooms are all equipped with a computer which has internet and intranet access and most have a projector that the teachers use on a regular basis. More than half of the classes have SMART® or Mimeo® boards (these are both interactive white board technologies). There are two classrooms which have a small bank of computers, one being the science classroom. There are two computer rooms (each with 25 computers) and a large bank of computers for student use in the library. Information technology (IT) forms a large part of student life at the school. There is an intranet where teachers post work and links relevant to their subjects, and each student has an email address for communication in and out of the school. Girls have IT as a subject from Grade 1 to Grade 9 and in the Senior Phase (Grades 7-9), and they study to complete their International Computer Driving License (ICDL).

There are many extra-curricular activities on offer. One school sport is mandatory at Grade 8 level. Many girls also participate in co-curricular activities such as Debating or Community Partnerships or Pottery. The school also hosts a variety of extra-curricular activities as a whole. These include guest speakers (such as Lewis Pugh) or theme days (such as Africa Day). These days increase awareness about issues from within their communities and extend to the continent. The school also has a Baraza meeting each term, when the girls listen to a speaker

or watch a movie and then break into small discussion groups from Grades 8-12 to discuss the meaning and impact of the presentation on their lives. These are student driven and lead.

There are about 50 teachers in the Senior School, who also come from a variety of backgrounds and socio-economic classes. Many are international or have spent a significant amount of time in another country (either living or teaching or both). Therefore the viewpoint that they bring to the class is broad and varied.

In terms of academic results, the school has had a 100% pass rate for the last 10 years. The school has appeared in the top 10 schools in their province during this period and often had students who are the top student in specific subjects in the province or the nation. Therefore the drive to succeed academically is strong amongst the student body.

There are just over 800 students in the school, with about 330 in the Senior School (Grades 8-12). Each grade has an average of 70 students. Students come from a variety of backgrounds and socio-economic classes, but the majority is from a top socio-economic class. In Grade 8, about 66% of the class is accepted from the Preparatory School and about 33% are new students from a variety of schools. Therefore the experiences of the girls up to this point are different. Due to the lack of a concrete curriculum in Natural Science at this point, the topics covered in their previous schools are also different. This may change in the future with the implementation of the new National Curriculum Statement's Curriculum and Assessment Policy (CAPS). For this cohort of students, there would have been a variety of topics covered in their Intermediate Phase and Grade 7 classes.

With regards to the numbers of science students in the FET phase, a decade ago, there was one class of Physical Science which had less than 20 students at the Grade 12 level. Therefore less than 30% of the matric class was taking Physical Science. In 2012, 41 students (54%) of the Grade 10 class registered for Physical Science and 41 students (54%) registered for Life Science. Out of 76 students in the grade, 31 students (40%) registered for both Life and Physical Science, two students (3%) registered for Life Science, Physical Science and Geography, and only 12 students (16%) did not register for either Life or Physical Science. Therefore, there has been an increase in the number of students who want to study science courses and who believe that they *can* study these subjects. This number may change over the course of the year due to students changing subjects, but the matric science classes of

2014 will still be the largest that the school has seen in 10 years. Because of the increase in students choosing science based subjects at Grade 10 level, it was decided that the impact of these alternative assessments driving the GET phase Natural Science curriculum at this school needed to be investigated.

3.4 Research Instruments and Analysis

3.4.1 Development of the alternative assessment

To determine the effect of an alternative assessment on attitudes, there must be a process by which an assessment is qualified as alternative. An alternative assessment was drawn up by the researcher and her colleagues to cover the topic of Sustainable Energy and Renewable Resources. This alternative assessment formed part of an alternative education week at the end of Term 1 (near the end of March). Within this week, the students investigated the theme of "Our Big Issues," a community-focused, hands-on approach to learning, concentrating on a number of subjects (Natural Science, Life Orientation, English, and Mathematics). No traditional classes were held during this week, and regular class groups were mixed across the grade. For Natural Science, the "Big Issue" covered was that of Sustainable Energy and Renewable Resources.

Sustainable energy and renewable resources was a topic in both Grade 7 and 8 within the National Curriculum Statement (NCS). Therefore at least some of the students had covered the topic in some detail. A two-fold quiz game was used to refresh their memory or teach them some content about sustainable energy practices and renewable energy sources. The students were split into teams of four and given four 10-question quizzes that they had to discuss and answer. There were prizes for the first to complete the questions and the team with the most correct answers, so accuracy and efficiency were rewarded. After the teams had completed this, each team nominated a member to participate in a knock-out round of single questions. This quiz formed the part of the time dedicated to content acquisition for the alternative assessment, but did not form any part of the marks.

When changes to the assessment task were being made, the criteria quoted by Corcoran, Dershimer & Tichenor (2004) were kept in mind. With the first criteria in mind (“to perform, create, produce, or do something”), the students were asked to create a survey, collect data from the survey, collate this into a presentation where they discuss their findings, and then develop an educational video about one aspect of their research. Students had completed a unit in the same term which focused on these skills; therefore, this was an application of previously learned skills. With the second criteria in mind (“tapping higher-level thinking and problem-solving skills”), students were asked to evaluate questions for the survey as well as the data that they collected. They were further asked to evaluate information to determine its educational value. With the third criteria in mind (“using tasks that represent meaningful instructional activities”), students were learning a variety of skills that would be applied throughout their other subjects, such as data collection and manipulation, collaboration, time management, and skilled communication. They were also learning about sustainable energy and renewable resources and awareness by asking their own questions and collecting their own data rather than reading about data from another source. With the fourth criteria in mind (“involving real world applications”), students had to involve the real world and real people in both collecting data and during the movie. The movie had to include an interview with a person who was relevant to their topic. This included parents, siblings, professionals, and like-minded strangers. With the fifth and last criteria in mind (“using human judgment to do the scoring”), a rubric was drawn up for each step of the project. This allowed the students to know the criteria beforehand as well as understand that they were being evaluated by their teacher, as opposed to a machine (as with standardized, multiple choice tests). A copy of the alternative assessment can be found in Appendix A.

3.4.2 Moderation of the alternative assessment

A moderation rubric was drawn up according to these criteria and the student assignment was moderated by five colleagues in Natural Science (See Appendix B). This group represented internal and external colleagues from both secondary and tertiary institutions. They all agreed that the task fit the criteria completely (See Appendix B). This independent analysis supports the construct validity that the assessment was alternative.

3.4.3 Informed consent and authenticity of work

Since Natural Science is a compulsory subject at this level, the assessment was carried out with all Grade 8 students at the school (67 in total). The headmistress gave informed consent for the school's students to be used. Sixty students and their parents also gave informed consent that their work will be used and anonymity preserved. Seven students and parents did not reply or give consent. All tasks were collected (surveys, power point presentations, presentation rubrics, movies, and movie rubrics). These formed a part of the authenticity validity to show that the work was the work of the students.

3.4.4 Beginning of the year questionnaire

At the beginning of the school year before any teaching took place, the students were asked to complete a written questionnaire which asked them to identify their favourite and hardest parts of Natural Science. Based on Mager's (1968) idea of "moving towards" responses and the link to positive attitudes, choices that students made in response to these questions indicated what parts of science and science classes they were the most attracted to or dissuaded from. This idea was supported by Bennett et al. (2006) which stated that the choices students made for further study was an indication of attitudes towards the subject. The more students choose to participate or study specific areas, the more of a positive attitude they would associate with these subjects.

The students were given as much time as they required to complete this form. The words they used were chosen by them. There were a few suggestions given to start their process, and these words were varied between skills and topics, such as "what we do in class" or "what topic you enjoy the most." Because there were no limits or choices given for these questions, there was an implicit trust in the validity of their answers as authentic. This information was collected and classified: first between skills and topics, and second into specific kinds of skills and topics. Within the topics, the words that the students wrote were used to determine the classification system. The topics were then classified into Biological Sciences, Physical Sciences, or Other. This formed a baseline for the interests in and attitudes towards science (See Appendix C).

3.4.5 Reflections of the alternative assessment

Each student was asked to write a one-page, open-ended reflection of the assessment during the alternative education week. Reflections by all learners of the assessment were collected and were linguistically analyzed. A classification system for the comments was created based on the affective data in the reflections. This system was used to code the reflections of the students to determine their attitude towards alternative assessments (See Appendix D).

3.4.6 The ROSE questionnaire

The Relevance of Science Education (ROSE) questionnaire was developed in 2004 for an international survey of student attitudes towards science education. This nine-part, closed question (except for Section I) survey was originally developed for an international group of academics to investigate the relevance of science education to 15-year-olds (Schreiner & Sjøberg, 2004). The validity of the survey was determined through its rigorous development process with academics from nine countries and can therefore be used internationally. It has a specific coding scheme and marking scheme which was used. However, only specific sections of the 9-part questionnaire were used for the following reasons. Section F (my science class) was used to see how important they rank classroom instruction. Section G (my opinions about science and technology) was used to understand how they view the relationship between themselves and technology, especially since the project delved into sustainable uses of energy. Section I (myself as a scientist) was used as it is an open-ended question to give the students a chance to reflect on what they can see themselves doing in the future. Through communication with Sjøberg, it was accepted that only some of the sections of the attitude survey could be used as they were developed to stand alone from each other (Sjøberg, S., personal communication, 10 April 2012). Questions used can be found in Appendix E.

Upon completion of the assessment, the students were given an electronic version of the ROSE questionnaire using SurveyMonkey® (an online survey tool) and asked to complete it. The students were brought to the computer lab and given unlimited time to complete the questionnaire. The girls were given instructions including not to discuss their answers with each other, but there was no adult present in the room to potentially influence their results. Results were compiled and analyzed based on the coding and marking schemes originally

developed by the authors. To determine the percentage of positive responses, the total Agree and Strongly Agree responses were added together and a percentage of the total was calculated. The coding question 3 about “If I were a scientist” was coded using the original researchers coding scheme and percentages of the totals were calculated (See Appendix F).

3.4.7 The end of the year questionnaire

At the end of the school year, the students were given a final set of reflection questions. They were asked again about their favourite and hardest part of Natural Science as well as the open-ended question from the ROSE questionnaire. The reason to ask these questions again was to determine the long-term effect of the alternative assessment on their attitude towards specific topics or skills in science. The girls hand wrote these responses. The results were analyzed in the same manner as before (See Appendix C and H).

3.5 Conclusion

To summarize, a mixed methods approach was employed. The students engaged with the alternative assessment on sustainable energy and renewable resources. Open-ended questions at three points in the year were asked of the students to gauge changes in their attitudes by identifying parts of Natural Science or science in general with which they enjoy engaging and potentially aspire to have as a career. These were administered two months before, two months after, and nine months after students had engaged with an alternative assessment. A quantitative survey was completed mid-year (two months after students had engaged with the alternative assessment) to determine their attitude towards science, comparable with an international body of data. This data forms the basis of the results that are reported on and analysed in the following two chapters.

Chapter 4

Results

4.1 Introduction

In this chapter, the results will be presented in the following order:

- Reflections on the alternative assessment
- Results from the ROSE questionnaire
- Results from the open-ended questions regarding the favourite and hardest parts of Natural Science
- Results from the “If I were a scientist” questionnaire.

These results from each bullet have been grouped per instrument, instead of chronologically, because it made the description of the results easier. In each section, relevant results are given and reported upon, but in certain cases, extra data can be found in the Appendices at the end of the document.

