THE EFFECT OF A GIRL-FRIENDLY SCIENCE CURRICULUM UNIT ON THE ATTITUDE OF GIRLS TOWARDS SCIENCE

by

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Statement of originality

I hereby declare that this dissertation is my own work and that it has not been submitted for a degree at any other University. In addition, all literature that has been used or referred to have been included in a complete list of the references.

F. A. Smit | Date

Approval

This research work has been examined and is approved as meeting the standards of scholarship for partial fulfilment of the requirements for the degree of Master of Education at the University of Pretoria

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SUMMARY

This study was undertaken to determine whether the implementation of a girl-friendly science unit had an effect on the attitude of girls towards science. In order to determine the above, the researcher developed a complete girl-friendly science unit. A checklist, which consisted of girl-friendly criteria, as defined in the study, was utilised to develop the unit. The complete unit was then implemented by three different teachers, as part of the daily curricular activities of the Grade 5 girls at an Afrikaans Primary school in Gauteng, over a period of six weeks. The boys were only involved for the purpose of behavioural comparisons. All three of the teachers attended a workshop, prior to the implementation, to establish consensus on 'girl-friendly' classroom practice and teaching strategies. Several instruments and techniques, such as interviews, questionnaires and observation sheets were used to gather data. The results of the data were analysed to answer the research questions.

An interesting finding that emerged from the data was that the girl friendly unit did have a positive effect on the attitude of girls towards practical work. However, the learning material was not the only factor that had an influence on their attitude towards science. According to the girls, the teachers' behaviour, classroom practice and other school factors had an even greater influence on their attitude towards science. Two of the three teachers were still discriminating against girls in a very subtle manner and one of the teachers even felt that the girl-friendly unit were a form of reverse discrimination, which in turn filtered through to the learners.

Finally, it can be concluded that the challenge to influence the attitude of girls positively towards science, appear to be more than merely implementing a girl-friendly unit. Teachers, administrators, and school communities should all work together to promote the development of girl-friendly science in order to encourage girls to take science subjects.

KEY WORDS

Girl friendly science

Curriculum

Social values

Attitude

Constructivist theory

Maslow's Humanistic and Pragmatic perspectives

The inquiry approach

Social value orientation

Cognitive development orientation

Classroom practice

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Science plays a key role in understanding the world we live in. The knowledge and problem-solving skills of scientists are essential in all disciplines and industries as well as to society at large. Science and scientists thus contribute strongly to the welfare and economic development of all nations. Therefore advancing science understanding is an exciting intellectual challenge that can benefit both women and men from all cultures.

Much has been achieved towards the advancement of science education for women in developing countries. Since 1990 female enrolment in African primary schools has more than doubled while at the secondary school level the increases have been dramatic (Gathu, 1998).

The United Nations (UN) has announced a ten-year Girls' Science education Initiative at the World Science Education Forum in Dakar in April 2000. The objective of this program was to procure national action plans by 2001 in order to promote gender equality and sensitivity in all aspects of science education. The initiative was intended to help developing countries to free up funds for girls' schooling by helping them to get the most from development cooperation, policy and science education reform. The aim was that by 2015, all children everywhere — boys and girls alike — should be able to complete primary science education as well as to ensure that by then boys and girls will have equal access to all levels of science education.

Indeed, females are afforded many more opportunities today than they enjoyed in the past. However, despite these gains, women are still under-represented at all levels of education relative to men. There are still fewer females who enter educational science programmes either formal or non-formal. Fewer women receive science, technical and vocational training and women account for a very small proportion of the enrolment in science for post secondary school education (UNESCO, 2000).

Literature indicates that there are a wide variety of factors that could affect female learners' subject choices. Vetter (1992) states that since expectations are so much lower for girls than for boys, girls are less likely to feel confident in their science and mathematical ability. Consequently, he admits that the confidence gap widens, as girls grow older. Later on, the lack of confidence leads to a very small percentage of female students being enrolled in advanced mathematics and science classes (Linn & Hyde, 1989). As the gender gap in confidence widens, the gap in interest also widens. In primary school, boys and girls show the same level of interest in mathematics and science as they do in literature and history. By the time the learners go to the Further Education (FET) and Training phase, female confidence levels in mathematics/ science are low and consequently, so are their interest levels (Linn & Hyde, 1989). Unfortunately, research shows that social attitudes tend to become fixed during the FET phase and early in high school (Heller & Martin, 1994). So girls who develop negative attitudes towards science and mathematics during this period of development are unlikely to pursue a career in science, mathematics or engineering.

The under representation of women in traditionally male science careers is another concern raised by many researchers (Kahle, 1988; Kelly, Smail, Whyte, 1984; Science Council of Canada, 1981). In Canada and the United States very few women, usually less than ten percent, are scientists, engineers or technologists (Kahle, 1983; Statistics Canada, 1985). Even in medicine and health-related careers, where women comprised 77.1% of those employed in these fields; most of the women in this area were nurses. Ninety-seven percent of all nurses were women as contrasted with 35 percent female physicians and 20 percent female dentists (Statistics Canada, 1985).

However, science education can make all the difference to a girl's future career, not only economically but also for her development as a person. When choosing science subjects it should not only be seen as a vocation, but it is important that the broader scope of developing a scientific and technological culture should be kept in mind. Girls should as far as possible be encouraged to take science subjects, not only those girls who might one day pursue a scientific or technological career. Girls should furthermore be encouraged to apply scientific concepts in their daily lives.

The purpose of this study is to determine whether the implementation of a girl friendly science curriculum unit will have an effect on the attitude of girls towards science in order to encourage them to take science subjects. Only when women participate fully as active learners in the classroom, as researchers in the laboratory, as science teachers and lecturers, as scientific leaders in society and as policy makers, they will feel equal partners in a technological society.

1.2 Statement of the purpose

The purpose of this study is to determine whether the implementation of a girl friendly science curriculum unit will have an effect on the attitude of girls towards science.

1.3 Critical Questions

- What are the criteria for a girl-friendly science unit?
- What effect does the implementation of a girl-friendly science unit have on the attitude of girls towards science?
    - *What is the attitude of female learners towards **science in general**, **prior** to the implementation of a girl-friendly science unit?*
    - *What is the attitude of female learners towards **science activities** in the classroom, **prior** to the implementation of a girl-friendly science unit?*
    - *What is the attitude of female **learners towards science in general, after** the implementation of a girl-friendly science unit?*
    - *What is the attitude of female learners towards **science activities in the classroom**, **after** the implementation of a girl-friendly science unit?*

1.4 Rationale

As mentioned earlier, the purpose of this study has been to determine whether the implementation of a girl-friendly science curriculum unit will have an effect on the attitude of girls towards science. For this purpose it is necessary, at the outset, to determine the meaning of the term curriculum in the relevant context. Todd (1965) defines a curriculum as "the planned educational experiences offered by a school which can take place anywhere at any time". Johnson (1967) describes it as "a structured series of intended learning outcomes". A curriculum has furthermore been defined "as a social artefact, an outcome of social life as well as a pedagogical device" (Eltis, 1995). It may accordingly be concluded that appropriate curriculum driven teaching in schools would impact positively on the conscious and unconscious decisions of a variety of people in a particular social and economic context.

In this study, the researcher has developed a girl-friendly science curriculum unit within the framework of the new outcome-based (OBE) approach applied in South Africa (Department of Education, 1997). The emphasis of the OBE curriculum is learner-centred. Furthermore, it focuses on the changing role of the learner from novice to expert and then from learner to teacher. The learning process is dynamic, self-directed, and often includes the social nature of that process. The learning context (the environment, climate, and community) supports the learner and the learning process (Barr & Tagg, 1995).

In the implementation of a curriculum or curriculum unit, learning support material plays a significant role. According to the National Science Education Program Standards, science content must be embedded in a variety of curriculum patterns that are developmentally opposite, interesting, and relevant to learners' lives.

Learning support material is very crucial in our South African educational system and may have a range of benefits. For example:

- It may be a source of information.
- It may be image forming.
- It may shape attitudes.
- It may shape learning.
- It may shape teaching.
- It can be an agent of socialisation.
- It can be a basic tool to improve long time knowledge.

From the above it is evident that learning support material forms a large integral part of any curriculum in an educational system. It is, therefore, important that there should be a fair presentation of both male and female interests reflected in the material. Until recently the science curriculum for schools has introduced little that favoured women. Several studies conducted in this field indicate gender bias in image portrayal of women in textbooks. According to a study conducted in Kenya (Obura, 1990) the portrayal of women in textbooks was almost invisible. This also related to agriculture where women are very productive and contribute much labour. Jacklin (1992) sampled learning support material published by four major publishers in order to determine how individuals are depicted in publications for the first three grades of education. He found that boys are usually portrayed as aggressive, physically exerting and problem solving, while girls are presented as indulging in fantasy, inclining to submissive conduct and "making statements". Therefore, instead of fostering basic equality between men and women, the learning support material encourages male dominance. Instead of freeing individuals from conformity to stereotyped sex roles, these materials fortify the notion of gender inequality, e.g. in labour. According to Vetter (1992), the fact that boys dominate science classrooms, may lead to the undermining of girls' confidence in their scientific and mathematical ability. As this gap in gender confidence widens, the discrepancy in the interest in science and mathematics also widens. A lack of interest in science and mathematics would naturally lead to lower levels of participation of females in these fields of education. There are a number of other factors that can also deprive girls of their interest in and inclination to science education. These factors include teacher bias, classroom practice and social values. This is alarming in many respects. In a study conducted by Dever (2001), it was established that girls who received their science education in male dominated classes were less likely to pursue traditionally "scientific" careers and did not feel prepared for college because of the academic workload and the existence of a gender barrier in the traditionally male-dominated areas of mathematics and science.

Although a number of programs in South Africa have been implemented to improve the South African environment for women/ girls in science e.g. Women in Science and Engineering (WISE), Women in Research (W-I-R), African Gender Institute (AGI), Royal Society of South Africa and The Third World Academy of Sciences (TWAS), the number of women involved in science in South Africa has remained discouragingly small. There has also recently been a transformation towards featuring females equally in learning support material. Despite all the laudable efforts to improve the learning support material, very little change has occurred concerning classroom practices that are girl-friendly.

The aim of this study has been to create and implement a girl-friendly science curriculam unit. The results have been analysed to determine whether it had an effect on the attitude of girls towards science in general and towards the girl-friendly curriculum unit in particular.

1.5 List of abbreviations:

- UN -United Nations
- AGI -African Gender Institute
- COWS -Centre of West European Studies
- CWES -Chairs for Women in Engineering and Science
- E C -European Commission
- EDDI -Education for Development and Democracy Initiative
- FET -Further Education and Training phase
- LSM -Learning support material
- NGO -Non Governmental Organisation
- NSERC -Natural Science and Engineering Research Council
- NRC -National Resource Centre
- OBE -Outcomes Based Education
- RPL -Recognition of Prior Learning
- TWAS -The Third World Academy of Sciences
- UN -United Nations
- UNESCO -United Nations Educational Scientific and Cultural Organisation
- UNICEF -United Nations Children's' Fund
- WES -Women in Engineering and Science
- WISE -Women in Science and Engineering
- W-I-R -Women in Research

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The purpose of this study has been to determine whether the implementation of a girl-friendly science unit had an effect on the attitude of girls towards science. The study was conducted according to a multi-method research strategy: utilising qualitative research as underpinned by the philosophy of action research, as well as certain quantitative methods. Kemmis (1988) developed a simple model of the cyclical nature of the typical action research process. Each cycle has four steps. The first step of the action research process is planning. A literature review was therefore conducted as part of the planning step. The aim thereof was to explore:

- Curriculum development.
- Girl-friendly science:
    - Gender differentiation in science education.
    - Educational outcomes.
    - Impact of school factors on female education.
    - Teaching practices and how it can influence girl-friendly science.
- Curriculum 2005 (revised version).

2.2 Curriculum development

When defining a *girl-friendly science curriculum*, it is important to note that various meanings have been attributed to the term *curriculum*. Dave (1988) and Johnson's (1967) respective definitions of the word curriculum are closest to how, in my view, the term ought to be understood for present purposes. Johnson (1967) defines it as follows:

> "In view of the shortcomings of the currently popular definition, it is here stipulated that curriculum is a structured series of intended learning outcomes. Curriculum prescribes (or at least anticipates) the results of instruction."

This particular definition has been selected as it resonates most pertinently with the Outcomes Based Education model in South Africa.

According to Dave (1988):

> "The curriculum consists of all goal-directed activities that are generated by the school whether they take place in the institution or outside it."

Dave's statement that a curriculum consists of goals and outcomes were applied in this this study. Therefore, it was planned to expose the learner to different learning, teaching and assessment experiences in order to achieve certain aims in line with a girl-friendly curriculum.

As previously mentioned, until recently the curriculum offered in schools has changed minimally in favour of women (Obura, 1990; Jacklin, 1992). Literature suggests that the experiences and contributions of women in history as well as in the contemporary society should also be reflected in the curricula. In this study it was intended to develop and implement a girl-friendly science curriculum unit that would incorporate the aforementioned.