4.2 Reflections of students regarding the alternative assessment

At the end of the first day of the alternative education week in which the students had to complete the quiz, create the survey, and begin collecting data, the students were asked to write a 1 page reflection on their experiences. The day had also included a different activity linked to Life Orientation (another subject at school). Therefore the reflections contained information from both activities. Students were able to demonstrate what they had learned from the activities and assessment at this point (see *Figure 2*). Students showed a positive attitude toward the activities and assessment rather than a negative one. 42% of the comments were classified as “fun, interesting, exciting, enjoyable, or helpful” as compared to 3% being classified as “tedious, uninteresting, not exciting, unenjoyable” (see *Figure 3*).

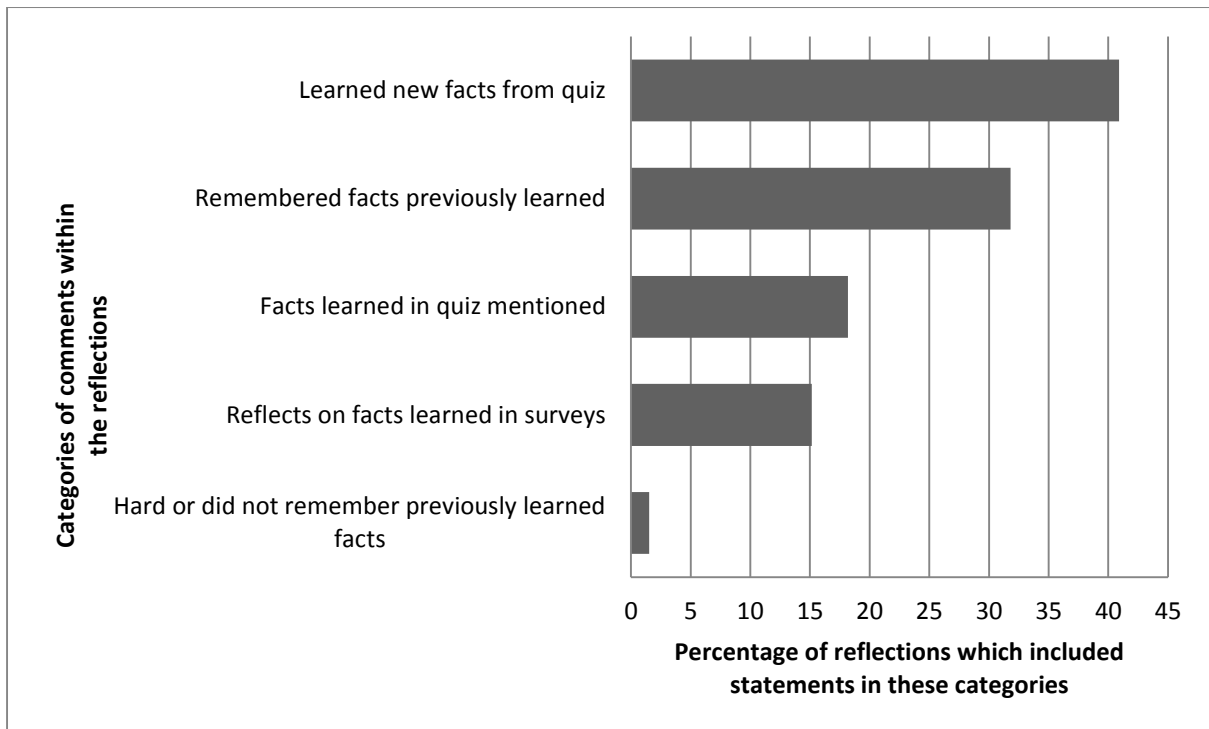


Figure 2: Percentage of reflections which included comments about facts from the quiz and survey

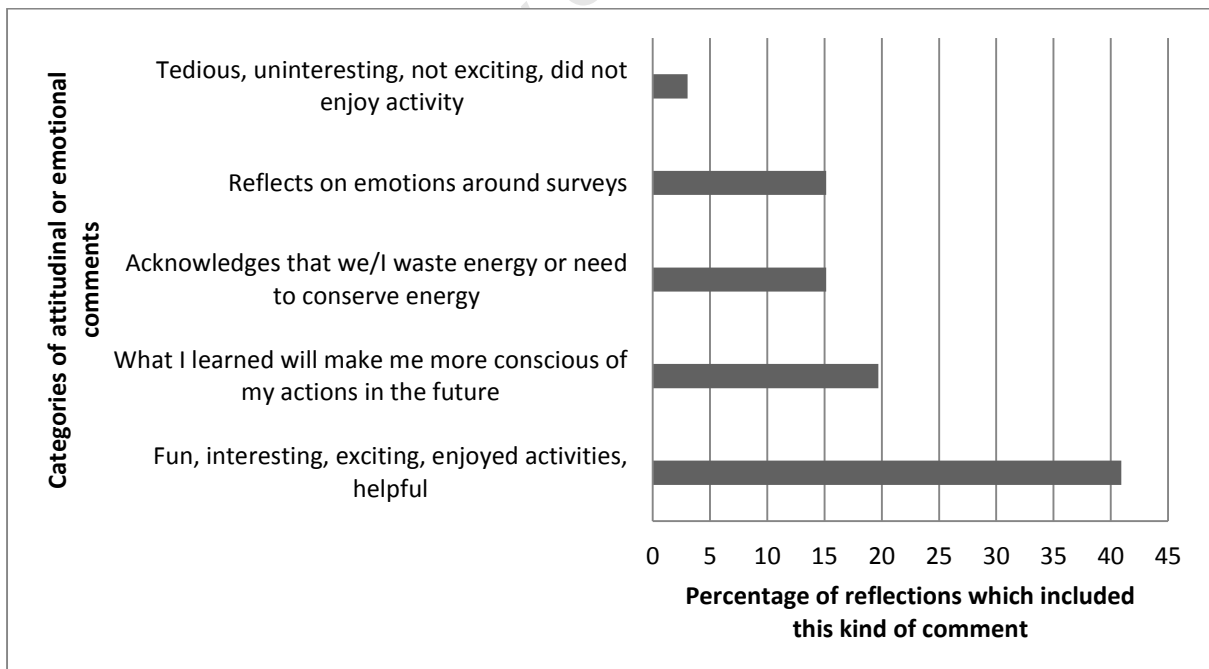


Figure 3: Percentage of reflections which included an attitude or emotional comment

4.3 Student responses from the ROSE questionnaire

The ROSE questionnaire used contained four sections of statements to which students responded on a 4-point Likert scale. Question 1 dealt with specific details of “My Science Classes” and question 2 dealt with specific details of “My Opinions of Science and Technology.” The Likert scale associated with these two questions was a 4-point scale which ranged from Strongly Agree to Strongly Disagree. Results for the survey consisted of adding the two categories of Agree and Strongly Agree to determine the percentage of students who had a positive response to the statement. Certain relevant data are reported on here. The full data can be found in Appendix G.

With regards to school science, students had an overwhelmingly positive response, finding the subject interesting (92%), important for our way of living (85%), and helpful for their everyday lives (71%). The data suggests that students find this subject linked with the world around them in concrete, obvious ways. Compared to the results from Schreiner & Sjøberg (2010), the students were above the international average in their responses to these statements (pgs. 11-14), thus exhibiting a very positive attitude toward their science classes (see *Figure 4*).

With regards to their future paths in science however, students were not as positive. Only 20% stated that they would like a job as a scientist and 22% would like a job in technology. Within one year, these students will make a choice about their subjects to study at school level, and only 39% stated that they would like to take as much science at school as possible (see *Figure 4*). This dichotomy is concerning because it means that although they find their science classes interesting, they do not link this interest into something that they would want to pursue in future studies. This was in line with results from Schreiner & Sjøberg with regards to the more-developed countries in their survey. This indicates a similar future problem with recruitment into science careers that many developed countries are currently experiencing (Schreiner & Sjøberg, 2010, p. 26).

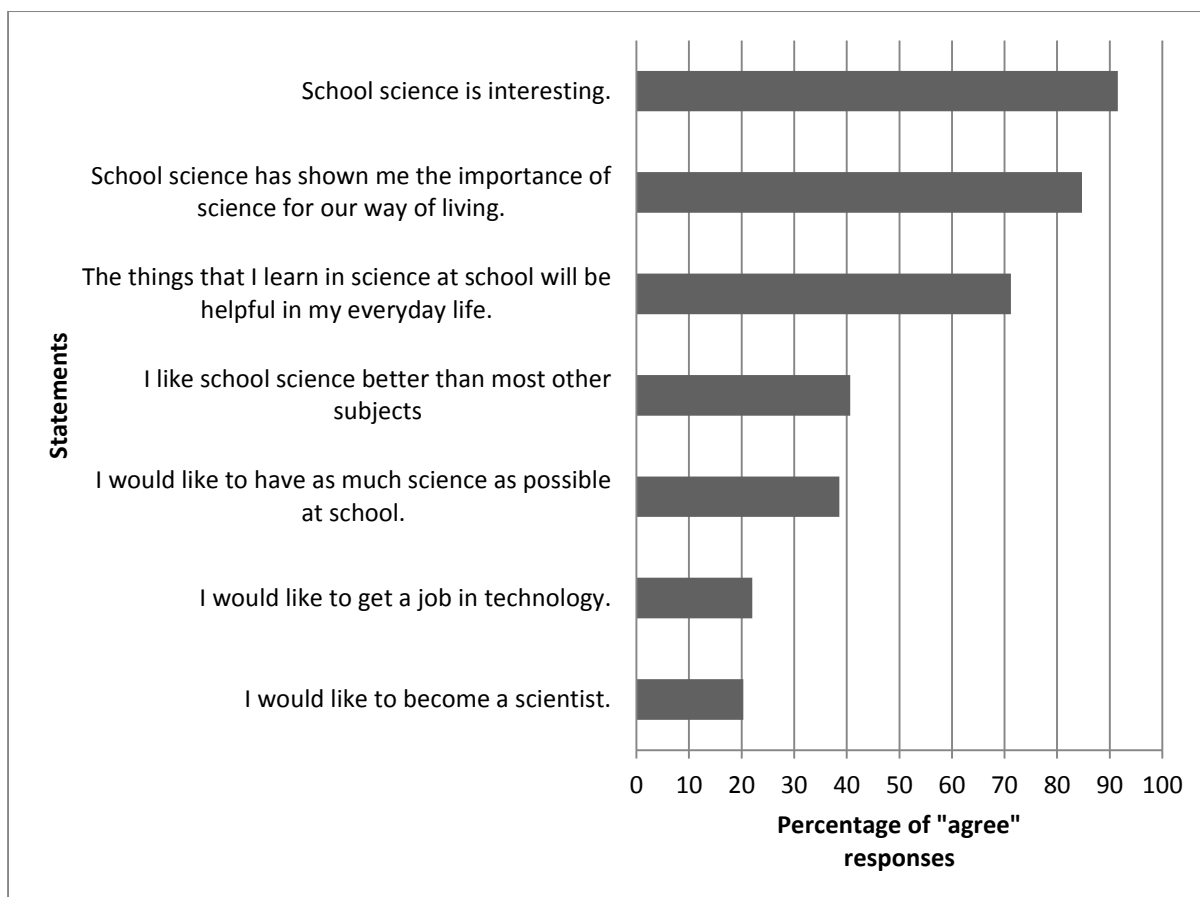


Figure 4: Responses to My Science Classes

With regards to their opinions of science and technology, students believed that science and technology are important for society (92%), and that it will give future generations more opportunities (90%) (see *Figure 5*). There was a general optimism about science and technology, but this was juxtaposed against skepticism about the stability and trustworthiness of science and technology. Students believed that scientific theories are developing and changing all the time (88%). When presented with the statements “we should always trust what scientists have to say” and “scientists are neutral and objective,” few students agreed with these statements (17% each) (see *Figure 5*). These results bear an interesting comparison to the results of Schreiner & Sjøberg (2010). In their findings, it was the students of more-developed countries that had a positive attitude but more skepticism than students of less-developed countries (p. 7).