2.3 Girl-friendly science

One of the outcomes of this project has been to develop and implement a girl-friendly science curriculum unit. The rationale behind this project was vested in the fact that research showed that girls were marginalized in the science class and that it resulted in a negative attitude towards science (Sukhnandan et. al, 2000). Research suggests several reasons for this phenomenon. These reasons include:

- *Gender differentiation in education*
- *Educational outcomes*
- *Impact of school factors on female education*
- *Teaching practices*

When designing a *girl-friendly science curriculum*, it is important at the outset to determine the exact meaning of the term *girl-friendly science*. The Newton Academy (New Experiences for Women in Science and Technology) created a girl-friendly science program (Chandrasekhar & Phillips, 1999). Possible guidelines for a girl-friendly approach to science were listed in it. These guidelines include the following:

- Hands-on integrated physics, engineering and mathematics experiences for female learners.
- Opportunities for the participants to interact with women scientists who may serve as role models.
- Peer groups of female learners who are interested in the physical sciences.

These guidelines were utilised as a checklist in order to develop a girl-friendly curriculum unit.

2.3.1 *Gender differentiation in education*

There is a very significant gender differentiation in education with regard to access, wastage, educational achievement, attainment and accomplishment among developing countries. For example, according to the UNESCO/UNICEF report (1993) about 36 million girls were not at school in the Sub-Saharan Africa Region. By 1990, girls made 45% of secondary school learners and 31% of the tertiary level students in Sub-Saharan Africa. While the average level of education in developing countries has increased, completion rates continue to remain low. About 3% of the children in developing countries who enrol in primary schools do not complete their schooling. This is caused by high repetition and dropout rates that, amongst others, reflect on the quality of instruction.

Tremendous efforts have been made by several African as well as First World governments to increase access for African girls to education. Following President Clinton's visit to Africa in March 1998, the US has launched the Education for Development and Democracy Initiative (EDDI, 2000). This initiative was designed to increase access to quality basic educational opportunities and increase the number of teachers in

Africa, especially at the primary school level. To achieve this goal this U.S.-led, multi-year initiative will:

- Provide 266,667 scholarships for African girls.
- Train 160,000 new teachers.
- Provide in-service training for 264,000 existing teachers.
- Partner with historically Black Colleges and Universities in America to provide 4.5 million more textbooks and other learning material for children in Africa.
- Increase the role of parents in their children's education by working to make school systems more transparent and open to reforms from parents.

Despite these efforts, the most daunting challenge is still that of promoting females in science education. While overall improvements in education are always desirable, special attention is needed to level the playing field for girls. Experiences show that if reforms are implemented without explicit identification of girls as targets, gender disparities may not be reduced and may even widen. Efforts to improve the status of girls and women call for changing of deeply engrained attitudes and practices. It requires serious efforts and initiatives in providing an opportunity for creating an enabling environment where girls can participate fully.

Article 10 on Education in the U.N. Convention for the Elimination of All Forms of Discrimination Against Women signifies the importance of eliminating the stereotyped concept of the roles of men and women. It further encourages types of education that will help to achieve this end.

Articulating gender concerns among the developing countries is perhaps one of the most complex undertakings of our times. It involves re-conceptualisation of a strongly embedded social order characteristic of most of the communities in the developing world. In this social order, femininity and masculinity constitute the basic tenets and serve as the regulatory framework for power relations as well as the basis for reducing human conflict. This social order produces gender conflicts and promotes lopsided power relations in most of these countries. The male gender normally prevails in this struggle as reflected in all social, economic and political spheres of life. In the realm of school education this phenomenon is of no lesser consequence. Any attempt to rectify this state of affairs would at the outset have to acknowledge and endorse women's contributions and achievements in society.

2.3.2 *Educational outcomes*

Studies on women's educational outcomes have been carried out in many countries of the world. The central problems facing female education have been identified. These problems include: access, attainment in years of schooling, academic achievement and accomplishment after school. While statistics show marked improvement in female enrolment in many countries, their enrolment still lags behind that of boys especially at the secondary school level. Poor educational outcomes for females have also been documented especially in Science, Mathematics and Technology.

Research also indicates that while significant programmes and projects have been implemented to reduce gender gaps in education they seem to have had limited impact. Therefore, while education should be seen as a vehicle to empower women and give them confidence, it is apparent that girls' experience in schools reinforces ideas about the assumed "appropriate roles" whether in relation to the family, employment or men. It can accordingly be argued that the under-representation of girls in education is not so much a product of their under achievement but a product of their marginalization. In all these circumstances, the environment where instruction takes place could be described as gender inflicted to the detriment of girls.

In addition to the foregoing, there are certain critical factors affecting girls' education that have not been addressed in research, policies or otherwise. Some of these factors relate to institutional policies and practices while others are associated with societal customs, beliefs and attitudes about women's roles, responsibilities and capabilities.

Generally, schools have been implicated in promoting the non-participation of girls in education (Gathu, 1998). Research indicates that school related factors affect both the supply and the demand for female education.

These factors include:

- The quality of instruction.
- Lack of role models.
- Teachers' attitudes.
- Types of instructional materials used.
- The nature of the curriculum offered in schools.

There is a considerable body of research literature on gender issues concerning science and mathematics education. However, there is a striking dearth of literature on the development of a girl-friendly science curriculum. Moreover, the available studies do not focus on specific activities that could be regarded as girl-friendly. They are generally confined to recommendations that interventions should be made in regard to specific problems (e.g. teacher bias, learning support material and classroom practices). Research studies and practical intervention programs concerning the entrance, retention, and achievement of girls in mathematics indicated probable areas for fruitful programs in science (Kahle, 1994). The areas indicated include (1) emasculating and demystifying science; (2) improving girls' self-confidence and self-perceptions of their ability to do science; (3) implementing teaching strategies that actively involved girls in science lessons; and (4) developing girls' skills of doing science (Kahle, 1994). In spite of these suggestions, the actual implementation thereof has not been canvassed in any of the studies.

2.3.3 Impact of school factors on female education

Research on the impact of school factors on female education provides some interesting insights into the way schools perpetuate the gender gap in education. The school environment, teacher attitudes and the pedagogy all affect female performance and attainment in schools.

Consensus from literature is that girls in single-sex schools tend to perform better in national examinations than those in co-educational schools particularly in science, maths and technology. Thus, the educational attainment of girls is associated with the type of educational institution one attends. For example, research carried out in Malawi on institutional factors affecting girls' education at secondary school level indicates that in co-educational schools, girls were a minority averaging 30% of the learners. The learning environment was also described as being hostile to the girls with harassment, teasing and ridicule from the boys — whether a girl performed well at school or not. Another study carried out in Nairobi, Kenya indicated that girls in single-sex schools had more positive experiences with science and were better able to study and follow science careers. In the co-educational schools, the girls were passive in science and mathematics classes. During the practical and laboratory sessions, girls did the recordals while the boys carried out the experiments. Studies also indicate a strong gender bias in subject choices available for girls and that girls often left science and mathematics in numbers to take up traditional female subjects.

Jimenez and Lockeed (1988) found that even after controlling factors such as socio-economic family background and school resources were removed from the equation, girls in Thailand performed better in girls' schools than in co-educational schools whereas boys did better in co-educational schools. Local conditions, school rules and methods of pedagogy all influence performance and proficiency in schools. A study carried out in Australia on gender differences in Australian schools established that schools which sought to achieve competitive academic success in senior school mathematics by filtering learners through selective grouping practice and restrictive promotional policies, had higher rates of attrition for female learners in mathematics.

The study also determined that schools with more open promotion policies and fewer traditional organisational and teaching practices in the junior years, protected girls better from relegation to devalued streams in mathematics. Therefore, differences in school policies as to curricula, teaching and classroom organisation, helped to explain the differences in gender selection in mathematics. For example, gender differences became articulated more strongly in schools that exposed children to a more academic structure in programme and organisation at an early stage.

An aspect also to be referred to in this context, is Becker's finding (1994) that teachers' expectations for learners' responses in activities like teacher-led whole class discussions differed as boys were spoken to more frequently and asked higher order questions.

Recent research (Alvermann and Hynd, 1989) on discussion about concepts in science text shows that males dominate whole-class discussion. It has been argued that classroom discussion that disenfranchises females has a significant influence on the attitude of girls towards science. In principle classroom discussions are beneficial in science as it advances the scientific thought and stimulates learners' interest. It is for this reason that girls should be afforded an equal status in such discussions. Moreover, students report discussions to be the activity that contributes most to their understanding of science (Tobin and Garnett, 1987). Alvermann and Hynd (1998) endorsed the fact that male learners dominate both ordinary discussion and recitation type discussion in schools and furthermore that science teachers take a boy's argument on a position more seriously than a girl's argument. Research into instructional practices conducted in Malawi reveals that teachers favour boys during lessons and that girls are sometimes ridiculed for failing to answer what a teacher believes to be a simple question and that boys generally serve as leaders in practical science lessons.

Many studies indicate that schools fail to provide environments conducive to girls' learning. For example, teacher-learner interactions are biased in favour of boys as early as elementary school. In the face of failure, boys are encouraged to try again and girls allowed giving up (Oakes, 1990). Pedagogy is often based on male learning styles especially when competition is emphasised. Under all forms of instruction, girls have less access to science equipment, hands-on activities and computers than boys (Kahle & Lakes, 1993, 1991).

Oakes (1990) contend that girls are expected to fail in tasks that are unfamiliar, difficult or perceived to require high ability. When they fail, girls internalise their failure, attributing it to themselves. The poor self-concept leads to taking fewer maths and science courses.

2.3.4 Teaching practices

The impact of teaching practices on the attitude of girls towards science has been studied for present purposes. In researching this topic, the information from print sources has been incorporated in this study. Furthermore, focus groups, interviews and observations at a local primary school, have been utilised and analysed.

The print sources information revealed that the study of actual teaching practices rather than the assessment of teacher quality were predictive of higher attainment in science (Lockheed and Komenan, 1985). There are teachers who, despite their obvious expertise in science, continue their biased ways, which leads to male domination inside the classroom and detracts from a healthy learning environment. Sadker and Sadker (1985) observed learners in more than 100 classrooms and found that at all grade levels and in all subjects, boys were permitted to dominate classroom communication. This could be due to the fact that teachers pay more attention to male learners for their aggressive effort to seek, give and obtain information (Linn & Hyde, 1989). This inhibits and discourages girls in participating to the best of their ability and may lead to a negative attitude towards science.

Available evidence indicates that teachers are generally oblivious to gender differences in talk and classroom participation. But even when teachers are aware thereof, they may consider such differences to be the expected norm or be unaware of how to cope with it. Lafrance (1991) cites three reasons for male domination of talk in classrooms. Firstly, he argues that there is a cultural proclivity for regarding any talk by a woman as too much talk. Secondly, it is incumbent socially that women should be good listeners and be attentive to others rather than participants in discussions. Thirdly, men discourage women from talking by verbal and non-verbal means such as gaze aversion, delayed feedback, interruptions and withholding of active listening responses like nods. Tannen (1991) reports that males dominate whole class discussion whatever the topic. She even recommends small group discussions in order to involve the girls.

Barr and Dreeben (1983) observed classroom practice in the United States. They submit that the organisation of the classroom time and the use of classroom materials can raise the achievement level of learners apart from their ability.

From the above, it is evident that girls' under-achievement is not so much a product of their incompetence but a product of their marginalization. To improve girls' participation teachers need to be aware of these problems so that they may introduce appropriate interventions. It is apparent that suitable interventions would include measures to raise teachers' awareness of the problem and the variable ways they can be used to solve the problem. In general, therefore, teachers ought to receive gender sensitivity training in order to muster their relevant awareness and skills. It is important to note that learning is not always teacher driven. This calls for the need to develop a gender inclusive curriculum that will incorporate considerations such as self-reflection, critique of current textbooks and gender roles.

It is essential, further, that girl-friendly practices in the classroom must be expanded and that teachers must be sensitised to girl-friendly learning environments. This also calls for the need to re-structure the teacher-training curriculum for the pre-service and in-service teacher training programmes so as to include gender issues.

2.3.5 Criteria for a girl-friendly curriculum

From the literature referred to above, it is evident that girl-friendly science can be organised according to the following categories:

- **Learning material:** It is important that the learning material should be attractive and girl-friendly (colourful, female role models, decorative etc.). In most cases learning material is replete with stereotyping and male gender based a fact that discourages girls from effective learning (Mbilinyi and Omari, 1998).
- **Teacher biasness and classroom practice:** Many studies report that boys receive disproportionate teacher time and attention. (Becker, 1981; Sadker, 2001).
- **Social values:** Research suggests that the problem with regard to the marginalization of girls in science stems from factors outside the school. Cultural stereotyping of science as masculine is very strong. (Frieze & Hanusa, 1984).

Each of the three categories will now be discussed in more detail.

Learning material

According to the literature the following guidelines for girl-friendly learning material are suggested:

- The learning support material should expose learners to female role models and should provide opportunities for the learners to interact with other women scientists. The teacher should try to provide role models by, for instance, inviting women scientists as speakers, and on occasion arranging for job shadowing or periods of attachments to university departments (Clarke, 1991).