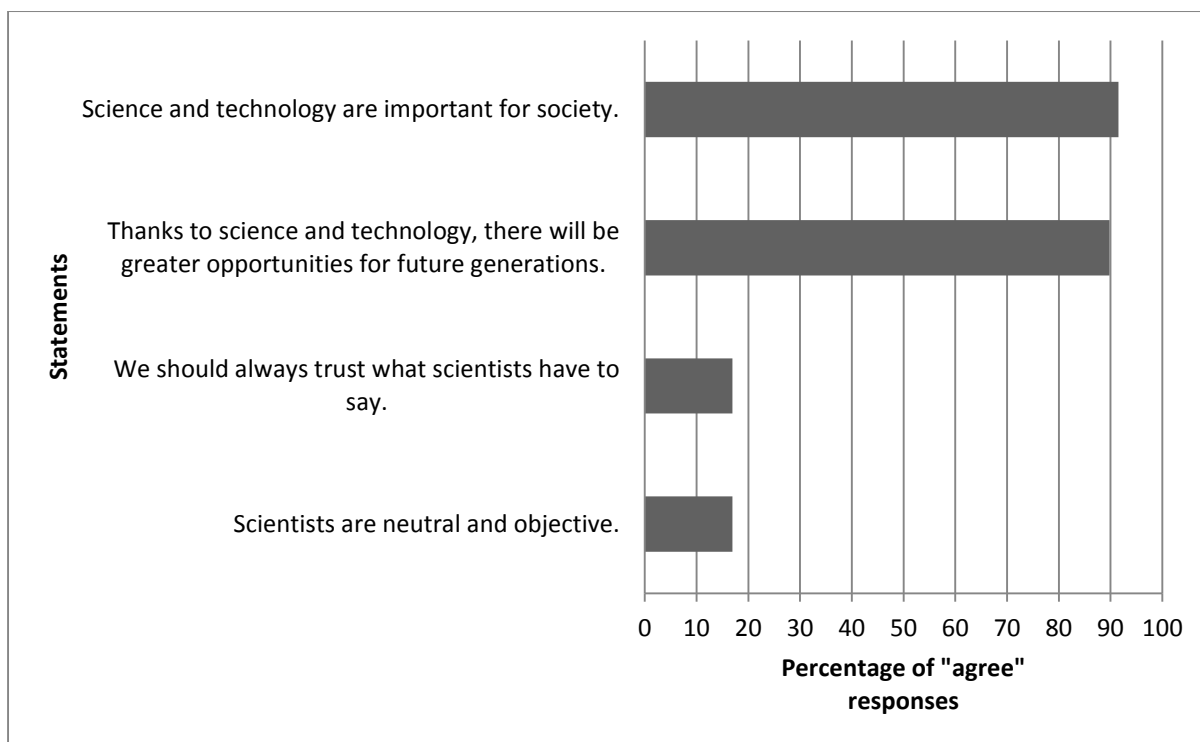


Figure 5: Responses to My Opinions about Science and Technology

4.4 Students' Favourite Part of Natural Science

4.4.1 Beginning of the year (January) reflections

In January, the students preferred both skills and topics in Natural Science (see Figure 6). The only skill mentioned was experimentation. In Harwell (2000), in an open-ended interview, Grade 7 girls also mentioned experimentation specifically and chose "active learning strategies" as their preferred method of learning science (p. 229). Other than skills and topics, there was a small mention (2%) of the teacher. Schibeci (1982) had previously identified "Science Teacher" as one of the eight stimuli that students would react to when forming an attitude toward science. (p 566) This is why it is interesting that this presented itself as a factor to a very small percentage of students, but it was not an overwhelming factor mentioned. In terms of the topics preferred, there was a preference for Physical Science (31%) to the Biological Sciences (12%). Within the Physical Sciences, there were a variety of topics mentioned from Astronomy (22% of Physical Science topics) to General

Chemistry (22% of Physical Science topics) and Electricity (11% of Physical Science topics). Within the Biological Science topics, students mentioned Animals, Human Body, Biology, Genetics and Plants. There were other topics mentioned at this time such as the range of topics covered and conservation (both classified as Other Topics).

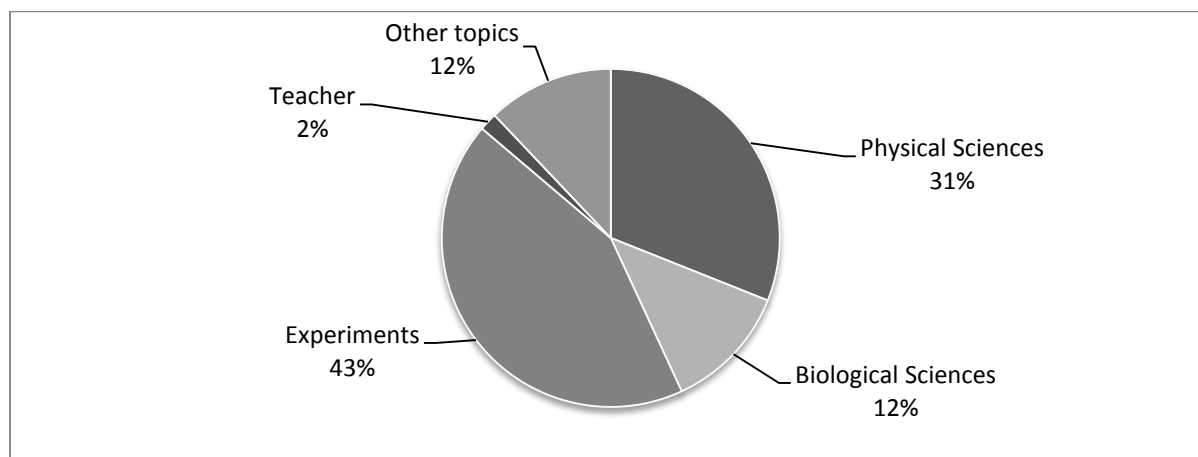


Figure 6: Students' Favourite Parts of Natural Science in January

4.4.2 End of the year (December) reflections

In December, the students chose more topics than skills in Natural Science (see Figure 7). There was a marked increase in the number of Biological Sciences topics which appeared at this point (34%). There was also not a significant change in the number of students who chose a Physical Science topic (29% now as opposed to 31% in January). Topics under Physical Science included Astronomy (32% of Physical Science topics mentioned), Light (32%), Gases (12%), and General Chemistry (8%). Skills and processes were much more varied at this time. Experimentation was listed 50% of the time for skills. Other skills and processes included games for learning and review, projects (including the alternative assessment on sustainable energy and renewable resources), how work was approached, the logical order of learning science, and the random conversations which took place between topics.

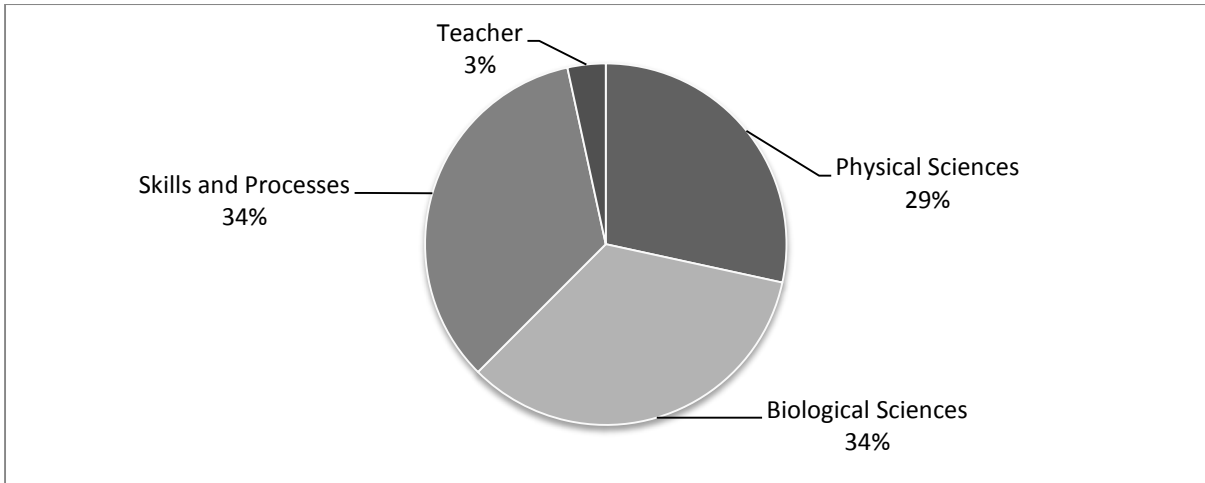


Figure 7: Students' Favourite Parts of Natural Science in December

4.4.3 Changes from January to December

As one can see in Figure 8, students had a drastic change in their favourite topic, favouring the Biological Sciences in December.

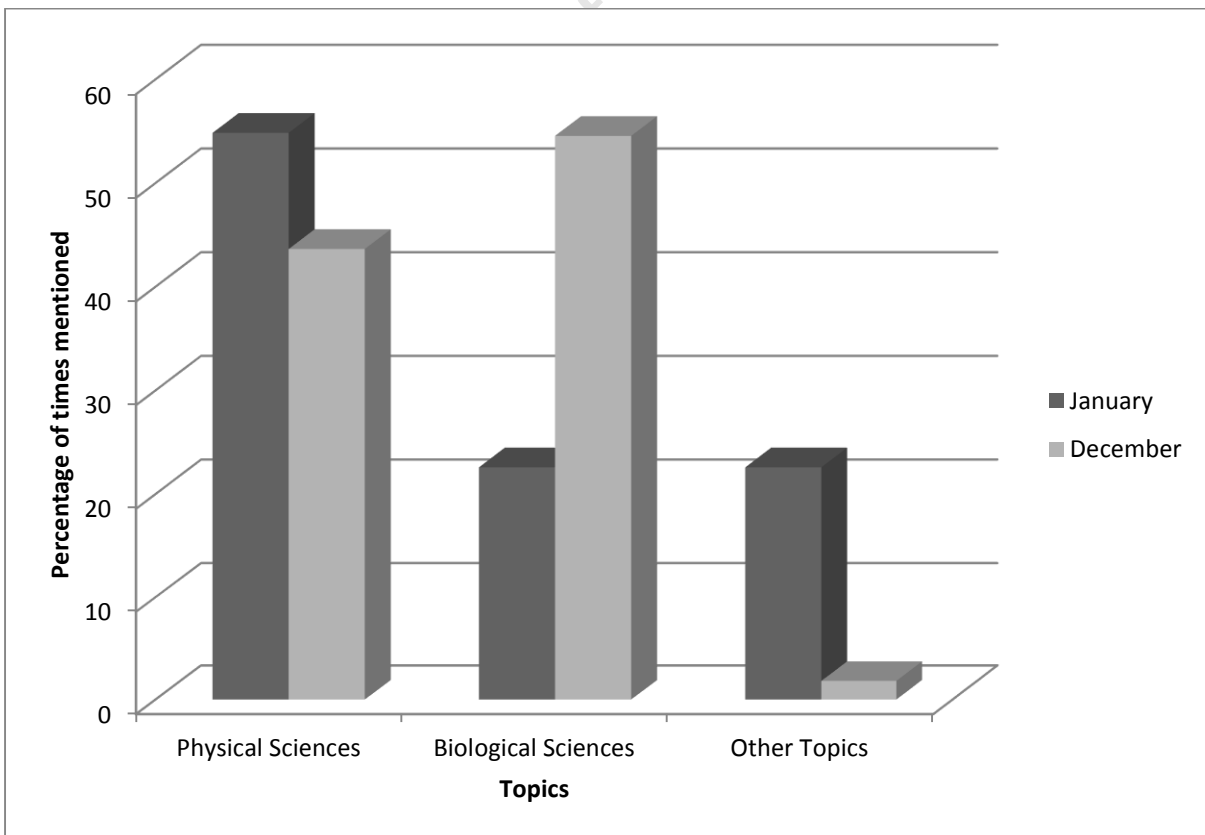


Figure 8: Chart showing the changes in favourite topics from January to December

4.5 Students' Hardest Part of Natural Science

4.5.1 Beginning of the year (January) reflections

In the beginning of the year, there was a fairly even split between skills and topics that the students found difficult (see Figure 9). There were three major skills and processes that students found extremely challenging: memorizing things, organizational skills, and writing. Other things listed included paying attention, creating and interpreting graphs and diagrams, the mathematical side of science, projects, and tests. The Physical Science topics mentioned were Astronomy, Chemistry, the Periodic Table, and Electricity. The Biological Science topics mentioned were Biology, Body Systems, Classification, Dissecting, and Plants. Other topics mentioned were scientific names and seasons. Two students mentioned that they did not find anything hard about Natural Science thus far.

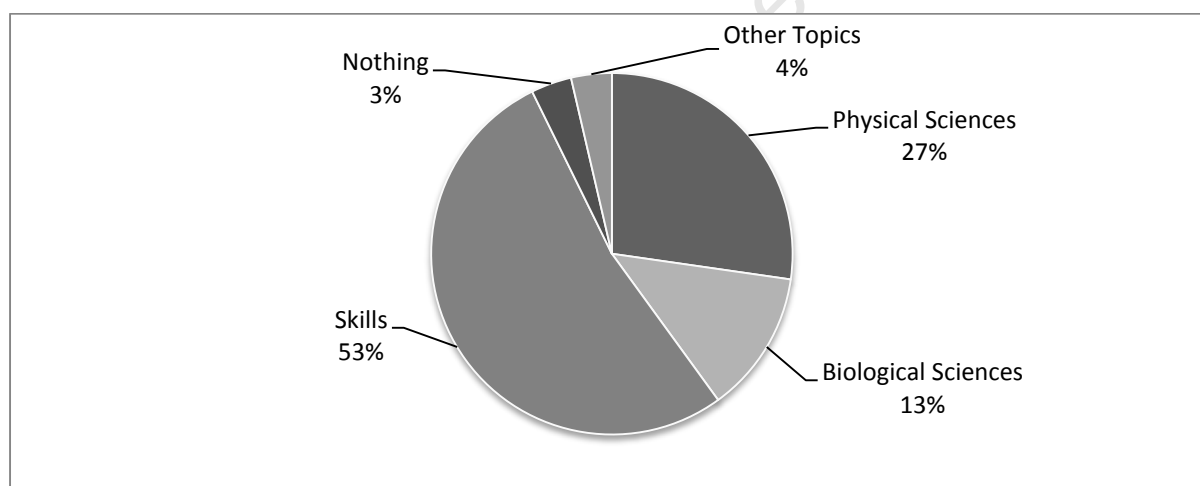


Figure 9: Students' Hardest Parts of Natural Science in January

4.5.2 End of the Year (December) reflections

In December, students were more descriptive about what they found challenging in Natural Science (see Figure 10). In terms of skills and processes, the largest category was Key Issues (a skills-based, month long unit on environmental problem solving done at the very beginning of the year). Memorizing things was the second most common thing mentioned. Other skills and processes mentioned were keeping answers concise, creating surveys,

creating graphs, the Expo project (a personally designed scientific experiment on any topic), the large amount of work, learning things on their own, the pace of work taught, and tests and examinations.

In terms of the topics that students found hard, there was also an increase in the number of students who found a Biological Science topic challenging (24%, as compared to 13% in January).

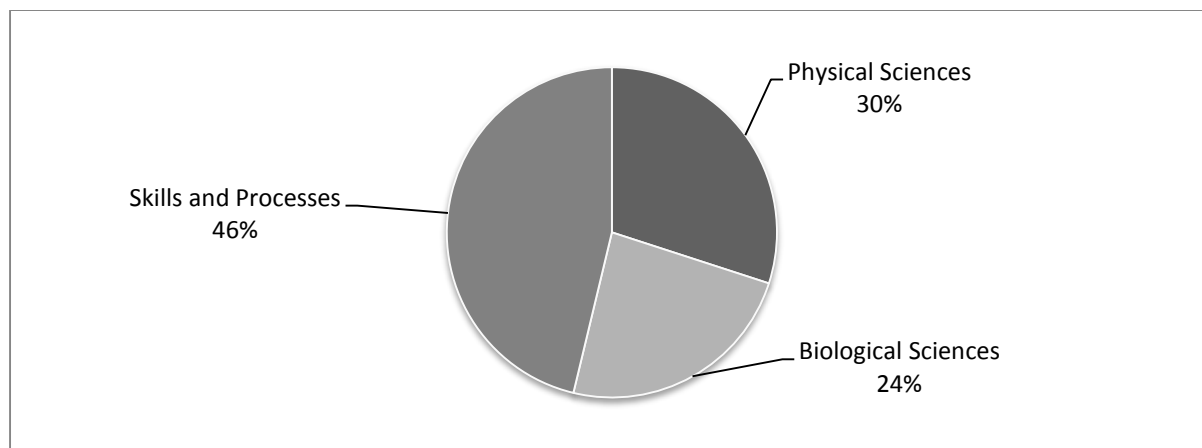


Figure 10: Students' Hardest Parts of Natural Science in December

4.5.3 Changes from January to December

As one can see in Figure 11 below, the students found Biological Sciences and Physics more challenging as the year progressed, but they found Astronomy and Chemistry less of a challenge. In these results, Physical Science was divided into these three sub-subjects because of the significant shift within Astronomy and Physics. However, when combined, there is no noticeable shift in Physical Sciences from January (27%) to December (30%) (see Figures 9 & 10).

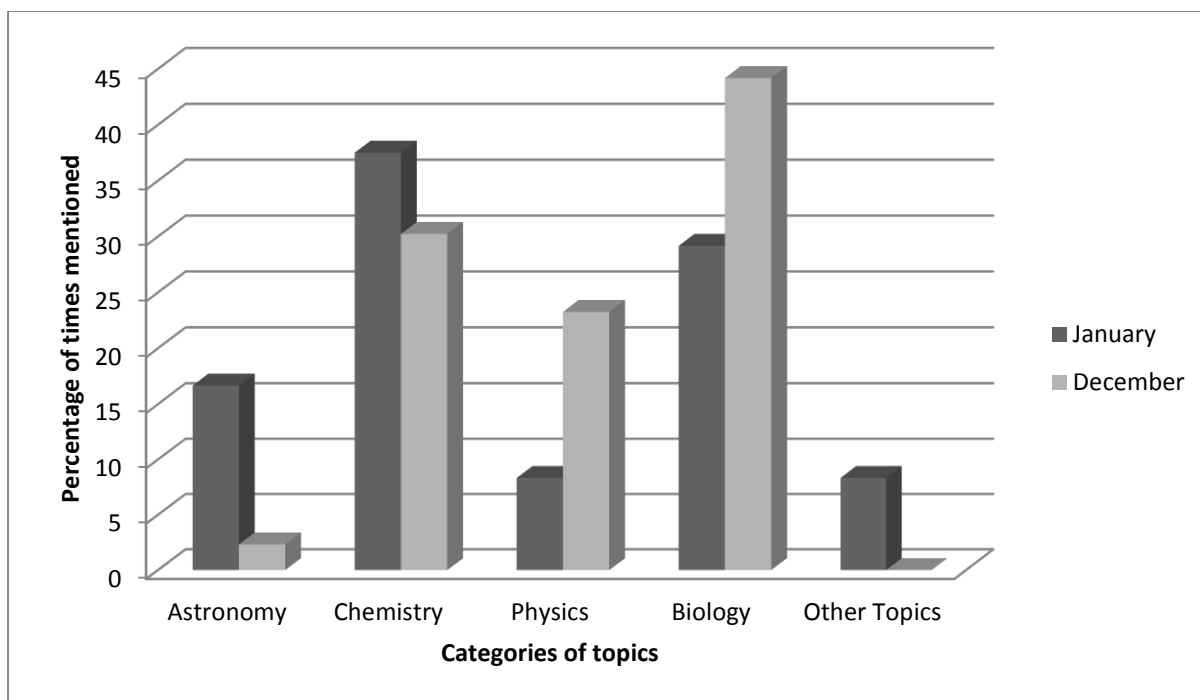


Figure 11: Chart showing the changes in topics perceived as hard from January to December

4.6 Responses to “If I were a scientist” open-ended question

4.6.1 Mid-year (June) responses

In June, the students preferred to study Biological Sciences to Physical Sciences or other sciences (such as Environmental or Paranormal Science) (see Figure 12). Within the Biological Sciences, the most commonly chosen category was “Animals, Plants and Nature” (see Figure 13). This category included all answers that involved some aspect of this category.

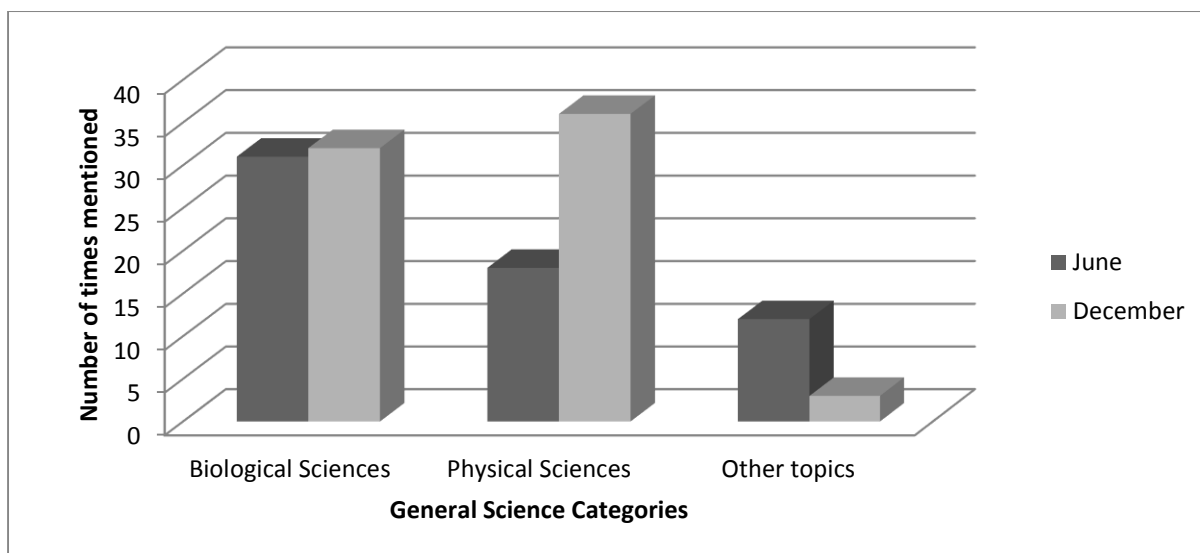


Figure 12: Categories of topics chosen to study if they were a scientist

4.6.2 End of year (December) responses

In December, there was a marked change in the choice of a Physical Science topic to study. The main category mentioned here was “Space and Astronomy” (see Figure 13). There was also a decrease in topics that were not covered by the Natural Science syllabus. The categories of “Paranormal, Philosophical, etc.”, “Environment” and “General Technology” decreased to zero times mentioned.