- The activities demonstrated in learning material should include aesthetic elements. The emphasis should be on presenting science as beautiful, enjoyable, accessible and necessary (Szpitun, 1999).
- The learning material should include activities that cover elements of fantasy (Rosser, 1990).
- Games should be incorporated into the activities (Yager, 2000).
- Clear instructions should be provided for each activity (Heeter, 2005).
- Activities should allow the learners to draw their own conclusions (Riddell, 1992).

Classroom practice

According to the literature the following guidelines for girl-friendly classroom practice are suggested:

- Learners should have hands-on integrated physics experiences (Franklin, 2002).
- Learners should have the opportunity to interact with other female learners who are interested in the physical sciences (Acker, Oatley 1993).
- Science should be emasculated and demystified (Longbottom, 2002).
- The classroom practice should improve the self-confidence and self-perceptions of the learner's ability to do science (Matkin & Fritz, 2004).
- Teaching strategies should actively involve girls in science lessons (Hammrich, 1998).
- Teaching strategies should develop girls' skills of doing science (Lagoke, 1992).
- Less traditional organisation and teaching practices should be used (Boaler, 1998).
- Classroom practice should provide girls with access to science equipment (Knuth, 1991).

Social Values

According to Chisholm and McKinney (2003) gender issues in schools are generally deeply embedded in social values, attitudes and practices. In terms of the literature the following guidelines for girl-friendly social values are suggested:

- The theory of intellectual development and gender difference in terms of morality was considered by Gilligan (1982) to give rise to a predominance of masculine values, in particular in the field of science education, it is therefore important to focus on feminine values, when designing a girl-friendly curriculum.
- According to Frieza and Hanusa (1982) cultural stereotyping of science as masculine are very strong in the educational field. Changing unequal access to, participation and performance in schools requires that not only in-school issues be resolved, but also out-of-school issues such as social norms and values.
- Mahlase (1997) states that in patriarchal environments, it is difficult to commit and involve females in gender equity programmes. It is therefore important that students should be helped to grasp the dynamics of a socially unjust society and to see science as a means to an end.
- Designing interventions from a critical perspective that addresses the above matters would be a challenging task, a long way from simply encouraging girls to take science as a subject.

In order to validate the girl-friendly unit; the above-mentioned guidelines were used as criteria for designing the unit.

2.4 Curriculum 2005

The proposed girl-friendly science unit was implemented as part of Curriculum 2005. It is therefore important to understand the underlying philosophy of Curriculum 2005 .

Curriculum 2005 was South Africa's attempt to implement the paradigm, precepts and principles of Outcome Based Education and was introduced at the GET level in 1998. This replaced the content-based approach, which focused mainly on the learning of content. After a review of the first version was completed, a revised version has been scheduled for introduction in 2004. In 2003 the FET phase (grades 10-12) National Curriculum Draft Statements were published. Curriculum 2005 presents a view of what South African education should achieve and how to achieve it. It is built around a belief system (or paradigm) that states that we should strive towards an education that accomplishes results where all learners and teachers become successful learners. It stresses that educators should be more concerned with what and whether learners (and teachers) learn and not when and how they learn it. "The emphases of the curriculum are learner-centred and focus on the individual learner (the changing role of that learner from novice to expert, from learner to teacher), the learning process (the dynamic, self-directed, and often social nature of that process), and the learning context (the environment, climate, and community that supports the learner and the learning process)" (Barr & Tagg, 1995).

The learning context should include teacher and technology support, time structures for collaboration, learning partnerships and mentoring relationships and adaptability to learner needs. The teacher must further be aware of the use of local contexts in the classroom. Content and contexts, when aligned to the attainment of the Assessment Standards, provide a framework for the development of Learning Programmes. Flexibility and adaptability are central design features of Curriculum 2005. The concept of "emergent" curricula are at the heart of the system, wherein curricula, that include dynamic and up-to-date information, can evolve at any given period of time, based on the needs of the particular group of learners. Therefore, curricula can dynamically change with each new group of learners, based on their needs, interests, goals, backgrounds, etc. The types of teaching and learning experiences should meet the learner's need for success, belonging, and autonomy. Learning and motivational strategies that would help learners to become self-directed learners should be integrated in the teaching practices and should address both communal and individual needs. Learners must be involved in co-creating all instructional experiences with their teachers and others in their learning communities. This promotes active learning in the classrooms and laboratories with an emphasis on each learner's perceptions, needs and motivation. Learning Outcomes should therefore include affective, cognitive, social, and performance domains. The subjects in the National Curriculum are categorised into learning fields. Physical, Mathematical, Computer, Life and Agricultural Sciences are grouped together in one learning field.

The Critical Outcomes form a new and valuable framework within which the subject and learners can develop, e.g. to be able to make an informed career and subject choice, being culturally and aesthetically sensitive across a wide range of social contexts. The Learning Programme Guidelines and the Assessment Guidelines present ways for recording and reporting on school-based and external assessment as well as provide guidance on assessment issues specific to the subject. Continuous assessment should be used to assess learners, and should be integrated into the process of learning and teaching. Learner-designed assessment and feedback should present individual and group levels; these must be co-created with teachers, parents, and other stakeholders. To assist with benchmarking the achievement of Learning Outcomes, subject competences have been described to distinguish the grade expectations of what learners must know and be able to achieve. Science has three learning outcomes and four content strands. These outcomes address the critical and developmental outcomes of the curriculum.

The Outcomes-Based approach further describes the skills, knowledge, understanding and values that are the results of learning. This allows for the recognition of achievement without regard to how the learning takes place. South Africans today are still living with the legacy of a past in which we were institutionally separated and deprived of the opportunity to work together in dealing with the challenges we face as a nation. As we are building our nation, we need to develop the skills to work together in different spheres and on different levels. Learners learn best from one another. Working together in groups, as the curriculum suggests, will provide the supportive environment to give even the weaker learners the opportunity to learn, to make their contribution and to experience success. A variety of assessment strategies/approaches can be implemented in the classroom. Furthermore, feedback is available for learners and provides ways for learners to remediate and enrich their knowledge and skills in areas of science. The notion that different active learning/teaching strategies must be used, for example group work, co-operative learning, investigations, authentic learning, practical work, etc. is important. This allows learners to be exposed to the development of several skills, attitudes and values, as well as process and problem-solving skills. South Africa is in the fortunate position of having rich natural resources, through Curriculum 2005 learners can learn to manage, use and develop these natural resources. The learner also develops cognitive skills by means of the enquiry approach and knowledge construction, critical and logical thinking skills. Furthermore, the curriculum can help to broaden the vision of educators and learners, since each theme contributes to an understanding of the world as a set of related systems.

2.4.1 Implications of C2005 for teaching

Curriculum 2005 calls for a teaching methodology other than simply transmitting facts and expecting learners only to recall these facts in summative tests or other activities. Learners should instead be challenged with problems/issues for which they have to apply their acquired knowledge and skills in order to solve these problems/issues. These problems/issues should be mainly of local or national relevance. In teaching there should be a constant endeavour to allow learners to observe or to expose learners to data and other sources in order to construct knowledge themselves. Learners should be guided to record their observations or findings. From the recordings, inferences and deductions should be made. The enquiry approach is an important strategy for learner's learning. Learners must develop the skill of asking questions to direct the investigation and to be used as signposts on the path to understanding. Such an approach would help learners to manage their own learning, handle issues objectively and use skills purposefully. The educator has to find opportunities for learners to engage all their senses and thinking in the learning process, for example co-operative learning, group work, practical work, research assignments, presentations, reports, mind maps, investigations, interviews, debates, authentic learning, etc. Furthermore, the educator should act as a mediator through answering questions, asking questions and ensuring that everybody is actively involved in the learning process.

2.5 Conclusion

In this chapter, a literature review was conducted as part of the developmental phase of the girl-friendly science curriculum. Different interpretations of the term *curriculum* were explored in order to establish an appropriate definition for the purposes of this study. Evidence from literature on gender differentiation in science education, educational outcomes, the impact of school factors on female education and teaching practices were explored to determine the criteria for a girl-friendly science unit. Finally, since the girl-friendly science unit was implemented as part of Curriculum 2005, the underlying philosophy of Curriculum 2005 was also discussed.

CHAPTER 3

THEORETICAL FRAMEWORK

3.1 Introduction

Theory has an underlying importance when it comes to our lives and our teaching. Therefore, testing, extending, or challenging a theory is the most useful contribution to knowledge. Wilson (1997) stated that, "theories bear a resemblance to our mental schemas, which help us make sense out of the world and provide a framework for behaving intelligently." When viewed this way, we use theories all of the time. We revise them as needed as we encounter new experiences.

Theory is behind our teaching philosophies and practices; therefore it is of great importance to educators. It also helps us envision new worlds. A critical role that theory can play is helping us see the world in new ways. Theories can furthermore open up possibilities for action by simply changing the way we see. I incorporated the following theoretical learning orientations into the module:

- Constructivist theory
- The inquiry approach
- Social value orientation
- Cognitive development orientation

3.2 Constructivist theory

In accordance with the constructivists the researcher agrees that learning should be an active process in which children interact intellectually with both the content and with each other. Knowledge cannot be imparted, but it is rather constructed by each person through his or her own experiences.

Constructivism is not a new concept. It has its roots in philosophy and has been applied to sociology and anthropology, as well as cognitive psychology and education. Perhaps the first constructivist philosopher, Giambatista Vico commented in a treatise in 1710 that "one only knows something if one can explain it" (Yager, 1991). Constructivist approaches to teaching and learning have emerged from the work of psychologists and educators such as: Jerome Bruner, Jean Piaget and Lev Vygotsky. Piaget (1972) believed that knowledge is both 'real' and constructed, that is, that aspects of our common biological development condition our interactions with invariant environmental structures so that our conceptual knowledge and cognitive representations of the world develop progressively through the process of equilibration.

Though rooted in Piagetian research, constructivism is an avenue of research pertaining to teaching and learning that departed from the neo-Piagetian mainstream twenty years ago and has continued on a distinct path of development. The departure was evident by the late seventies, clearly marked by two publications, Novak (1977) and Driver & Easley (1978). Immanual Kant (1992) further elaborated this idea by asserting that human beings are not passive recipients of information. Learners actively take knowledge, connect it to previously assimilated knowledge and make it theirs by constructing their own interpretation (Cheek, 1992).

In addition constructivists believe that knowledge 'does not exist outside a person's mind' (von Glaserfeld, 1996) and believe that learning is the organisation of the individual's internal cognitions and experiences not the discovery of an external, objective reality. Learners create their own knowledge and understanding through active engagement with realistic tasks in authentic contexts using actual tools. As there are many learners, there will be a multiplicity of understandings, though these will be moderated through social discourse. Learning is also seen as the process of 'assimilation, augmentation and self reorganisation of incomplete mental structures' (Soloway, 1997), and is considered to be most effective where learners are pro-active in and control the construction of their own explanations (Davidson, 1995; Gergen, 1997; Strommen & Lincoln, 1992).

For constructivists, learning is not knowledge written on, or transplanted to, a person's mind as if the mind were a blank slate waiting to be written on or an empty gallery waiting to be filled. Constructivists use the metaphor of construction because it aptly summarizes the epistemological view that knowledge is built by individuals.

Constructivism places more emphasis on the development of the learner, but still within the context of the subject. The locus of learning is on internal cognitive structuring. The learning process is viewed as an internal mental process (including insight, information processing, memory, and perception). Learning is seen in terms of developing mental structures in the mind of the learner. The planned module would structure the content of the learning activities in a girl-friendly manner in order to facilitate the building of mental structures. It is believed that these structures need to be built by the learners themselves, and that the teacher cannot do this for them. It is however, essential for the teacher to create a constructivist-learning environment.

In order to create an environment where inquiry and motivational learning occurs, a variety of teaching methods should be used. These methods should entail the use of meaningful problem solving skills and the integration of new knowledge with past knowledge learned through their environment. Jonassen's (1994) description of the general characteristics of constructivist learning environments is a succinct summary of the constructivist perspective. He proposed that there are eight characteristics that differentiate constructivist-learning environments:

1. Constructivist learning environments provide multiple representations of reality.
2. Multiple representations avoid oversimplification and represent the complexity of the real world.
3. Constructivist learning environments emphasize knowledge construction inserted of knowledge reproduction.

4. Constructivist learning environments emphasize authentic tasks in a meaningful context rather than abstract instruction out of context.
5. Constructivist learning environments provide learning environments such as real-world settings or case-based learning instead of predetermined sequences of instruction.
6. Constructivist learning environments encourage thoughtful reflection on experience.
7. Constructivist learning environments "enable context- and content-dependent knowledge construction."
8. Constructivist learning environments support "collaborative construction of knowledge through social negotiation, not competition among learners for recognition."

The above-mentioned characteristics would create an optimum learning environment in the classroom. By creating a constructivist classroom through, problem solving, particularly those occurring within the community and across the globe, Socratic questioning to help guide learners in learning, and hands-on activities to increase motivational interest, learners become actively involved in their learning process. As a result these methods assure that every learner, despite ethnicity, gender, income, language, or different learning styles becomes actively involved in their learning processes. In addition, the teacher must take an active role, constantly assessing and reassessing effective teaching methods.

Constructivist instruction furthermore provides an experiential base for learning science content. The aim of the planned girl-friendly unit is to give learners an opportunity to develop the capacity and skills to learn better. Scientific principles and concepts will be introduced following explorations with hands-on activities and investigations such as practical tests. Learners (girls) will also be required to do research assignments on prominent women in science. Learners (girls) build their confidence by exploring increasingly complex ideas on successive levels.

The theorists, Ausubel, Novak, & Henesian (1978), have argued that the construction of new knowledge in science is strongly influenced by prior knowledge, that is, conceptions gained prior to the point of new learning. Learning by construction thus implies a change in prior knowledge, where change can mean replacement, addition, or modification of extant knowledge. Learning by construction involving change is the basis of the Posner, Hewson, & Gertzog (1982) conceptual change model. Learners approach each lesson by using skills that they have gained from prior knowledge. As we teach, there should be a constant endeavour to allow learners to observe or to expose learners to data and other sources in order to construct knowledge themselves. The proposed module aims to guide learners to record their observations or findings. From these recordings, inferences and deductions should be made. Learners, especially girls (because they have been previously disadvantaged) should also have opportunities to engage all their senses and thinking in the learning process through active learning strategies, for example group work, co-operative learning, investigations, authentic learning, practical work, etc. Working together in groups, as the unit suggests, will provide the supportive environment to give girls the opportunity to learn, to make their contribution and to experience success.

In order to determine whether the implementation of a girl-friendly science curriculum unit had an effect on the attitude of girls towards science, the study took place within an Action Research Paradigm. A main cornerstone of action research is that knowledge is derived from practice, and practice is informed by knowledge, in an ongoing process. Action researchers also reject the notion of researcher neutrality, understanding that the most active researcher is often one who has most at stake in resolving a problematic situation. Though sharing a number of perspectives with the interpretive paradigm, and making considerable use of its related qualitative methodologies, there are some researchers who feel that neither it nor the positivist paradigms are sufficient epistemological structures under which to place action research (Lather, 1986; Morley, 1991). Rather, a paradigm of Praxis is seen as where the main affinities lie. Praxis, a term used by Aristotle, is the art of acting upon the conditions one faces in order to change them. It deals with the disciplines and activities predominant in the ethical and political lives of people.

3.3 Maslow's Humanistic and Pragmatic perspectives

It is important that the educational practices in a classroom should always endeavor to encourage independent learning. In addition, learners should be encouraged to become responsible for what they learn and how they learn it, within reasonable limits. The teacher's role becomes more that of facilitator than lecturer. (Guide at the side rather than sage on the stage.)

The humanistic orientation focuses on the development of the whole person, and not just the intellect. The learning process is viewed as a personal act to fulfil potential. The locus of learning is on affective and cognitive needs. The humanistic purpose in education is to become self-actualised, autonomous as well as developing a positive self-concept and the development of inter-personal skills.

In relation to science education, a teacher with a humanist orientation will see the area of science as an opportunity to infuse humanistic values. The educator's role is to facilitate the development of the whole person. Group work in a science laboratory could be used to develop collaboration and co-operation where self-directed learning is emphasised.

One of the primary goals for the proposed unit is to allow learners to make knowledgeable scientific decisions within the community. It will furthermore allow the learner to gain problem solving skills, critical thinking skills as well as observation skills. This allows for inquiry based learning to occur using standards and hands-on objectives to gain such skills. The unit will aim to educate and empower learners scientifically in order to think critically and make responsible decisions on issues or problems occurring within their community and environment.

As mentioned earlier, the purpose of this study is to develop and implement a girl-friendly science unit, in order to determine whether it will have an influence on the attitude of girls towards science. As a curriculum developer, it was attempted to produce an environment conducive to learning. This environment has been a result of a motivational interest that was instilled into the learners through the use of a constructivist and inquiry based framework.

For learners, motivation occurs through their own active exploration and inquiry of relevant girl-friendly topics. The teachers were also guided on how to implement the module. A learner was allowed to be responsible for his/her learning experience. In addition to a motivational environment, it was also my responsibility to create a safe and diverse environment in which all learners, including under-privileged learners, were accepted and catered for. To achieve this, reference material were provided for learners who did not have an Internet facility at home or access to a public library. Provision was also made for learners who could not pay for the field trip. This humanistic approach ensured that all learners were given an equal chance to learn.

3.4 The inquiry approach

The inquiry approach is another important strategy that was incorporated in the module. Scientific inquiry is an approach to science that encourages learners to enjoy and foster a wonder and curiosity of discovery in order to develop the creative- and analytical abilities of the learners. Inquiry-oriented science instruction has been characterised in a variety of ways over the years and promoted from a variety of perspectives. Some have emphasized the active nature of learner involvement, associating inquiry with "hands-on" learning and experiential or activity-based instruction. Others have linked inquiry with a discovery approach or with development of process skills associated with "the scientific method." Though these various concepts are interrelated, inquiry-oriented instruction is not synonymous with any of them.

From a scientific perspective, inquiry-oriented instruction engages learners in the investigative nature of science. Novak (1977) suggested a long time ago that, "Inquiry is the set of behaviours involved in the struggle of human beings for reasonable explanations of phenomena about which they are curious." So, inquiry involves activity and skills, but the focus is on the active search for knowledge or understanding to satisfy a curiosity. Though inquiry-based teaching strategies typically engage learners in investigations, it is not the physical activity that defines inquiry. The focus is shifted away from merely *learning* about science to *doing* it with time set aside for the collection, discussion and analysis of data.

From a pedagogical perspective, inquiry-oriented teaching is often contrasted with more traditional expository methods and reflects the constructivist model of learning, often referred to as active learning, strongly held among science educators today. According to constructivist models, learning is the result of ongoing changes in our mental frameworks as we attempt to make meaning out of our experiences. In classrooms where learners are encouraged to make meaning, they are generally involved in "developing and restructuring their knowledge schemes through experiences with phenomena, through exploratory talk and teacher intervention" (Driver, 1989). Learners are likely to begin to understand the natural world if they work directly with natural phenomena, using their senses to observe and using instruments to extend the power of their senses

3.5 Social value orientation

This orientation emphasises the acquisition of social values that are deemed to be of value to the community in which education is occurring. Girl-friendly scientific activities that are relevant to learners within local, national, regional and global contexts will be applied. This will enable them to understand the changing world around them more effectively in terms of gender, cultures, use of natural resources and social systems in the past, present and future. All learners, especially girls will learn the skills of social inquiry to assist them in becoming more autonomous, purposeful, tolerant and involved members of society. These skills include investigating, reasoning, participating in debates such as the environmental impact of mining vs. the socio-economic impact of mining. Learners also develop communication skills and are required to work with others as members of a team or group.

Learners explore the values of the social justice for mining as well as ecological impact of mining, enabling them to exercise judgment on moral and ethical issues, and to develop a commitment to the core values shared by most humans. Empowered with this knowledge of mining and metals, thinking and practical skills and ethical values, girls will become better thinkers and better decision makers. They will then be able to take action in a socially responsible manner and contribute to the achievement of more desirable futures for all.

3.6 Cognitive development orientation

Operating from cognitive development orientation would mean acknowledging the distinct developmental stages the learner passes through to adulthood as well as the challenges faced by each learner in each developmental level. The learning content and style should match the developmental level (pre-operational, concrete operational and formal operational level) of the learner and relate to his/her immediate environment. It is within this orientation that learning is viewed as an active process where the learner interacts with his or her environment. The teacher's role is not just to expose the subject matter but also facilitate learning by gathering relevant, unbiased Learning support material. Cognitive developmental orientations further imply that we select teaching and learning material that matches the cognitive development of the learners and employ both formative and summative assessment. Learners who are at a concrete operational level are given tasks that match their level of development, but are then guided to employ more abstract thinking and problem solving strategies and skills.

3.7 Conclusion

Theory has an underlying importance when it comes to research. Testing, extending, or challenging a theory can be regarded as one of the most useful contributions to knowledge. In this chapter, the constructivist theory, inquiry approach, social value orientation and cognitive development orientation were discussed comprehensively in order to provide a framework for the theoretical learning orientations employed in the girl-friendly unit.

CHAPTER 4

RESEARCH DESIGN

4.1 Introduction

This study was undertaken essentially to determine whether the implementation of a girl-friendly science unit had an effect on the attitude of girls towards science. In view of this, three main objectives needed to be achieved:

- To determine the criteria for a girl-friendly unit.
- To design and implement a girl-friendly curriculum unit.
- To determine what effect the implementation of a girl-friendly science unit had on the attitude of girls towards science.

In order to determine the above, a literature review was conducted to establish the criteria for a girl-friendly unit. The literature review evolved into a girl-friendly study unit and was implemented in order to determine whether it had an effect on the attitude of girls towards science. Three different science teachers were asked to implement the unit. Data evident from the empirical study as well as evidence from literature was drawn upon to determine whether the implementation of the girl-friendly unit had an effect on the attitude of girls towards science.

4.2 Research Methodology

This study was conducted according to a mixed-method research strategy. Brannen (2005) describes the mixed-method research approach as a research strategy that employs more than one type of research method. Researchers in Educational sciences increasingly adapt the mixed methods approaches, which utilise different strategies to collect and analyse both qualitative and quantitative data (Cresswell, 2003). A combination of different qualitative and quantitative methods was employed in this particular study and will be discussed in the following section.

4.2.1 Quantitative research methods

According to Hopkins (2000) the purpose of quantitative research is to determine the relationship between two different variables (an independent variable and a dependent variable) in a population. Quantitative research designs can either be descriptive (subjects usually measured once) or experimental (subjects measured before and after a treatment).

Certain parts of this specific study were conducted within an experimental research paradigm. The fundamentals of **Action Research** (an experimental design), were employed to **develop** the girl-friendly unit.

Action Research

According to Zuber-Skerrit (1992), action research reflects the dialectic relationship between theory and practice. The theory are tested and rationalised in practice and the findings may lead to action.

Kemmis (1988) has developed a simple model of the cyclical nature of the typical action research process (Figure 1). Each cycle has four steps: plan, act, observe, and reflect.

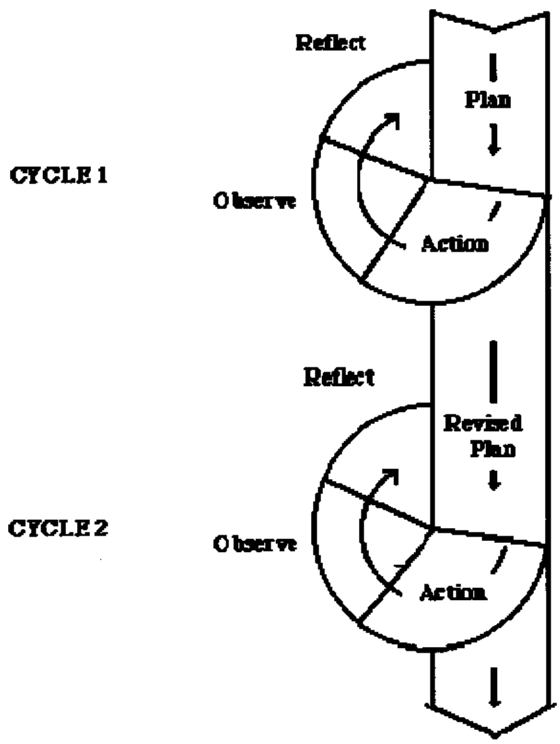


Figure 1

Initially, a problem is identified and data is collected for a more detailed diagnosis. In this specific case the problem was that girls tend to have a negative attitude towards science. Research suggests a number of reasons for the aforementioned. One of the reasons is a gender bias in image portrayal of women in science textbooks (Jacklin, 1992). According to one study conducted in Kenya (Obura, 1990) it was found that women are nearly invisible in textbooks. Therefore, instead of fostering the basic equality between men and women, the messages given to schoolchildren in Learning support material encourage the dominance by males. Instead of freeing individuals from conformity to sex roles, the current Learning support material fortifies a sex division of labour.

In another study by Jacklin (1992) it was found that classroom behaviour is another reason why girls tend to have a negative attitude towards science. The study indicated that boys displayed aggression, physical exertion and problem-solving behaviour and tends to dominate classroom discussions, while girls were engaged in fantasy, following orders or making statements.

Vetter (1992) states that girls are less likely to feel confident in their scientific and mathematical ability, because boys dominate science classrooms in terms of behaviour. Therefore girls are more likely to develop a negative attitude towards science. As the gender gap in confidence widens, the gap in interest also widens. The lack of interest in science can lead to a negative attitude towards science and result in lower levels of participation of females in science education.

There are a number of other factors, which can also cause girls to have a negative attitude towards science. These factors include teacher biasness, classroom practice and social values.

The above-mentioned problems were followed by a collective postulation of several possible solutions, from which a single plan of action (girl-friendly science unit) emerged.