4.6.3 Changes from June to December

Figure 13 shows the changes in individual categories from June to December.

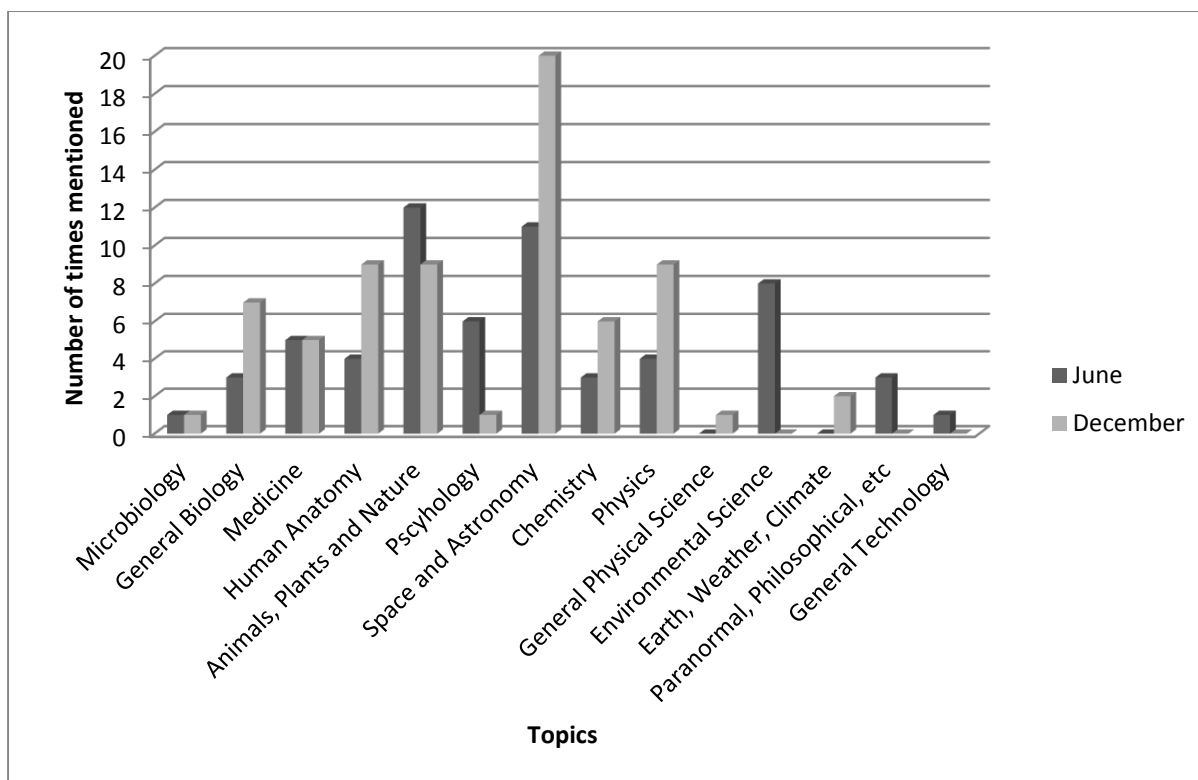


Figure 13: Number of times that students chose this topic to study if they were a scientist

Z-values were determined for the data samples of June and December. There were two significant changes between the samples. The category of “Animals, Plants and Nature” decreased in standard deviations from the mean from 2.02 to 0.71. The category of “Space and Astronomy” increased in standard deviations from the mean from 1.75 to 2.67. No other category changed more than one standard deviation from the mean. This statistically shows a meaningful change in the numbers of times these categories were mentioned in their choices of what science to study (see *Table 1*).

Table 1: Z-values for two topics which significantly changed in preference

TOPIC	Number of times mentioned in June	Z-values	Number of times mentioned in December	Z-values
Animals, Plants and Nature	12	2.02484	9	0.71226
Space and Astronomy	11	1.75991	20	2.67098

4.7 Changes from June to December with regards to “why” they would study this topic

There was a shift from June to December with regards to the reasons why they would choose specific subjects (see Figure 14). In June, students responded with big picture, world-view style answers. For example, one student responded with the following answer: “I want to make the planet greener and enjoy the green planet. Let our children see what we are seeing today” (*sic*).

In December, student answers were much different, focused more on individual motivation rather than global or future thoughts. Five students were even able to specify that they would study something because it would benefit a specific job (i.e., being an environmental conservationist or a doctor). The length of student answers were also much shorter than in June, most probably because they were using a computer in June and hand-writing answers in December.

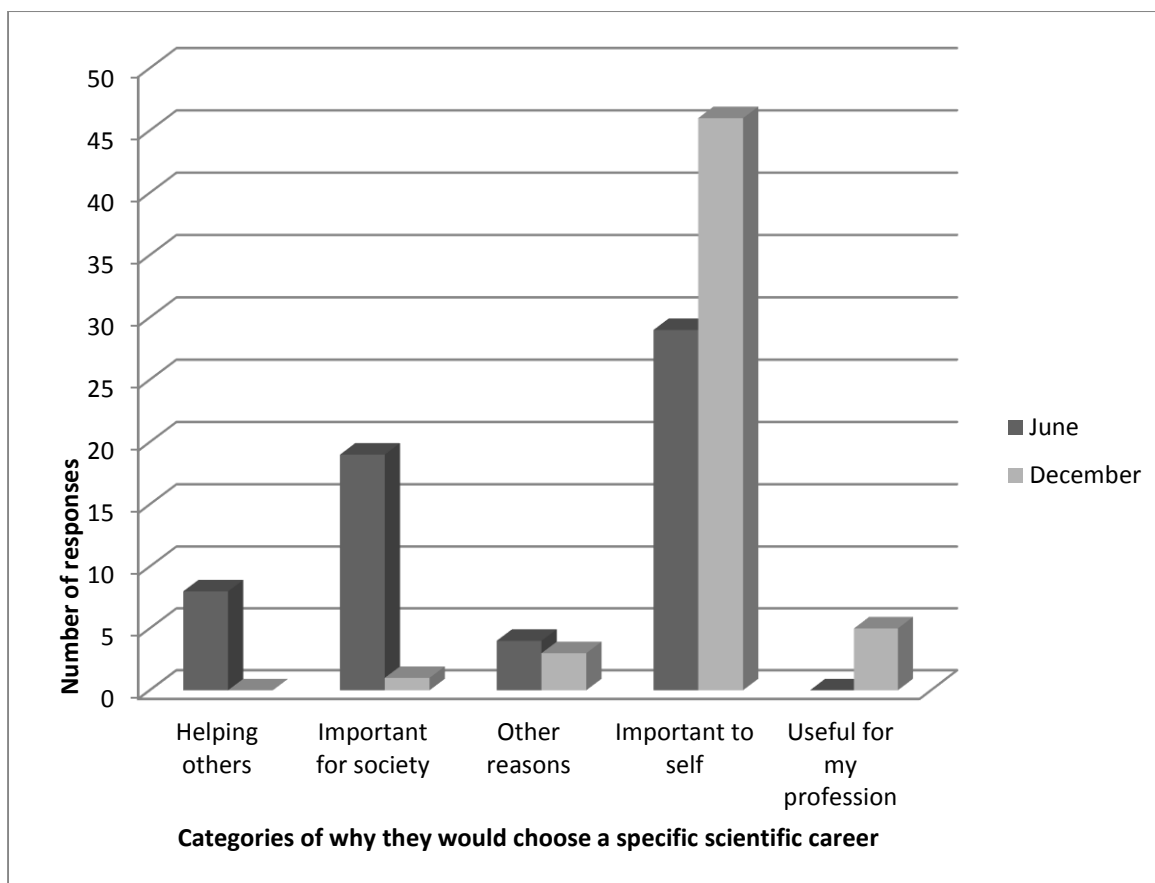


Figure 14: Attitude responses to why students would choose a specific scientific career

4.8 Conclusion

Students found the alternative assessment enjoyable and felt that they had learned something or refreshed their previous knowledge. Through the ROSE questionnaire, students said that they enjoyed science classes, but few said that they wanted to continue into a job in science or technology. Students also indicated a dichotomy in their attitudes towards science and technology, revealing that although they find it important, they are wary about the trustworthiness of science and scientists. Students showed a change in their favourite subjects from January to December, showing an increase in the Biological Sciences. This same change was also seen in the comparison from January to December with regards to the hardest part of Natural Science. Students showed a significant change in the career aspirations from June to December, the largest changes being between the Animal, Plants and Nature and Astronomy categories. Their rationale behind these career

aspirations also changed from June to December from helping people or finding the topic important to society to wanting to study a subject because of personal reasons (interest or career). These results will be discussed further in Chapter 5.

Chapter 5

Discussion

5.1 Introduction

The hypothesis stated that with the presence of an alternative assessment within a curricular year, students would show a positive attitude toward the subject matter by choosing to continue studying it past high school in a theoretical context as well as an overall positive attitude towards science. While the results were reported on in groups according to the instrument, this analysis will be cross-instrument and cover three of the intersections from the original conceptual framework as seen below in Figure 15. This discussion will examine the following relationships as shown in Figure 15. The intersection of 'Alternative Assessments' and 'How girls learn best' will be discussed in section 5.2. The intersection of 'Alternative Assessments' and 'Attitudes towards science and school science' will be discussed in section 5.3. Finally, the overall relationship between the three variables will be discussed in section 5.4. The final intersection of 'How girls learn best' and 'Attitudes towards science and school science' will not be discussed as the tools used did not aim to collect or report on this relationship.

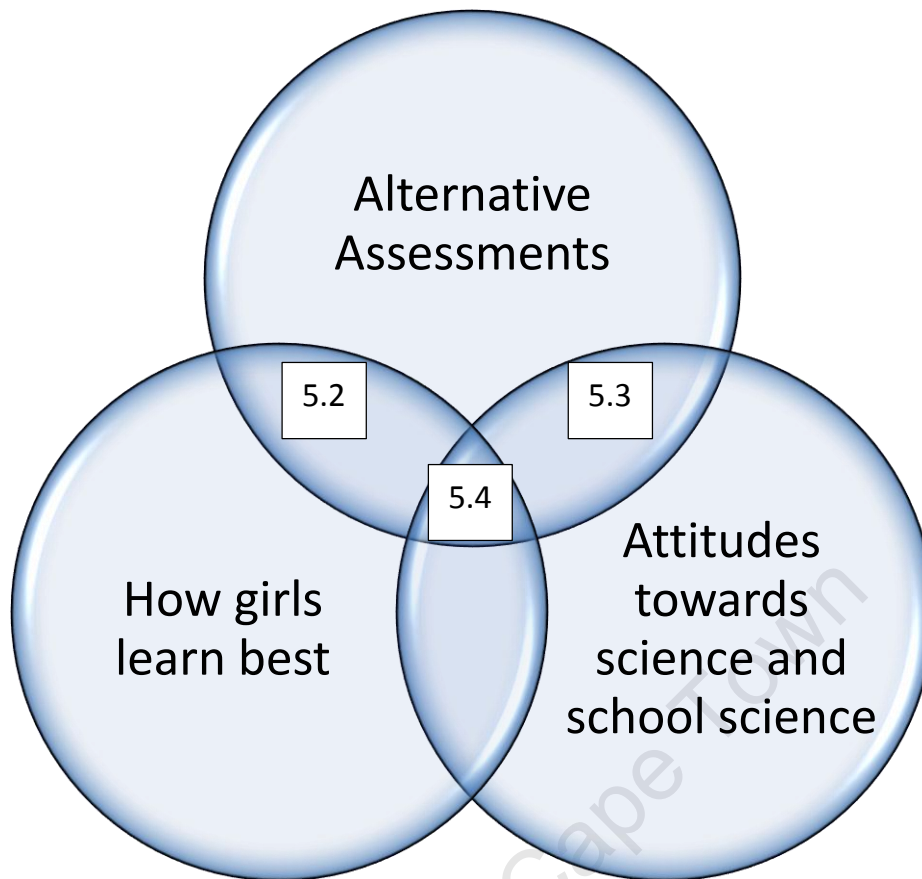


Figure 15: Analysis of the intersection of alternative assessments, learning styles of girls and attitudes towards science

5.2 Reflection on alternative assessments

The assessment was developed in line with the criteria given in Chapter 1 by Herman, Aschbacher & Winter (1992) (as quoted in Corcoran, Derschimer, & Tichneur, 2004). The assessment was then moderated by peers and found to be alternative based on the five criteria outlined. When the students were given the assessment, they reflected that the assessment was fun, enjoyable and interesting, indicating a very positive attitude toward the assessment. This is in line with international studies which have identified positive student responses to alternative assessments (Couling, 2011; Janich, Liu, & Akrofi, 2007; Kirikkaya & Vurkaya, 2011). As stated in Chapter 2 by Gurian & Stevens (2004), “children will naturally

gravitate toward activities that their brains experience as pleasurable” (p. 22). A positive attitude toward the assessment would indicate that this assessment was in line with how these girls enjoy learning.