The girl-friendly science unit (Appendix A) was designed by the researcher and consisted of a complete unit plan, teaching strategies, lesson plans, (activities, teaching models, reading assignments, laboratory work, homework and reference materials) as well as the different assessment instruments (tests, tasks, observations, marking memos and rubrics). The complete girl-friendly science unit was then handed to three different science teachers for implementation as part of the intervention. Literature clearly states that no curriculum can be "teacher proof" (Cuban, 1993). The researcher recognized the fact that the teacher's beliefs and values shape the atmosphere of the classroom itself. Therefore, all three of the teachers attended a workshop to get consensus on girl-friendly classroom practice and teaching strategies.

Due to the fact that I do not teach science at school, I did not have the opportunity to implement the unit myself. This was regarded as a strong point for the study, since it protected me from biasness towards the unit and learners. It furthermore afforded me the opportunity to conduct an analysis of the practical feasibility (in terms of implementation) of the unit.

Data on the results of the intervention were collected and analysed quantitatively and the findings were interpreted to determine whether the implementation of a girl-friendly science curriculum had an effect on the attitude of girls towards science. The problem was re-assessed and the process began another cycle.

4.2.2 Qualitative research methods

According to Creswell (1998) qualitative research can be defined as a process of inquiry to achieve an understanding, based on distinct methodological traditions, of a social or human problem. Hull (1997) states that the purpose of qualitative research is to understand a social phenomenon and to reveal the processes by which people construct meaning about their worlds and to report what those meanings are.

The role of the researcher in qualitative research is of vital importance since she/ he as a person is the research instrument. According to Oka and Shaw (2000) it is essential for qualitative researchers to be aware of different philosophical research paradigms in order to recognise a research problem as well as to analyse qualitative data. Guba & Lincoln (1994) identified four main philosophical paradigms that influence qualitative research. They include positivism, post-positivism, critical theory, and constructivism. Certain parts of this specific study were conducted within the **post-positivistic** paradigm.

Post-positivism

In a post-positivistic design, it is the problem under investigation (in this specific case, - the attitude of girls toward science) that determines the methodologies needed for its resolution, which can only be as exacting as allowed for by the topic under consideration (Popper, 1987). Different theories and perspectives on girl-friendly science were logically interpreted and developed in to a practical manifestation (girl-friendly science unit).

Post-positivism (Fischer, 1998) assumes that scientific and common sense reasoning are essentially the same thing. Post-positivists furthermore accept that, although researchers will endeavour to limit the subjectivity present in their work, research can never be completely objective at all times and that subjectivities will be found in their work. In order to protect myself from biasness towards the unit and learners, the unit was handed to three different teachers for implementation. As a post-positivist it was accepted that the information provided by the individual is important and cannot necessarily be generalised to others. Phillips and Burbules (2000) describe the concept of truth as a constant quest for answers through thorough inquiry. Based on the above, several different methods of triangulation were employed to obtain a better understanding of the effect of a girl friendly unit on the attitude of the girls towards science.

4.2.3 Rationale for the unit topic

One of the knowledge areas for the Science Curriculum is *Matter and Materials*. Learning Outcome 1 suggests investigations into the properties (conductivity, hardness, malleability, and ring) of metals. Learning Outcome 2 states that learners should have the ability to identify metals by using the periodic table as well as the basic metallic bonding. Learning Outcome 3 advocates for core science/society relationship studies, mining and metal extraction, the environmental impact of mining and mine dumps as well as other disposal and pollution problems. As an optional Learning Outcome alloying, hardening and the crystalline structure of metals are suggested. The Optional Learning Outcome in the knowledge area *Chemical Interactions 1* is suggested as electrolysis for refining/extracting copper and other materials. It was therefore desided to use *Mining of Metals* as the topic for the unit. The metal mining industry contributes greatly to our economy and provides employment to thousands of labourers countrywide. This unit enabled me to incorporate the aforementioned Learning Outcomes as well as some of the Critical and Developmental Outcomes prescribed by Curriculum 2005.

The topic *Mining of Metals* was deliberately chosen, since the mining industry is generally male dominated. Literature (Hoffmann, 1995) indicates that girls show little interest in this topic. I therefore perceived it as a challenge to attempt to present a traditional "male topic" in a girl-friendly manner.

In order to achieve the above mentioned I concentrated on the interests of girls. According to Hoffmann and Häussler (1990) girls are interested in natural phenomena, like weather, rainbows or the eclipse of the moon. Although they normally do not prefer physics, they are interested when it is presented in a biological context. They are furthermore interested in exploring the social implications of science and the development of different scientific theories.

Hence, girls feel themselves more involved when examples are chosen from their direct personal experience rather than from the classical history of science such as engines, technical apparatus and war material.

During a pilot study the girls were also asked to complete a questionnaire (Appendix F.a) in order to determine what their general preferences regarding science are.

To make the study more relevant and attractive for girls, I incorporated the above suggestions into the unit e.g. the use of familiar materials i.e. teaspoons, jewellery and the exposure to female scientists etc. (Appendix A.b)

4.2.4 Procedure for the implementation of the curriculum unit

Permission to do the research was obtained from the principal (Appendix G). Due to the fact that I am an educator at the specific school, the school was purposefully selected for the practical feasibility of the study. Appointments were made with the principal as well as with the science educators who implemented the unit, to provide a synopsis of the research project. Dates for the completion of the unit and the collection of data were mutually agreed upon. The learners were assured of anonymity of participation.

4.2.5 Specifying the Population and Sample

A sample that represented the population in gender and race was selected for this study. In order to apply findings to a large group of individuals and to draw accurate conclusions about a target population (called a population); participants of different genders were selected. One must however, remember that a sample is only an *intimate* of the population and the average scores from the sample only *approximate* the population values and have a typical discrimination of (say, ± 3%).

The participants for this study were the Grade 5-learners in the GET phase of an Afrikaans Primary School in Gauteng. The majority of respondents fell into the age group of 11 years. Almost all (98%) of the respondents were white. The proposed learning programme was implemented as part of their daily curricular activities over a period of six weeks (four science periods of 40 minutes per week and two weeks allowed for homework).

As part of the intervention, the complete unit was handed to three different science teachers for implementation. All three of the teachers agreed to implement the unit, as long as it corresponded to the curriculum, which it did.

The fact that the three teachers were of different gender, proved to be a strength as well as a limitation for the study. It provided the opportunity to get an understanding as to how teachers of different genders perceived the girl-friendly unit. However, the fact that two of the teachers were male can also be regarded as a possible limitation, since it limited the exposure of girls to female role models.

4.2.6 Demographics of the teachers

Teacher 1

Teacher 1 is a white, female teacher and has 5 years of teaching experience. She also acts as the hockey coordinator of the school. She is 28 years old and claims to have an absolute passion for children. She describes herself as a sporty and adventurous person. Her goal in life is to become the coach of the Springbok Hockey Team. In order to motivate learners she implements an appraisal system in class. She enjoys teaching science, although she would not mind to be the physical training teacher as well. She is frustrated with the fact that although affirmative action are compulsory everywhere, it is still more difficult for women to get promoted in this specific school.

Teacher 2

Teacher 2 is a white, male teacher and has 18 years of teaching experience. He is 43 years old and acts as the Head of Department of Sport. His passion in life is rugby. He describes himself as a no-nonsense person "What you see is what you get". His goal in life is to create a better life for his two children and to win the National Rugby Trophy for primary schools. He enjoys science, but says being the coordinator of sport consumes a lot of his academic time. He is considering it to resign in order to start his own business. He is frustrated by the lack of discipline in schools as well as the low salaries that teachers are paid. He is also annoyed by the fact that the male teachers are regarded as lazy, lackadaisical and careless when they are not in class, although they are expected to do all kinds of odd tasks at school (i.e. the marking of sport fields).

Teacher 3

Teacher 3 is a white, male teacher. He is 28 years old and has 5 years of teaching experience. He was previously employed at a high school, and got promoted recently. He now acts as the Head of Department: Educational Guidance. He describes himself as a positive, dynamic person "A go getter". His goal in life is to become a school principal before the age of forty. He enjoys science, although he regards mathematics as his favourite subject. His passion in life is to motivate children to become the best they can be. Although he considers himself to be a very positive person, he is frustrated by affirmative action. “It is difficult for a young, white male to get promoted in our Educational System”.

4.3 Data collection methods

4.3.1 Types of data

In the study several instruments have been used for collecting data. The data has been used to get an understanding as to whether the implementation of a girl-friendly science curriculum has an effect on the attitude of girls towards science.

Attitudinal Measures

Researchers use attitudinal measures when they seek to assess affect or feelings towards an educational topic (e.g. assessing positive or negative attitudes towards giving learners a choice of school to attend.) An example of an attitudinal instrument measuring learner's adaptation to college is the “Student Adaptation to College Questionnaire” (Baker & Siryk, 1989).

Croft (2000) defines *attitude* as the affective responses that students express towards certain areas (science) and towards themselves as learners. General feelings such as liking/disliking of the learners must also be considered, along with the perceptions of difficulty, confidence, self-concept, usefulness, attributions of success and failure, and anxiety to gain an understanding of a learner's attitude towards a certain area.

Baker & Siryk (1989) propose that in order to determine the attitude of learners towards a school related issue; one needs to measure the academic adjustment, social adjustments and emotional adjustments of the learners. All three of the above was employed in this study.

For this specific study questionnaires were employed as a pre-test in order to determine the attitude of girls prior to the intervention. To determine whether the intervention had any effect on the attitude of girls towards science, the same questionnaire was used as a post-test. Self-assessment rubrics (Appendix C) were also employed in order to provide insight as to how the girls experienced the unit.

Attitude can be regarded as an elusive concept; therefore assessment instruments were also designed to measure the performance and behaviour.

Performance Measures

One can use performance measures to assess an individual's ability to perform on an achievement test, intelligence test, aptitude test, interest inventory, or personality assessment inventory. The results of the performance measures were used as a post-test to provide a better understanding of the attitude of the girls towards science.

Behavioural Observations

Behavioural observations consist of selecting an instrument to record behaviour, observing individuals for that behaviour, and checking points on a scale that reflect the behaviour (behavioural checklists). According to (Klawe & Phillips, 1994) young children do not always provide answers that are a true reflection of their own attitude and thoughts. Unfortunately, the learners often provide answers that they think the teacher wants to hear. This manifestation however, may also be true for self-reporting data generation instruments. Behavioural observations were therefore valuable for this particular study, since it provided a clear indication of the attitude of girls towards science, each other and the unit.

4.4 Description of the data generating instruments

4.4.1 Factual Information on the learners (Demographic data)

Factual information or personal documents consist of numeric data in public records of individuals. Mark-sheets and test result records were gathered from the school office in order to obtain factual information (e.g. Science results, gender and age) about the participants. The factual information was necessary to determine whether there were remarkable differences between the previous science scores of the learners and their results for the girl-friendly unit. This information was then compared and correlated with the results of the questionnaires.

4.4.2 Observations

Observing learners has several advantages. These advantages include (Hammersley & Atkinson, 1995):

- The opportunity to record information as it occurs in a setting.
- The opportunity to study actual behaviour.
- The opportunity to study individuals who have difficulty verbalizing their ideas (e.g. very young children or verbally challenged participants).

First-hand information was gathered by observing the behaviour of the teachers with regard to girl-friendly science. Data – gathering observational sheets (Appendix D) were used in order to gather information on the above mentioned. The researcher acted as one of the two observers (Observer 1). In order to protect the researcher from being bias the Head of Department: Science and Technology acted as a second observer (Observer 2). The observations, focussed on the facilitation and implementation of the girl-friendly science curriculum unit.

The observation sheets included the following criteria:

- Did the teacher create a positive learning climate?
- Logical progression through the Learning Support Material.

- Were the Girl-friendly unit implemented as agreed upon between the researcher and the teacher?
- Were learners exposed to female role models during class interaction?
- Discipline.
- Were girls actively involved in the science classroom?
- Did girls actively participate in the practical experiments?
- Did girls ask questions in the science classroom?
- Were girls asked to answer questions?
- Were girls involved in the set tasks?

These observation sheets enabled the researcher to record data such as the behaviour of individuals and to chronologically list the sequence of events. Observing in a natural setting, such as a classroom requires good listening skills and careful attention to visual detail (Hammersley & Atkinson, 1995). The learners observed the two observers as "outsiders", given that they were not Grade 5 teachers and thus did not have any relationship with the learners. However, one of the observers could also be regarded as an "insiders" to the teachers, since she developed LSM. It therefore required management of issues such as the potential deception by the learners and the initial awkwardness of being an "outsider" to the learners and an "insider" to the teachers, without initial personal support in the setting.

4.4.3 Interviews

For this study unstructured and semi-structured, one-on-one interviews were conducted with the three different teachers and focus group interviews with the learners (girls) prior to and after the implementation of the girl-friendly science unit.

I have asked the learners (girls) and teachers in the study mostly general, open-ended questions and recorded their answers. This information was then transcribed into a data file for analysis.

Open-ended questions such as "How would you describe a girl-friendly class?), were asked so that the participants (both teachers and learners) could best voice their experiences unconstrained by any perspectives of the researcher or past research findings. Open-ended responses to the questions allowed the participants to create the options for responding. The open-ended responses furthermore allowed the participants to provide the researcher with the personal experiences of the girls in a particular science class. These open-ended responses also allowed the researcher to gain a better understanding on the effect that an individual teacher had on the implementation of the girl-friendly science unit (e.g. male/female teacher; experienced/ inexperienced teacher).

Conducting Interviews

There were several general steps that I followed when I conducted the interviews. These steps were the following:

1. The interviewees were identified by purposeful sampling strategies.
   - All all three of the science teachers were interviewed.
   - Only girls were chosen to participate in the focus-group interviews.
2. Consent was obtained from the interviewer to participate in the study.
3. The interview took place in a quiet, suitable venue, the Media Centre of the school.
4. During the interview all the questions and responses were audio – taped.
5. Brief notes were taken during the interview.
6. In order to obtain additional information, probing questions were used.
7. The researcher aimed to be courteous and professional at all times while conducting the interview.

4.4.4 Portfolio journals of the learners

According to the National Revised Curriculum (2004) learners are required to create a portfolio for every subject. The portfolio journals should contain an example of all the different activities that the learners performed during the year. These portfolio journals of the learners were used as a method of triangulation, to obtain a better picture of the attitude of the girls towards science in general and were only used to determine whether there was a relationship between academic achievement and attitude.

4.4.5 Questionnaires

The learners (girls) were asked to complete three different questionnaires for this study. The researcher developed all of the questionnaires. The first questionnaire requested demographic information of the learners (Appendix F.a) that included information on the gender, age and location of the learners. The girls completed the second (Appendix F.b) and third (Appendix F.c) questionnaire in order to determine the attitude of girls towards science prior to, and after the implementation of a girl-friendly science unit as a pre- and a post-test.

4.5 Data Collection Techniques

The following table indicates the methods used to answer the different research questions.

4.5.1 Data Collection Techniques: Needs Analysis for the LSM.

1. *What are the criteria for a girl-friendly unit?*	Questionnaire	Literature	Observation	Interviews
What type of activities do girls prefer in the science classroom?		✓	✓	
What are the general interests of girls regarding science activities?		✓		
What type of science activities do girls dislike in the classroom?		✓		

2. What are the general preferences of girls regarding science activities?	Questionnaire	Literature	Observation	Interviews
What type of activities do boys prefer in the science classroom		✓	✓	
What would a girl-friendly science curriculum consist of?		✓		
What types of practical activities do girls prefer?				
What type of science activities do girls dislike in the classroom?		✓		

4.5.2 Data Collection Techniques: Attitude of girls before and after the intervention

What was the attitude of girls towards science prior to the implementation of a girl-friendly science unit?	Questionnaire	Literature	Observation	Interviews
What is the general attitude of the learners towards the science activities?	✓		✓	✓
What is the general attitude of girls towards the science curriculum?	✓		✓	✓

Are learners (girls) aware of female science related role models?	✓		✓	✓
Are learners (girls) aware of female science related role models?	✓			✓
Are girls actively involved in the science classroom?			✓	✓
What is the attitude of girls towards science after the implementation of a girl-friendly science unit?	Questionnaire	Literature	Observation	Interviews
What is the general attitude of the learners towards the science activities?	✓		✓	✓
What is the general attitude of girls towards the science curriculum?	✓		✓	✓
What is the general attitude of girls towards a career in science?	✓		✓	✓
Are learners aware of female science related role models?	✓			✓
Are girls actively involved in the science classroom?			✓	✓
Did the girl-friendly science unit have an effect on the attitude of girls towards science?	✓		✓	✓

4.6. Reliability

4.6.1 Learning support material (LSM)

The purpose of the study was to determine whether the implementation of a girl-friendly science unit had an effect on the attitude of girls towards science. A checklist, consisting of girl-friendly criteria, was utilised in order to develop a girl-friendly curriculum (See section 2.5). As mentioned earlier, the complete unit was handed to three different science teachers for implementation. The fact that I did not implement the unit myself protected me from biasness towards the learners and the LSM. It furthermore entailed me to make an analysis of the practical feasibility (in terms of implementation) of the unit. To establish reliability for the study, I observed the science teachers by means of an observation sheet. The Head of Department also observed the teachers according to the same observation sheet. The lesson plans were also verified by the Head of Department to ensure the correct standard (according to the New Revised Curriculum). The science teachers were asked to write a report on how they experienced the unit and to focus specifically on their interpretation of the girl-friendliness of the unit.

Academic assessment of the learners

In order to determine whether the summative test was reliable I applied the Kuder-Richardson 20 formula, since the summative test items required only a wrong (0) or correct (1) score. There were 25 items in the summative test. I analysed the results of the different classes. In order to obtain a better picture of the attitudes of the learners (girls), the results of the test and group assignments (in the portfolio) were statistically correlated with the results of the attitude questionnaire and were used as a method of triangulation. German (1994) hypothesized that attitude towards biology in school, directly or indirectly influence learners' performance in biology. He posited that students with a positive attitude towards biology were expected to perform well in biology and science-like activities.

Attitude of the girls

The learners (girls) were asked to complete a questionnaire before the implementation of the unit on their attitude towards science. To determine whether the intervention had any effect on the attitude of girls towards science, the same questionnaire and self-assessment rubrics

(Appendix C) were used as a post-test. Since attitude is an elusive concept, documentation such as worksheets, assessment tasks, a written summative test, and an observational checklist were utilised. In order to determine whether the unit had any influence on the attitude of girls towards science the results of the aforementioned pre- and post-tests and documents were analysed and compared. The aforementioned will serve as reliable conducts to measure the attitude of girls towards science.

4.6.2 Content Validity

Content validity is the consensus (i.e., intersubjective, negotiated) of the community of scholars as to whether the items used to measure a construct actually refer to the domain of the construct and to no other construct. In other words, the issue of content validity is, "Does the community of scholars agree that a particular instrument is appropriate to measure a particular physical entity or abstract construct?" Assessment of content validity depends entirely upon the opinions of the community of scholars. They have no empirical elements to them.

Validity of the Instruments

To establish content validity I focussed on the questionnaires that the girls had to complete as well as the Observation Sheets used for observing the teachers. The primary validity evidence appropriate to the instruments is *content validity.* That is, -do the instruments adequately measure what it is suppose to measure? Content validity was established in the beginning by consulting with other school colleagues and science lecturers on whether the questionnaires adequately measure attitude. Each item was directed at measuring specific attitudes of girls towards science. Therefore I constantly reviewed, and revised the different items.

In order for an item to be included in the self-assessment rubrics (Appendix C) and questionnaires (Appendix F) the above-mentioned consultants had to assess each potential question in terms of the following criteria:

- Does the question measure the outcome it was designed to measure?
- Does the question appropriately measure the attitude of girls towards science?
- Is the difficulty of the question appropriate?
- Is the question free from content that stereotypes, offends, or unfairly penalizes learners on the basis of personal characteristics such as gender, ethnicity, religion, or socio-economic status?

Any item that appeared upon review not to match its stated standard was removed from the questionnaire.

Validity of the learning material:

The curriculum unit (Appendix A) was designed by the researcher and consisted of a unit plan and teaching strategies (Appendix A.a), worksheets (Appendix A.b), memorandum (Appendix A.c), assessment plan (Appendix A.d), and assessment instruments (Appendix A.e).

Content validity of the learning material was established in the beginning by consulting with four other science teachers and two other science lecturers on whether the worksheets reflected the content stated by the outcomes. Each item had to be directed at measuring the specific outcomes according to the assessment standards (Appendix A.d). Therefore the summative test items were constantly reviewed and revised. In order for an item to be included in an activity or summative test the potential question had to meet the following criteria:

- Does the question measure the outcome it was designed to measure?
- Does the question appropriately measure content or skills that learners should be expected to learn by the end of the activity/unit?
- Is the difficulty of the question appropriate?
- Is the question free from content that stereotypes, offends, or unfairly penalizes learners on the basis of personal

characteristics such as gender, ethnicity, religion, or socio-economic status?

Any item not matching its stated standard upon review was removed from the summative test.

In order for a potential question to be included in an activity, it had to meet the following criteria.

- It measures what it actually claims to measure. ` (Knowledge, understanding, skills).
- An individual learner's performance is similar in two or more items that claim to measure the same aspect of learner achievement.
- Learners have adequate opportunity to demonstrate their competence.

In terms of the written assessment task the following guidelines were followed to establish criterion-referenced validity:

- Is the purpose of the task stated in a clear and concise fashion?
- Is it clear from a list of objectives what the task measures?
- Does the set of objectives measured by the task serve as a representative set from some content domain of interest?
- Are the task items in an appropriate format to measure the objectives they were developed to measure?
- Are the task items free of bias (gender, ethnicity, religion, or socio-economic status)?
- Are the task directions clear?

4.7 Conclusion

As mentioned earlier, this study was undertaken essentially to determine whether the implementation of a girl-friendly science unit had an effect on the attitude of girls towards science. In order to determine the above a mixed-method research strategy was employed. Certain elements of action research as well as basic fundamentals of a post-positivistic approach manifested throughout the study. The rationale for the topic as well as the procedure for the implementation of the curriculum unit was discussed in this unit. Several instruments and techniques were employed to collect data. The data were utilised to gain an understanding as to whether the implementation of a girl-friendly science curriculum had an effect on the attitude of girls towards science. The above instruments and techniques were validated and tested for reliability.

CHAPTER 5

DATA PRESENTATION AND ANALYSIS

5.1 Introduction

As mentioned in previous chapters, the purpose of this study is to determine whether the implementation of a girl-friendly science unit had an effect on the attitude of girls towards science. In order to determine the above, an empirical study was conducted as part of the study. Data was collected through various instruments. The results of the data were analyzed by means of the approach of Rubin and Rubin (1995) in order endeavour the answering of the research questions.

5.2 Data Analysis Approach

"The goal (of the data analysis) is to integrate the themes and concepts into a theory that offer an accurate detailed yet subtle interpretation of the data. The analysis is complete when you feel that you can share with others what your interpretation means for policymaking, for theory, and for understanding the social and political view" (Rubin and Rubin, 1995).

This study was conducted at an Afrikaans Primary School in Gauteng. The sample consisted of 140 girls (Grade 5). Since this specific study only focused on the attitude of *girls* towards science, the boys were only involved for the purpose of classroom practice- (to compare the classroom practice of teachers towards boys and girls) and behavioural observations (to compare the classroom behaviour of girls and boys).

To measure the attitude of girls towards science, the same questionnaire (Appendix F.c) was used as a pre- and a post-test. The evaluative attitudes were: very positive (S4), positive (S3), average (S2) and negative (S1). The instrument included 15 items.

The attitude scores for an individual were determined from the four evaluative scales producing a range of one, (negative attitude), to four, (very positive attitude). A score of 40 to 50 represented a positive attitude. Self-assessment rubrics (Appendix C) were also utilised as an additional measure to confirm the results of the questionnaires. The above-mentioned questionnaires and self-assessment rubrics were tested for reliability in a survey involving a time interval of one month prior to the main study.

Since attitude is an elusive concept the performance and behaviour of the learners were also documented. The impact of teaching practice on the attitude of girls towards science was also studied. Lockheed and Komenan (1985) shows that teaching practices rather than teacher quality were predictive of a positive attitude towards science. Evidence in the print sources (Longbottom, 1999; Matkins, 2004) suggests that there are several teaching practices e.g. teacher biasness that influences the attitude of girls towards science. In researching this topic, I incorporated information from print sources, but also made use of focus group interviews with the girls and the science teachers. The results of the performance measures, behavioural- and classroom practice observations, were analysed and compared to the results of the questionnaires and utilised as a method of triangulation.

The above process was assisted by making use of available computer-aided software for the analysis of qualitative data, which was used as a tool to aid in the management of textual data, for the storage and retrieval of information as well as the other functions that these programs offer.

5.3 Results and Analysis of Data

5.3.1 Analysis of the Questionnaires:

a) The demographical information of the participants

Results of Questionnaire A:

1	**Age**	**N=120(%)**
	Age 10 Years	3,2%
	11 Years	94,6%
	12 Years	2,8%
2	**Gender**	**%**
	Male	39%
	Female	51%
3	**Race**	**%**
	White	99%
	Black	1%
	Indian	0%
	Coloured	0%
	Other	0%

TABLE 5.1

The majority of respondents (94, 6%) fall into the age group of 11 years. Almost all of the respondents (99%) were white.

b) Attitude of the girls towards the science curriculum and the science teacher *prior* to and *after* the implementation of a girl-friendly science unit (Questionnaire B):

Item Number		Results N=122(%)	
1	**General attitude of learners towards science**	**Pre-Test**	**Post-Test**
	Very Good	11%	27%
	Good	14%	33%
	Acceptable	38%	44%
	Negative	37%	18%
2	**General attitude of learners towards the science teacher**	**%**	**%**
	Very Good	14%	11%
	Good	36%	27%
	Acceptable	38%	23%
	Negative	12%	39%
3	**General attitude of girls towards the existing science curriculum?**	**%**	**%**
	Very Good	7%	19%
	Good	37%	17%
	Acceptable	36%	48%
	Negative	22%	16%

4	**General attitude of girls towards a science career**	**%**	**%**
	Very Good	3%	37%
	Good	26%	31%
	Acceptable	32%	8%
	Negative	39%	24%

TABLE 5.2

Analysis of the Pre- and Post Test:

An increase of 17% of the girls described their attitude as very good towards Science in general after the implementation of the girl-friendly unit. 33% (19% more than the pre-test) of the girls described their attitude as good towards Science in general, after the implementation of the girl-friendly unit. There was an increase of 6% of girls who described their attitude as acceptable towards science after the intervention of the girl-friendly unit. What is noteworthy is that there was a decrease of 19% of the girls who described their attitude as negative towards science after the implementation of the girl-friendly unit.