5.3 Reflection on the relationship between alternative assessments and attitudes towards science and school science

After the alternative assessment was completed, students completed the ROSE questionnaire which highlighted their attitudes towards science and school science. The responses to the statements under the question of “My Opinions about Science and Technology” reveal their attitudes towards science. When reviewing the results in from Figure 5 in Chapter 4 (p. 39), there seems to be a dichotomy within their answers. They showed a positive response to the statements which indicated the importance of science, such as “Science and technology are important for society.” But they also showed a low agreement with statements about the trustworthiness of science and scientists, such as “The benefits of science are greater than the harmful effects that it could have” and “Scientists are neutral and objective.” This dichotomy does not reveal a negative attitude towards science, but rather highlights the critical thinking and evaluation skills that the alternative assessment purports to teach. It stands to reason that if students are taught to critically evaluate information, then they would not agree with these last two statements. Therefore, there is a possible positive effect of the alternative assessment on their attitudes towards science, however without a pre-test to which to compare these results, it not possible to positively link these two concepts.

The responses to the statements under the question of “My Science Classes” highlighted the students’ attitudes towards school science. Students found their classes interesting and important which was very much above average for the international survey. But when compared to other subjects, students exhibited average responses (41% said that they like science better than most other subjects). This was followed by a low desire to remain in science subjects and even lower desire to continue into science or technology as a career path. The results of this questionnaire highlight that while students found their science classes interesting, it was not enough motivation for students to think about remaining in science

subjects or picture themselves in these career paths. These results are in line with the findings of Bennett et al. (2006). Their meta-analysis concluded that while similar assessments and approaches improved attitudes towards school science, there was little conclusive evidence that these positive attitudes would translate into further study or career paths in science. This is also in line with the findings of Shamaï (1996) who tracked students from Grade 6 to Grade 11 to determine if there was a relationship between their attitudes in Grade 6 and their course of study in Grade 11. Regardless of gender, there was no significant relationship between a student portraying a positive attitude toward science in Grade 6 and choosing to study a science in Grade 11.

5.4 Reflection on the intersection of alternative assessments, learning styles and attitudes towards science and school science

It was proposed that if girls were presented with an opportunity for learning which was developed in line with how they learn best (i.e., the alternative assessment), then they would exhibit positive attitudes towards that the subject matter by choosing to continue studying it past high school in a theoretical context as well as an overall positive attitude toward science. When reviewing the data collected from the January, June and December open-ended questions, two points of analysis emerge: there is a difference between the attitudes of these students towards specific science subjects compared to international norms, and there does not seem to be a long term effect of alternative assessments toward students' attitudes towards science.

5.4.1 Discussion of attitudes towards school science

To discuss the positive attitudes of the students towards specific school science topics, it is important to compare these students to international literature. Gender and attitudes towards specific subjects in science have been positively correlated (Baram-Tsabari & Yarden, 2010; Britner, 2008; Osborne et al., 2003; Schreiner & Sjøberg, 2010). In most studies, girls have a more positive attitude towards Biological Sciences (Biology, Ecology, and Health) than Physical Sciences (Chemistry and Physics) (Baram-Tsabari & Yarden, 2010; Reigle-Crumb,

Moore, & Ramos-Wada, 2011). In this Grade 8 class, there was a very different profile throughout the year. In January, girls exhibited a more positive attitude toward the Physical Sciences than Biological Sciences by choosing these topics more often in the initial questionnaire. This was upheld in the June questionnaire as the majority of the topics chosen to study were categorized as Physical Sciences. In December, however, there was a shift from Physical Sciences to Biological Sciences in terms of the students' favorite parts of Natural Science, but when the topics chosen for future study were analyzed, students still preferred Physical Science topics. This cohort of students therefore, goes against the internationally recognized perception that girls prefer the Biological Sciences.

This difference to international norms is interesting because these students come from a number of different primary schools, so the education within the Preparatory School of this school cannot be held solely accountable for the results. However, most of the students within this Grade 8 class have a background in a single-sex school. Carter (2005) found that more girls in single-sex schools were choosing to take sciences in the FET phase in her study of South African schools. An avenue for further research would be to follow these students through high school and monitor their subject choices and attitudes throughout the next four years to see if there are changes and investigate possible causes of these changes.

5.4.2 Discussion of the effect of the alternative assessment on attitudes towards science

To determine the effect of the alternative assessment on attitudes towards science, one must compare the results across all the open-ended questionnaires throughout the year. In January, 9% of the students mentioned that Energy was their favourite topic in Natural Science. In June, 6% of the students chose to study sustainable energy or renewable resources if they were a scientist. These terms are important as they are in line with the topic of the alternative assessment and show they have internalized what they learned from the assessment. However, in December, 0% of students mentioned either energy, sustainable energy or renewable resources as a favourite topic or a topic they would study as a scientist. Two students (2.3%) mentioned the movie aspect of the alternative assessment as their favourite part of Natural Science, but this could have been because they enjoyed this form of assessment rather than the topic.

If Mager's (1968) concept of positive attitudes as "moving towards responses" is applied here, then there was no long term effect of the alternative assessment on the students' attitudes towards science. Bennett et al. (2006) stated that "subject choices...and/or career aspirations are important indicators of attitude toward the subject" (p. 363), and it is clear that there was a change in their career choices over the course of the year, indicating a change in their attitude towards science. This does not reflect a negative attitude now, but it does mean that their positive attitude toward Energy was replaced by a more positive attitude towards a different topic.

This change in positive attitudes could have been because of an internal shift within the students. When the rationale behind their answers is analysed, one can see a shift from external rationale in June to an internal rationale in December with regards to their career choices if they were scientists. This shift indicates that students are choosing a career now based on interest rather than its importance to society or other people. Five students went as far as to say that they would choose to study a subject because it is in line with their actual career goals (i.e., they want to become a doctor or environmental conservationist). This shift could indicate that although students may still think that studying sustainable energy and renewable resources is important, it is not something that they find interesting enough to study themselves.

Smith & Matthews (2000) also found a shift in the rationale behind the subject choices of 15-year old students in Ireland. After a Science, Technology and Society (STS) approach in the classroom, more students were choosing science subjects because they were interested in the subject matter. This could be because STS and other alternative approaches allow for open-ended research, discussion and assessments which allow for creativity and freedom of expression. This allows students to critically explore and develop their own interests and therefore understand the rationale behind their choices. This internal shift is important as it highlights the time that students are beginning to understand and value the choices about their future, which means that a study of career options and career guidance could be more effective at this stage, rather than later on in high school when most career guidance takes place (mainly Grade 9 & 12).

The change in their positive attitudes could have also been because of a limitation of the study. The open-ended questionnaires were designed to have little or no input from the teacher as to the words or topics that students may use, thus validating their answers as authentic. However, it has been noted that students may have struggled to remember the entire year's work in such a short amount of time without prompting. This may have lead students to choose topics or skills which were in the second half of the year, especially since they had just completed an examination on this material and these topics and skills were fresh in their minds.

Overall, there were no long term effects of alternative assessment on attitudes towards science based on the results from this study. Evidence exists that students exhibit a positive attitude towards science from the ROSE questionnaire results and that the skills honed by the alternative assessment may give rise to the positive attitude towards science. However, when looking at the subject choices over the year as an indicator for positive attitudes towards science, there is no obvious relationship between the alternative assessment and attitudes towards science.

5.5 Limitations of the study

5.5.1 Sample population

The limitations of this study are that the student population represents a small microcosm of South African society, and therefore extrapolation to the larger South African population of high school students is very limited. Correlations may be seen with similar schools in similar urban settings, but a larger sample size from varied urban environments would be needed before reliable comparisons could be made.

5.5.2 Methodology

To improve the results, a ROSE questionnaire could have been completed before the alternative assessment took place. This would have enabled another layer of comparison and analysis of their attitudes towards science based on the alternative assessment.

With regards to the open-ended questionnaire in December, the students may have struggled to remember the entire year's work on their own. Therefore, it may have altered the results if a list of topics and skills was provided for them so that they could choose their favourite and hardest parts of Natural Science. Also, the format of the January and December questionnaire was written and this may have discouraged some students to embellish their reasons behind their choices, especially in December after examinations when students are less likely to write prolifically. To improve this, using a computerized version of the questionnaire (such as via SurveyMonkey™) may have encouraged them to be more descriptive in their answers.

5.6 Conclusion

To conclude, an investigation into the effect of alternative assessment in Natural Science on attitudes towards science in Grade 8 girls was completed over one school year. Data was collected via open and closed questionnaires at three points in the year. Through an analysis of this data, three conclusions can be drawn. First, the students showed a positive attitude toward the alternative assessment. Second, students showed a positive attitude toward school science, but this positive attitude did not directly indicate a desire to continue in the fields of science or technology. Third, by analysing their subject choices over the course of the year, there is no long term effect of the alternative assessment on their attitudes towards science.

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Appendix A: The Alternative Assessment on Sustainable Energy Awareness

This project will use the skills that you learned in Key Issues in Natural Science to gather information about the awareness of Sustainable Energy-related issues in the greater school community. As you may know, sustainable energy is a large problem in southern Africa. Your job will be to create a survey to see what your community knows and present these findings in a presentation format.

Step 1: Learn about Sustainable Energy through the Quiz + Weakest Link

Step 2: Create a survey with 10 questions

Step 3: Survey 10 people each

Step 4: Compile your results into tables and graphs (EXCEL)

Step 5: Create a presentation with your information (POWER POINT)

Surveys

You are being tasked with writing a survey to determine how aware your community members are about Sustainable Energy. However, this issue is so big that you can't cover it all in one 10 question survey. Therefore, choose a topic and ask 10 questions related to your subtopic. Some suggestions are Availability of Sustainable Solutions, Ease of Use of Sustainable Solutions, and Knowledge of Different Solutions.

Your Audience: The greater school community (students in grade 9-12, teachers, parents and older siblings)

You will need to collect the data from 10 surveys (this means that you will ask 10 people to answer each of the 10 questions). Things to keep in mind when asking survey questions:

- Is this question appropriate for this audience?
- Does this question relate to my topic?
- Does the question have an easy answer scheme (yes/no, T/F, one-word answer, etc.)?
- Have I used too many different answer schemes in my survey? (generally no more than 2)
- Will this be an easy question for which to compile data?

Each question will be marked according to the following criteria: (1 mark each)

- Question has appropriate answer scheme
- Question is well-worded and spelling is correct
- Question relates to the topic chosen

Make sure that you give your survey a title and a short introduction paragraph about why you are doing this survey so that your audience understands why they are answering the questions.

Graphs

When you receive your surveys back, you will need to compile the information into tables.

Example:

	Yes	No	Don't know
Question1: Use of Solar Geysers in our Community	15	12	13

If the majority said yes, this means that our community is aware of heating water and the electrical costs. If the majority answers “don't know”, this could mean that they don't even know what a solar geyser is. You must be able to explain the meaning of your survey results.

Now you must translate this information in your table into graphs. You might be able to use PIE graphs, BAR charts, or HISTOGRAMS for your information.

Below is the memo for all graphs:

- Does your graph have a title? (2 marks)
- Axis labels? (2 marks)
- Key? (1 mark)
- Correct data? (1 mark)

Presentation

Information that you collect is only useful when you share it! You will now need to create a presentation which has two goals:

1. To share the information you collect
2. To share if you believe that your community is well-educated about these issues

Your presentation must be at least 5 minutes long, and no longer than 10 minutes. Everyone in your group must participate in the presentation. The following criteria will be assessed:

- Good flow of presentation
- Covered all information collected

- Good layout (including colour) of Power Point slides or other information
- Good speaking skills (clarity, volume, etc.)
- Gives an opinion about the findings of their survey. (Total Marks: 30)

Sustainable Energy Movie Project

AIM: Using the data and information collected during the Internal Integrated Programme, create a 3-4 minute educational movie detailing the energy uses in our community and how we can improve

YOU MUST INCLUDE:

- Some reference to the information that you (or another group) gathered in the Integrated Programme.
- An interview with a person about the sustainable use of energy (Be creative here!)

HOW TO PROCEED:

- You must decide on your topic.
- Then you must collect the information that you'd like to present.
- You must decide how you'd like to present it.
- You must then use movie software to create your video (if you want to use the school's computers it must be in Windows LIVE Movie Maker; Mac users can use their own computers but the final product must play on a PC). Power Point may also be used in the process, but your final product must be a movie.

MARK SHEET: 42 marks

	Level 5	Level 4	Level 3	Level 2	Level 1
One topic chosen	One topic is chosen and clearly identified 3 marks		Topic is identified, but movie includes other topics 2 marks		One topic is not clearly identified 0-1 mark
Correct Length of time	Movie is 3-4 minutes 5 marks	Movie is 2.5 minutes 4 marks	Movie is 2 minutes 3 marks	Movie is 1 minute 2 marks	Movie is less than 1 minute 0-1 mark
References	Has 4 references correctly referenced 4 marks	Has 3 references correctly referenced 3 marks	Has 2 references correctly referenced 2 marks	Has 1 reference correctly referenced 1 mark	Has no reference list or all references are incorrectly referenced. 0 marks

Information gathered and presentation					
Information (educational points about energy use)	Information is correct, detailed but also broad 8-10 marks	Information is correct and broad 6-7 marks	Information is correct 4-5 marks	Most of the information is correct 2-3 marks	Less than half of the information was correct 0-1 mark
Interview			Person is relevant to your topic; questions asked are probing and inquisitive. 4-5 marks	Person is relevant to your topic; questions asked are appropriate 2-3 marks	Person is not relevant or questions are not appropriate (or both) 0-1 mark
Summary of information given	Able to evaluate and synthesize all the information into a coherent conclusion statement about this kind of energy resource. 5 marks	Able to evaluate and synthesize the information into a well-worded conclusion statement 4 marks	Able to create a conclusion statement from the information gathered and presented. 3 marks	Conclusion statement is given but it is lacking depth or evidence. 1-2 marks	Conclusion statement is not given within the movie. 0 marks
Audience			Relevant and interesting to target audience 4-5 marks	Somewhat relevant and/or interesting to target audience 2-3 marks	Irrelevant and/or boring for target audience 1-0 marks
Presentation	Movie flows elegantly between components 5 marks	Movie flows well between components 4 marks	Movie flows between components 3 marks	Movie is disjointed with breaks between components 2 marks	Movie has too many disjointed parts 1 mark

Tips on Windows Live Movie Maker:

- Use only 1 version of Windows Live. The school computers all have the same version.

- Bring all your pictures, songs, videos, etc. on a flash drive and keep them all on the same flash drive until you are finished working on the project & publish the movie. The same can be true for a network folder.
- Pictures must be in a JPEG format.
- Audio needs to be in .wmv or .mp4 formats. If you want to record your voice, try using Scratch or other audio programmes.
- When you are finished PUBLISH the movie. If you haven't done that, it won't work. Save it as a file with your name, such as "NWALLACE LIGHT MOVIE".

Due Date: 2 May 2012

These can be placed on the Student Public Folder under Natural Science/Grade 8/ Movies under your appropriate class. Otherwise, give this on a flash drive to your teacher during class.

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Appendix B:

Peer Analysis of the Alternative Assessment: Instrument and Results

Dear Colleague,

I am conducting Action Research with my grade 8 classes this year. The research question is as follows: “can alternative assessment in Natural Science affect attitudes towards science in grade 8 girls?” To this end, I’ve created an alternative assessment for them. Herman, Aschbacher and Winters (1992) described an alternative assessment as one that has the following characteristics:

(1) asking students to perform, create, produce, or do something; (2) tapping higher-level thinking and problem-solving skills; (3) using tasks that represent meaningful instructional activities; (4) involving real world applications; and (5) using human judgment to do the scoring.

(as quoted in Corcoran, Dershimer, & Tichenor, 2004, p. 213).

Therefore, I am using these criteria to evaluate my own assessment.

However, I cannot use my own evaluation of my own work. To ensure the validity of the assessment, I would like to ask you to evaluate this assessment task in terms of these 5 criteria. Please look at the project as a whole instead of 4 separate parts. I have included the project briefs, all relevant rubrics and a design grid using Bloom’s Taxonomy and the Learning Outcomes from the RNCS (since technically we are still using these in the Senior GET Phase).

Please return the grid below to wallacen@stcyprians.co.za by June 1, 2012. Please note that all correspondence will remain confidential.

Thank you for your time and help.

Sincerely,

Nickie Wallace

References:

Corcoran, C., Dershimer, E., & Tichenor, M. (2004) A teacher’s guide to alternative assessments: Taking the first steps. *The Clearing House*. 77(5) 213 – 216.

<i>Does this assessment...</i>	YES	NO
ask students to perform, create, produce, or do something?		
tap higher-level thinking and problem-solving skills?		
use tasks that represent meaningful instructional activities?		
involve real world applications?		
use human judgment to do the scoring?		

Assessment of Sustainable Energy Project

General Comments and/or suggestions:

Results

Table 2: Results of Independent Peer Analysis of Alternative Assessment

<i>Does this assessment...</i>	YES	NO
ask students to perform, create, produce, or do something?	5	0
tap higher-level thinking and problem-solving skills?	5	0
use tasks that represent meaningful instructional activities?	5	0
involve real world applications?	5	0
use human judgment to do the scoring?	5	0

Comments:

'An interesting, topical, relevant and fun activity that I am sure the students enjoyed. The task is well laid out and instructions are clear. The students gain a lot of knowledge without "realising" it.'

Appendix C: Coding Structure for Beginning and End of Year Questionnaire

The following is an example of the beginning of year questionnaire.

Short Biography for my Teacher

Who Am I? (name) _____

Where do I come from? (home city/country) _____

My Home Language is _____

My favourite thing about Natural Science

The hardest part about Natural Science

My goal in Natural Science for 2013

In both the beginning and end of year questionnaire, the same classification system was used for the results.

First, answers were classified based on Topics and Skills. The following table shows the Topics and Skills listed:

January		December	
Skills	Topics	Skills	Topics
teacher experiments attention drawing graphs/diagrams mathematical side of science memorizing things Not be able to "feel" chemicals without getting hurt one way to do things organizational skills projects tests using equipment properly writing	animals Biology Genetics Plants Range of topics Conservatio n Atoms Energy Rocks Metals Natural Disasters Chemistry Electricity astronomy biology body systems classification of animals dissecting matter periodic table plants scientific names seasons	Key Issues Experiments Expo Games for learning How work was approached Learning about everything Logical Order Movie on recycling Projects Random conversations The town debate Scientific Skills Concise Answers Creating surveys Diagrams Drawing Graphs Large Amt of work Learning on your own Memorizing Things Pace of work taught Statistics Studying all units before the exam Tests understanding at a grade 8 level understanding when you don't understand things worksheets	Astronomy Chemistry Density Electricity Gases Light Microscope Biology Human Body Reproduction The Cell The Eye Mass/Volume Metals Ecology Infertility The leaf

Appendix D: Coding Structure for Student Reflections from the Alternative Assessment

The following coding system was used for the student reflections about their experiences with the alternative assessment. The words chosen were derived from their word choice. An example of a student reflection is below. The researcher highlighted portions of each reflection which were relevant to this project.

FACTS
Hard or did not remember previously learned facts
Reflects on facts learned in surveys
Facts learned in quiz mentioned
Remembered facts previously learned
Learned new facts from quiz
ATTITUDES
Fun, interesting, exciting, enjoyed activities, helpful
What I learned will make me more conscious of my actions in the future
Acknowledges that we/I waste energy or need to conserve energy
Reflects on emotions around surveys
Tedious, uninteresting, not exciting, did not enjoy activity

Appendix E: ROSE Questionnaire

The following three images show the questions and Likert-scale responses for the sections of the ROSE questionnaire used. This survey was completed electronically and has only been printed for ease of access here.

ROSE questionnaire Edit this survey

My Science Classes

This section refers to all science classes that you've had in any school up to this point.

1. To what extent do you agree with the following statements about the science that you may have had at school? (Give your answer by clicking on a circle in each line. If you do not understand, please choose the "No Answer" circle on the right.)

	Disagree			Agree	No answer
School science is a difficult subject.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
School science is interesting.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
School science is rather easy for me to learn.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
School science has opened my eyes to new and exciting jobs.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I like school science better than most other subjects.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I think everybody should learn science at school.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The things that I learn in science at school will be helpful in my everyday life.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I think that the science I learn at school will improve my career chances.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
School science has made me more critical and skeptical.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
School science has increased my curiosity about things we cannot yet explain.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
School science has increased my appreciation of nature.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
School science has shown me the importance of science in our way of living.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
School science has taught me how to take better care of my health.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I would like to become a scientist.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I would like to have as much science as possible at school.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I would like to get a job in technology.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

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(SURVEY PREVIEW MODE) ROSE questionnaire - Windows Internet Explorer

H:\Proposals\Chapters\Appendices\Question 2.htm

File Edit View Favorites Tools Help

Web Slice Gallery

[SURVEY PREVIEW MODE] [SURVEY PREVIEW MO...]

ROSE questionnaire Exit this survey

My opinions about science and technology

This section will ask you about your opinions about science and technology. Technology does not refer to the class itself but of innovations that we use in our lives.

2. My opinions about science and technology
To what extent do you agree with the following statements?
(Give your answer by clicking on a circle in each row. If you do not understand, choose the "No Answer" column on the right.)