After the implementation of the girl-friendly unit 8% less of the girls described their attitude as positive towards the science Curriculum. However 12% more of the girls described their attitude as acceptable towards the current science curriculum and 6% less of the girls described their attitude as negative towards the current science curriculum.

There was a considerable difference (27%) of the girls who described their attitude as negative towards the Science teacher after the implementation of the science unit. Only 23% (15% less) of the girls described their attitude as acceptable towards the science teacher after the implementation of the girl-friendly unit. 9% fewer girls described their attitude as good- and 3% fewer of the girls described their attitude as very good towards the science teacher after the implementation of the unit.

A noteworthy 34% more of the girls described their attitude as very good towards a science career after the implantation of the unit. There was an increase of 5% of the girls who described their attitude as good towards a science career. There was a decrease of 24% of the girls who described their attitude as acceptable towards a science career and 15% fewer of the girls had a negative attitude towards a science career after the implementation of the girl-friendly unit.

C) Attitude of the girls towards science in general *prior to and after* the implementation of a girl-friendly science unit (Questionnaires C &D):

Item	Item Name	Results	
		Pre Test	Post-Test
1	Interested in science	56,9%	64.1%
2	Do want to continue with science until Grade 12	32.3%	59.7%
3	Would like to pursue a career in science	8.1%	27.3%
4	Do like their science teacher	63,5%	68.5%
	Do not like their science teacher	31.5%	36,5%
5	Satisfied in the manner in which the subject is presented	74,7%	84.7%
	Not satisfied in the manner in which the subject is presented	25,3%	15.3%
6	Think that the science curriculum is directed at all learners	76,3%	73.3%
	Think that the science syllabus is directed more at boys	10,7%	19.7%
	Think that the science syllabus is directed more at girls	2.8%	7.4%

7	Think that there are discrimination against girls in the classroom	17,1%	13,7%
	Think that there are no discrimination against girls in the science classroom	82,9%	85.3%
8	Participate in group activities in the classroom	96,3%	99.7%
	Don't participate in groups activities in the classroom	3,7%	0.3%
9	Good parental motivation towards science	67.3%	33.7%
	No parental motivation towards science	5.7%	33%
10	Consider the science teacher as a role model	21,1%	19,4%
	Don't consider the science teacher as a role model	78,9%	80.6%

TABLE 5.3

Pre-Test: Analysis of Questionnaire C (Appendix F.c)

54% of the respondents are interested in Science. However, only 82% of the respondents would like to continue with Science until Grade 12. Only 8% of the respondents would like to pursue a career in Science. The results furthermore indicated that most (63, 5%) of the respondents do like their Science teacher. The majority (74, 7%) of respondents are satisfied in the manner in which the subject is presented. The majority of girls (82, 9%) feel that there is no discrimination against girls in the classroom. The learners do participate in group-activities in the classroom. Most of the girls (67%) of the girls have good parental motivation towards Science. Only 21% of the respondents consider the Science teacher as a role model.

Post-Test: Analysis of Questionnaire C (Appendix F.c)

A lot (64.1%) of the girls are interested in Science. However, only 59% of the girls would like to continue with Science until Grade 12. Only 11% of the girls would like to pursue a career in Science.

It seems that fewer girls (63, 5%) like their Science teacher after the implementation of the girl-friendly unit. The majority (74, 7%) of girls prefer the girl-friendly, practical manner in which the unit was presented. The majority of girls (95, 3%) feel that there was no discrimination against girls in the classroom. Almost all of the learners did participate in group-activities in the classroom. However, this can be attributed to the fact that group activities were compulsory. Only (33.7%) of the girls do have good parental motivation towards Science. Fewer girls (19.4%) consider the Science teacher as a role model after the implementation of the girl-friendly unit

5.3.2 Analysis of the interviews with the teachers

Pursuant to the interviews I had with the three respective teachers the following themes with regard to girl-friendly science have crystallized.

Textbooks

All three of the teachers agree that the textbooks must present both male and female gender fairly. The reason for this is that the image that both boys and girls receive in school shape their self-perceptions and views of themselves. It also shapes what they grow up to be in society. Teacher 2 states that textbooks have relative durability as a pedagogical resource. He claims that they last for several years. "Some are used for over 10 years before they are changed." Teacher 3 agrees that textbooks present models of people. They present behaviour and thought patterns, which they imply, are good to copy. The three teachers have identified the following range of benefits of textbooks:

- It is a source of information.
- It is image forming.
- It shapes attitudes.
- It shapes learning.
- It shapes teaching.
- It is an agent of socialisation.
- It is a basic tool for access to approve and long-time knowledge.

Textbooks are further used as a basis in order to comply with the curriculum as well as for purposes of a theoretical platform. The textbooks also provide examples of experiments and definitions, but are not the only source of information. At this particular school material from the Internet and library are also employed. This is due to the fact that textbooks are regarded as poorly illustrated, not attractive to learners, have limited information, are generally outdated and most of the time in a bad condition.

However, teachers also agree with literature that illustrations and practical examples in the science curriculum concentrate mainly on the interests of boys and indicate a gender bias in image portrayal of women in textbooks. According to one study carried out in Kenya, (Obura 1990), it was found that women are nearly invisible in textbooks, even in agriculture where they are very productive and contribute much of the labour.

In another study by Jacklin et al (1992) based on stories sampled from the first three grades of the readers by four major publishers, it was found that boys displayed aggression, physical exertion and problem-solving behaviour while girls were engaged in fantasy, following orders or making statements (positive or negative) about themselves.

Kalia (1980) also analysed the images of men and women in Indian textbooks. The study revealed that males were the exclusive leading factors in 75% of the lessons with women taking precedence in only 7% of the lessons. Females were most often described for their beauty, obedience and self-sacrifice.

Men were most often described for bravery, intelligence and achievement. A total of 463 occupations in the textbooks were counted and of these 84% were filled by males and 16% by females. Therefore, instead of fostering the basic equality between men and women, the messages given to schoolchildren in textbooks sanction the dominance of males. Instead of freeing individuals from conformity to sex roles, the textbooks fortify a sex-division of labour. It is a recognized fact that it is unscientific to divide tasks and subjects on the basis of gender and regard them as either masculine or feminine. In misrepresenting the real world, these texts promote the perceived wisdom that women are not competent, active citizens and deprive schoolgirls of positive role models. This perpetuates a stereotyping, and erroneous view that women contribution to the economy is marginal. Though the texts that we use may or may not succeed in teaching the formal curriculum, they are successful reinforcers of the informal curriculum. It is interesting to note that even textbooks for supposedly objective subjects such as mathematics are also blatant in their gender stereotyping. For example, a study of sixth grade texts from 1963 - 1974 (Seeman 1974) found that females were significantly under-represented and engaged in a different array of behaviour than males. The behaviour characteristics of the females include sewing, house keeping, food preparation, food buying and enjoying music.

Despite the aforementioned, teachers admit that they adhere to the current curriculum and do not take their own initiative to deviate from the prescribed curriculum and refrain from conducting a more girl – friendly approach towards science. "Why change something that works?" as Teacher 3 puts it.

Academic Achievement

Notwithstanding the aforementioned teachers believe that girls generally perform better academically in science than boys. Teachers believe that this is the consequence of girls being more responsible and mature at this particular stage. In kindergarten, boys and girls do equally as well in tests of reading, general knowledge, and mathematics. Teacher 1 attributes it to the assumption supported by research (Gornman, 2004) that girls have slightly better reading skills than boys. All three of the teachers agree that the main cause for learners to lose marks during the exam, are the fact that the learners did not understand a question. As Teacher 1 stated "It is because they (learners) do not read anymore." In conflict to the findings of Oakes (1992), Teacher 3 feels that girls are motivated by tasks that are unfamiliar, difficult or perceived to require high ability. Girls are also regarded to be more competitive than boys at this stage of their lives and possess a greater willpower to achieve. However, Teacher 1 feels that if girls fail, they tend to internalise their failure, which can lead to a negative self-image. All three of the teachers support the research (Orenstein, 1994) that there is a general decline in school performance among girls as they enter adolescence. Teacher 2 feels that as girls become more aware of their body, they experience greater stress and are more likely to be depressed. She also suggested that teachers should make an effort to read between the lines to discover where real problems, if any, may occur.

Classroom practice

All three of the teachers made an emphatic point that they are not discriminating against girls in the classroom. However, the observations of two of the three teachers proved the above to be erroneous.

Teacher 1 even made the sexist remark that "The only thing that you girls want to do is chat about make-up and nonsense" (See section 6.2.4). Although informed differently prior to the implementation by the researcher, the boys were spoken to more frequently and asked to answer higher order questions by Teacher 2. Furthermore, girls were constantly discouraged from active participation by verbal and non-verbal means such as gaze aversion, delayed feedback, interruptions and the withholding of active listening responses like nods.

Although Teacher 3 did give some girls the opportunity to answer questions, he always asked the same girls to answer. He furthermore made the comment that although teacher-centred instruction, in which knowledge is presented in isolation, is not learner-friendly; it is conducive to a well-disciplined environment. Some boys even remarked that the certain activities were "boring and womanish" - so that Teacher 3, having already enough trouble with the boys' discipline, did not insist on their participation.

However, in accordance to Tobin and Garnett (1987) group discussions was one of the activities that contributed mostly to science learning. In all of the classes it seemed to have had a positive influence on the girls since it gave them the opportunity to carry out practical experiments instead of just taking records. One of the girls even made the remark "This is so cool!" The cooperative learning-groups, in which the roles were well defined and rotated, gave every learner the opportunity to exhibit his/her competence in a variety of ways.

Teacher 1 feels that there is a lot of scope to enhance the appeal and attractiveness of science in the curriculum. "Science can sometimes be dull and boring, especially to girls." He also mentioned that girls tend to respond better to science if the scientific knowledge is linked to important societal issues. The other teacher (T2) feels that the curriculum should be presented in a manner that falls within the scope of interest of all learners, especially girls. The teachers also feel that the Science Curriculum should be relevant and contemporary and should keep track with scientific development. Teacher 2 feels that such a curriculum should contextualise the scientific facts and connects science to the lives of students. Although all of the teachers feel that the learners should be exposed to female role models, not one of them presented learners with the opportunity to do so.

5.3.3 Analysis of the written reports by science teachers

In order to protect the researcher from biasness, I did not implement the unit myself. The complete unit was handed to three different science teachers for implementation to separate the research from my teaching task. This helped me to make a comprehensive analysis of the practical feasibility of the unit. As already mentioned in section 4.6, the lesson plans were verified by the Head of Department to ensure the correct standard with regards to the requirements of the Revised National Curriculum. The three science teachers were also asked to write a report on how they experienced the unit and girl-friendly related issues (Appendix H).

According to the report by Teacher 2, the girls found the girl-friendly unit to be challenging and enjoyable. The girls put in a lot of effort, especially with the written assignment. They enjoyed the practical experiments very much and cooperated very well. Teacher 1 states that there were less conflict between the different group members than normal and he attributes it to the fact that the learners were often grouped into homogenous groups, based on gender. It gave girls the opportunity to conduct the experiments themselves and to experience the notion of "doing science".

The teachers were informed to concentrate on providing girls the opportunity to answer the questions in the classroom discussions as well as to assign tasks that challenge traditional stereotypes — for example, have a girl lead a practical activity while a boy takes notes. This had a negative effect on the boys and remarks like "this is unfair" were constantly heard. An interesting aspect that emerged from the unit was that some of the girls, who normally did well, did not perform as well in this unit. The teachers attribute this to the fact that this unit was practically orientated, and the learners were not used to practical work. Teacher 2 wrote that an important problem with the implementation of the unit was the lack of enough time. "There is already too little time to cover all of the topics in the science curriculum." She attributes it to the demanding full programme of extra curricular activities during the year. The teachers further commented that the girl-friendly unit was of a high standard and they would like to implement such a unit again.

5.3.4 Analysis of the observations of the three science teachers

As mentioned in section 4.4.2 a comprehensive observation was conducted on each of the three different science teachers. The researcher acted as one of the two observers (Observer 1). In order to protect the researcher form being bias, the Head of Department: Science and Technology acted as a second observer (Observer 2). The observations, focussed on the facilitation and implementation of the girl-friendly science curriculum.