	Disagree			Agree	No Answer
Science and technology are important for society.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Science and technology will find cures to diseases such as HIV/AIDS, cancer, etc.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Thanks to science and technology, there will be greater opportunities for future generations.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Science and technology make our lives healthier, easier and more comfortable.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
New technologies will make work more interesting.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The benefits of science are greater than the harmful effects it could have.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Science and technology will help to eradicate poverty and famine in the world.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Science and technology can solve nearly all problems.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Science and technology are helping the poor.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Science and technology are the cause of the environmental problems.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
A country needs science and technology to become developed.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Science and technology benefit mainly the developed countries.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Scientists follow the scientific method that always leads them to correct answers.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
We should always trust what scientists have to say.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Scientists are neutral and objective.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Scientific theories develop and change all the time.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Prev Next

(SURVEY PREVIEW MODE) ROSE questionnaire - Windows Internet Explorer

H:\Proposals\Chapters\Appendices\Question 3.htm

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ROSE questionnaire Exit this survey

Myself as a scientist

*** 3. Assume that you are grown up and work as a scientist. You are free to do research that you find important and interesting. Write some sentences about what you would like to do as a researcher and why.**

I would like to...

because...

Prev Done

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Done

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Appendix F: Coding for ROSE Questionnaire Results

For the first two sections (My Science Classes and My Opinions about Science and Technology), the following strategy was employed: The percentages indicate the sum of 3+4 on the 4-point Likert agree-scale that is used in all ROSE items (Schreiner & Sjøberg, 2010, p. 6).

For the last question (Myself as a scientist), the following coding structure was used. This is from the background and development of the ROSE project (Schreiner & Sjøberg, 2004, p. 108).

I: Myself as a scientist

Name Label

I1B_BODY	I.what	Biology: human, body
I1B_MED	I.what	Biology: deceases, medicine, cure
I1B_MICR	I.what	Biology: microbiology, gene technology
I1B_NATU	I.what	Biology: animals, plants, nature
I1B_OTHR	I.what	Biology: other
I1T_ICT	I.what	Technology: computers, electronic, new tech, etc.
I1T_CAR	I.what	Technology: motors, buildings, roads, car, transport, etc.
I1T_WEAP	I.what	Technology: weapon
I1T_OTHR	I.what	Technology: other or in general
I1G_ENVR	I.what	Environment
I1G_GEO	I.what	Earth, weather, climate
I1G_CHEM	I.what	Chemistry; atoms, reactions, etc.
I1G_PHYS	I.what	Physics; electricity, heat, etc.
I1G_SPCE	I.what	Space; stars and planets, black holes, space travel, etc.
I1O_PSYC	I.what	Psychology, human behaviour
I1O_INVN	I.what	Invent things

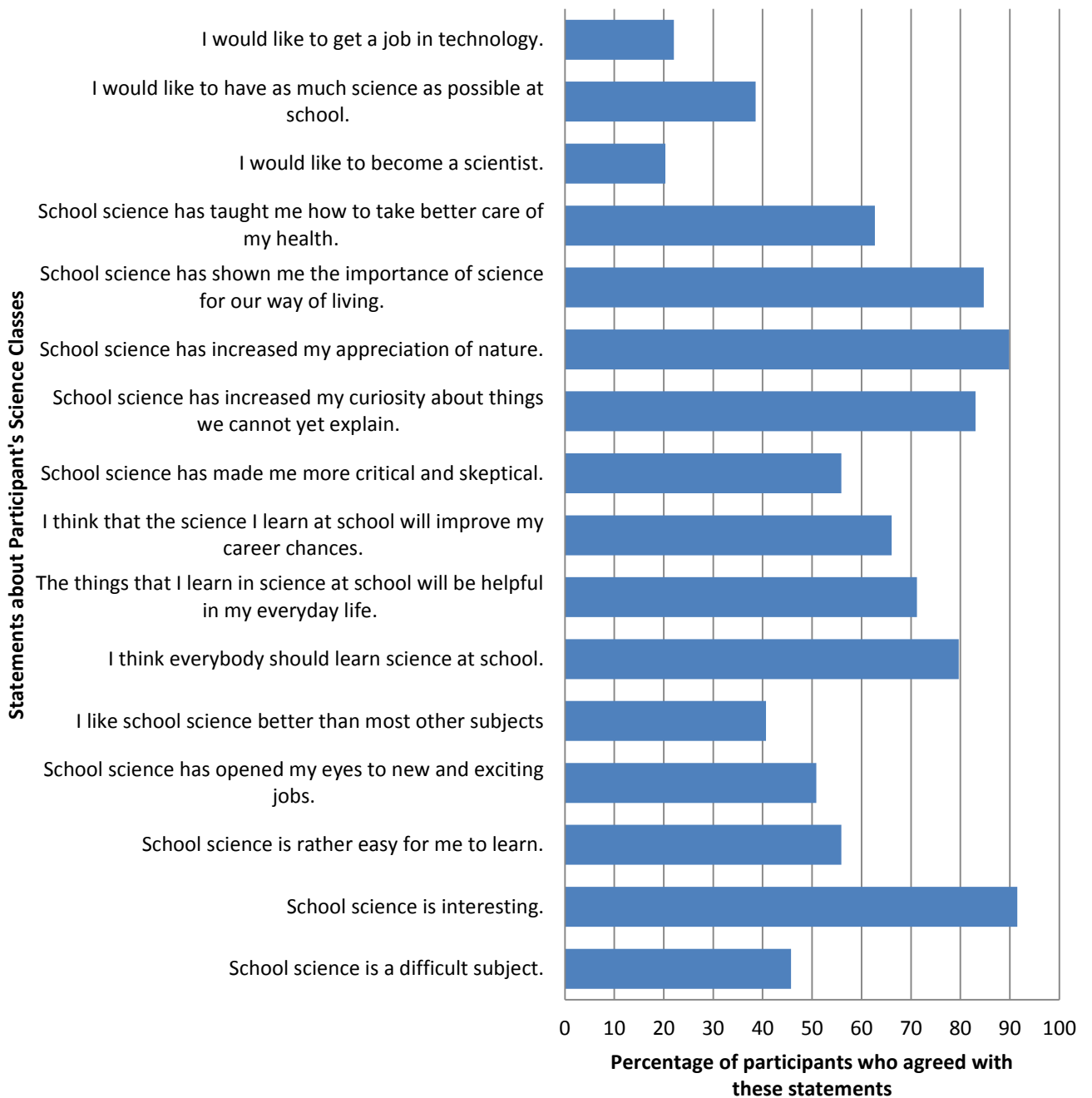
I1O_EXPR	I.what	Do experiments, work on laboratory
I1O_WNDR	I.what	Paranormal, philosophical, mysterious, wonder, etc.
I1O_SOC	I.what	Social and economic sciences
I1O_NO	I.what	Do not want to do research
I1O_OTHR	I.what	Other
I2_SELF	I.why	Curiosity, interests, seems fun, want to, exciting
I2_PROF	I.why	Related to the profession I want
I2_IMPRT	I.why	Important in general or for society/humanity
I2_HELP	I.why	Help (people, animals, etc.)
I2_RICH	I.why	Get rich, popular, famous
I2_OTHR	I.why	Other

University of Cape Town

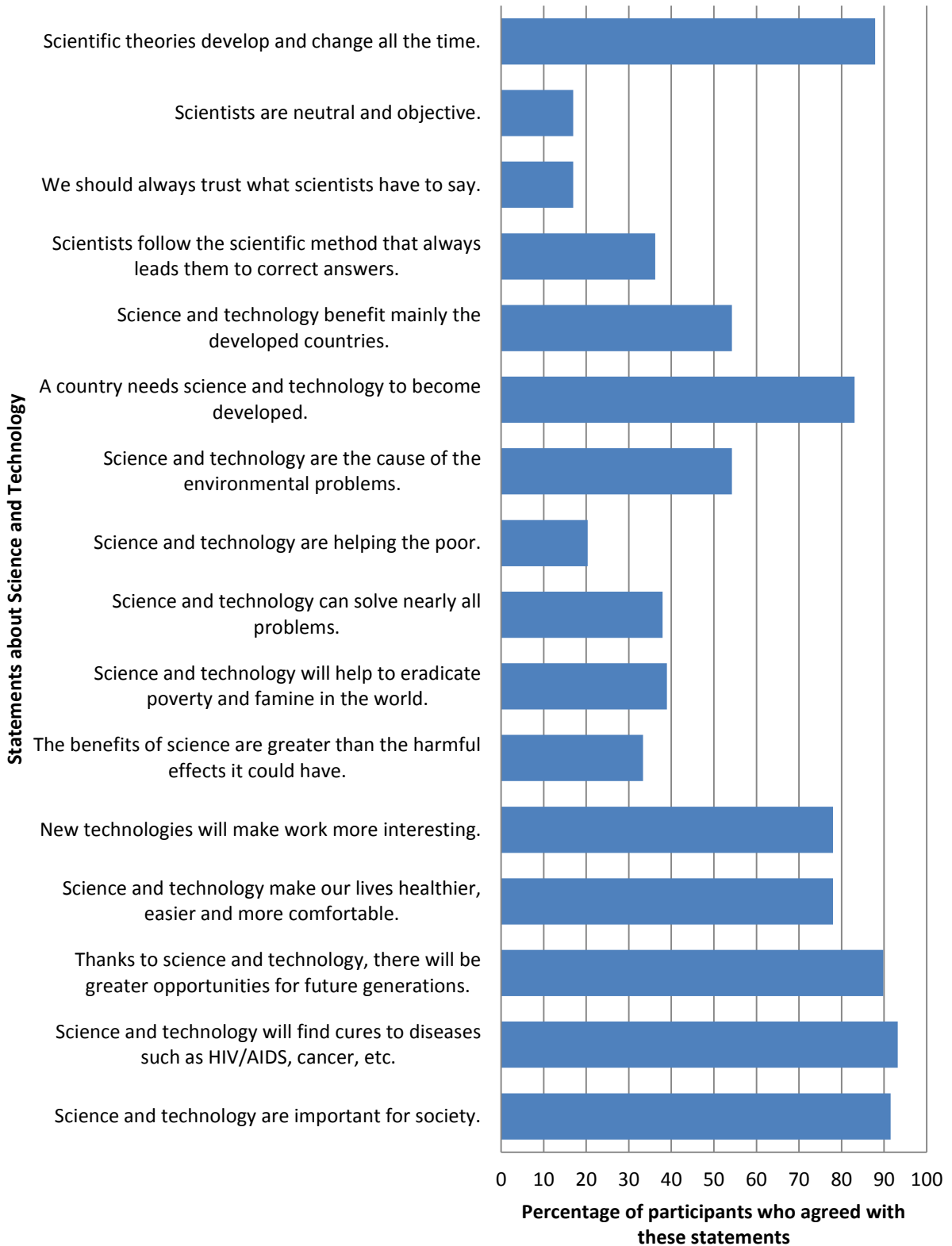
Appendix G: ROSE Questionnaire Results

The following two tables show to the complete results of the first two questions of the ROSE questionnaire.

My Science Classes



My Opinions on Science and Technology



Appendix H: End of the year (December) Questionnaire: an example and coding

The following is the end of the year reflection that the students were asked to complete. The coding structure used to identify their answers to the first two questions was identified in Appendix C. The third question was coded in line with the ROSE questionnaire coding system in Appendix F.

Reflection on the year past - 2012

My favourite thing about Natural Science was

The hardest part about Natural Science was

If I were a scientist, I would study _____

because _____