To observe the implementation of the girl-friendly unit, observation sheets (Appendix D) were employed.

The observation sheets included the following criteria:

- Did the teacher create a positive learning climate?
- Logical progression
- Were the Girl-friendly unit correctly implemented?
- Were learners exposed to female role models during class interaction?
- Discipline.
- Were girls actively involved in science class?
- Did girls actively participate in the practical experiments?
- Did girls ask questions in the science classroom?
- Were girls asked to answer questions?
- Were girls involved in the set tasks?
- Realisation of learning outcomes.

The scores for the three different teachers were determined from an evaluative scale producing a range of 0 (Not applicable); 1(Needs improvement); 2 (Acceptable), but certain aspects need to improve; 3 (Good); 4 (Excellent).

Teacher 3 scored the lowest marks from both of the observers. All three of the teachers scored relatively high marks with regard to the correctness of information and content. However, not one of the teachers made use of extra resources, in order to expose the learners to female scientists.

GRADE: ***5***

LEARNING AREA: ***SCIENCE***

DATE: ***04 - 07 – 2005***

OBSERVER 1: **-HED**
OBSERVER 2: **-Researcher**

* Scale: 0 = Not applicable; 1 = Needs improvement; 2 = Acceptable, but certain aspects need to improve; 3 = Good; 4 = Excellent

ASSESSMENT CRITERIA		**SCALE**					
		Observer 1			**Observer 2**		
		Teacher 1	**Teacher 2**	**Teacher 3**	**Teacher 1**	**Teacher 2**	**Teacher 3**
Facilitation	Introduction / creating a learning climate	3	3	3	3	2	2
	Logical progression	4	2	3	4	1	2
	Correct implementation of the girl-friendly unit	4	4	4	4	3	4
	Resources: Exposure to female role models	4	4	4	4	4	4
	Discipline	3	3	2	3	2	1
	Girls are actively involved in science class.	4	4	2	4	2	1
	Girls actively participate in the practical experiments.	3	3	2	3	2	1
	Girls ask questions.	3	2	2	3	2	2
	Girls are asked to answer.	3	2	3	3	2	2
	Girls are involved in the set tasks.	3	2	3	3	2	2
	Realisation of learning outcomes.	4	4	4	4	3	4

There were almost no learner-involvement in the class of Teacher 3, and excellent learner involvement in the class of Teacher 1. Teacher 3 did not create a positive learning climate and much time was wasted in administrative and disciplinary tasks. Teacher 1 and Teacher 3 managed good discipline in the class. Teacher 3 appeared confident but a bit authoritarian. In the classes of Teacher 2 and Teacher 3, prominent boys mainly yelled the answers out and almost no girls were asked to answer the questions. In the class of Teacher 3 the girls were not involved in the set tasks, since it was a teacher centred lesson; lecture dominated. There were display material, but the teacher only demonstrated. The learners (boys and girls) were not allowed to experiment on their own.

Subsequently, in order to get a better understanding of the influence of classroom practice on the attitude of girls towards science, a more comprehensive observation was conducted on the teacher who scored the lowest marks from both of the observers (see observation record Appendix E).

5.4 Conclusion

In order to determine whether the implementation of a girl-friendly science unit had an effect on the attitude of girls towards science an empirical study was conducted as part of the study. Data was collected through various instruments. In this chapter, the results of the data were analysed by means of the approach of Rubin and Rubin (1995) in order endeavour to answer the research questions.

CHAPTER 6

FINDINGS

6.1 Introduction

The purpose of this study was to determine whether the implementation of a girl-friendly science unit had an effect on the attitude of girls towards science. To determine the above, a checklist, which consisted of girl-friendly criteria evident from literature, was utilised. The complete unit was then handed to three different science teachers for implementation. All three of the teachers attended a workshop, facilitated by the researcher, in order to reach an agreement on what is meant by 'girl-friendly' classroom practice and teaching strategies.

Attitudinal measures, performance measures (to assess an individual's ability to perform on an achievement test, intelligence test, aptitude test, interest inventory, or personality assessment inventory) and behavioural observations of the teachers and learners were utilised to answer the main research questions. Instruments such as questionnaires and observation sheets were used to collect data.

Throughout the study certain aspects became evident as having an influence on the attitude of girls toward science. These aspects will be discussed under the following headings:

- Classroom practice
- Girl-friendly learning material
- Other school factors that influence the attitude of girls towards science

6.2 Classroom practice

From the questionnaires and interviews with the girls it became evident that the behaviour and teaching practices of the teachers were two factors that had an important influence on their attitude towards science. Only 57% of the girls described their attitude as positive towards their Science teacher. The teachers, on the other hand, were generally unaware of gender differences in classroom participation. Even when the researcher raised the issue during the interviews, they considered such differences to be the expected norm and were not quite sure how to address these issues. Teacher 2 even made remarks such as "Boys will be boys and girls will be girls, that's just the way it is". The female teacher seemed to have a better in-class relationship with the learners. However, according to the results of the questionnaire it seemed that fewer girls like their science teacher (male or female) after the implementation of the girl-friendly unit. A possible reason for the above might be the fact that the learners had a better understanding of the term 'role model' after the implementation of the unit. One of the assignments required the learners to study prominent women in science who can be considered a role model (Appendix A.b). As one girl pointed out "I didn't know that (female) scientists could be so cool!"

The observations substantiated that the male teachers paid more attention to the boys than the girls. One of the possible reasons for this relates to the ill-disciplined conduct of some of the boys. Despite the above the majority of the girls (95, 3%) feel that there was no discrimination against them in the classroom. This perception by girls, can however be attributed to a lack of knowledge on discrimination and on how it manifested in the teachers' behaviour. It is therefore suggested that the learning material as well as teaching strategies should also address out-of-school matters such as social norms and values. Accordingly, patriarchal environments should be avoided at all cost (Mahlase, 1997).

Practical Experiments

In the development phase of the girl-friendly unit, the researcher endeavoured to improve the self-confidence and the self-perceptions of the girls' ability to do science by stipulating that they should be provided with the opportunity to conduct practical experiments themselves (Matkins, 2004). The researcher concentrated on the development of assignments that challenge traditional stereotypes -for example, have a girl lead an experiment, while a boy takes notes. The researcher furthermore instructed the teachers to deliberately involve girls in the science lessons, although it did not mean that the boys had to be ignored altogether (Hammrich, 1998). However, this was not a good idea, for the reason that it had a negative effect on the attitude of the boys and the male teachers. Teacher 3 commented that some of the boys even refused to cooperate, since the girls were always prompted to answer questions. This was the case for all three teachers.

Difficult as it is to believe, this was the learners' first experience with practical experiments in the classroom. According to one of the teachers the reason for this is a lack of laboratories and apparatus at the school. This resulted in more demonstration experiments from the teachers than planned and also had the effect that the girls did not have enough opportunity to conduct the experiments individually. A cause for concern is that the information pertains to a financially strong school in a privileged area. One wonders what the situation would be like in an under privileged school. It is thus important to develop programs that focus on alternative methods of conducting experiments, such as the use of improvised, low cost apparatus. However, the introduction of pedagogic innovations and performing experiments in the classroom requires time, patience, the setting of long-term objectives and especially the willingness to do painstaking and unspectacular grass root preparation activities.

Despite the above problems, the girls participated very eagerly and mostly enjoyed their time in the laboratory. At first they seemed to lack confidence, but later on enjoyed it very much (according to the self-assessment rubrics). One of the teachers stated that the girls enjoyed the unit very much, since it gave them the opportunity to conduct the experiments themselves and to experience the notion of "doing science". The fact that the girls had the opportunity to conduct the practical experiments themselves also provided them with access to science equipment, which is a prerequisite for girl-friendly science (Knuth, 1991).

The use of familiar materials i.e. teaspoons, paperclips, butter etc. made the experiments more accessible and familiar to the girls. It furthermore had the effect that many experiments could be performed in a short time, often with no financial input or long sessions of preparation. The teachers enjoyed the notion of incorporating the "fun" element into the curriculum. By introducing the unit through a range of enjoyable girl-friendly learning activities, the content became more relevant to the girls.

As suggested by Boaler (1998), the researcher further encouraged the teachers to use less traditional organisation and teaching practices in the classroom. The learners were therefore divided into homogenous groups based on gender, which gave the female learners the opportunity to interact with other girls who are interested in the physical sciences. This had a positive effect on the girls and almost all of the girls participated actively in group-activities in the classroom. However, this can be attributed to the fact that group activities were compulsory and counted for the term mark. During the interviews with the three teachers it became evident that there are often conflict and competition between the boys and girls. However, according to Teacher 3, the fact that the learners were grouped into homogenous groups resulted in less conflict between the different group members than normal (fixed groups of boys and girls).

6.3 Girl-friendly Learning material

During the design phase of the girl-friendly unit (which consisted of a unit plan, teaching strategies, lesson plans, as well as the different assessment instruments) the researcher concentrated on matters that marginalize girls in the science class. This was done in an attempt to have a positive influence on the attitude of girls towards science. The researcher concentrated on gender differentiation in education, educational outcomes, the impact of school factors on female education and teaching practices.

Clark (1991) states that learning support material should expose learners to female role models and that it should provide opportunities for the learners to interact with other women scientists. The girl-friendly unit exposed the girls to female role models through a written assignment on prominent women in the mining industry, and by arranging for a field trip to a nearby mine where women are employed. The activity intended to emasculate and demystify (Longbottom, 2002) science for the girls, especially a 'male' topic such as Mining. The girls seemed to have enjoyed it very much and remarks like "I didn't know that women could be so strong" were commonly heard.

As mentioned earlier, a rather unforeseen aspect that became evident in this study is that fewer girls (19.4% compared to the 29% prior to the implementation) considered the science teacher as a role model, after the implementation of the girl-friendly unit. It is suggested that further research needs to be conducted on the reason for this phenomena.

Szpitun (1999) states that the emphasis of girl-friendly science should be on presenting science to girls as beautiful, enjoyable, accessible and necessary where possible. The activities, in the learning material were selected for this particular rationale. From the observations and literature (Crombie, 1999) it became evident that the girls predominantly enjoyed the type of activities that included aesthetic elements such as jewellery design and the structure of other household items. One of the girls even said "It is so cool that I am allowed to bring my jewellery case to the science class!" This in turn had a positive effect on their attitude towards science. The girls also enjoyed the debate against the boys. One girl stated that it gave them a feeling of "girl-power". During the group-discussions it became apparent that the girls appreciated the fact that they were allowed to experience science for themselves and one girl pointed out that "This is so much better than to sit in front of the boring books all the time." This however can be attributed to the fact that this was the first time that they had the opportunity to conduct practical experiments.

Literature indicates that clear instructions should be provided for each activity (Heeter, 1994) and that activities should allow the learners to draw their own conclusions (Riddell, 1992). The scores of the girls on the written assignments confirmed this claim (Appendix B.2). The girls performed better in the written assignment than the boys. Teacher 1 stated that at first, all the learners struggled to interpret, edit and apply information accumulated from the various sources. But once the learners were exactly instructed where and how to start their search for information, the girls put in a lot of effort and reacted very positively on the written assignments as was evident in their portfolios (Appendix A).

During the post-test (Questionnaire C) it became apparent that the learners enjoyed the girl-friendly curriculum very much. More than half of the learners (64%) described their attitude as acceptable towards Science in general. However, 53% of the respondents of the girls described their attitude as positive towards the new science curriculum unit. Pursuant to the questionnaire it became evident that girls appreciated the opportunity to do hands-on science. The majority (74, 7%) of girls in this study preferred the girl-friendly, practical manner in which the unit was presented. Although literature indicates that all learners appreciate hands on activities, the girls predominantly enjoyed activities that had a more girl-friendly approach (e.g. the activities that concentrated on different alloys used in jewellery, had a more 'crafty feel' to it). Since the study concentrated on girls, the researcher refrains from commenting on whether the abovementioned had a similar influence on the boys.

A problem that arose during the implementation phase of the girl-friendly science unit was the lack of planning by one of the teachers. Teacher 2 did not sufficiently plan and conduct one of his lessons according to the girl-friendly requirements of the lesson plans. Furthermore, the unit could not be completed in time due to the various contingencies inherent to school activities (e.g. Spring Sports day, Entrepreneurial day, Inter Class Dance competition etc).

6.4 School factors that influence the attitude of girls towards science

Although this section does not directly relate to the girl-friendly unit, it is significant to discuss, since there are indeed other factors that have an effect on the attitude of girls towards science. One of the most important constraints that manifested throughout the study in the classrooms was the attitude of girls towards marks. Activity 2 stated that learners had to choose a specific metal mine in South Africa and conduct an investigation on how metal deposits are allocated as well as the different methods of mining. The girls encountered a couple of problems with this assignment. The first comment following the announcement of the assignment was directed towards how this assignment would affect their marks. An interesting phenomenon that became apparent during this research was that learners, who usually performed well, failed to perform in the same way during the set summative test. The different teachers contributed this to the fact that the summative test was based on the practical work and not on mere memorisation. German (1994) theorised that attitude towards biology in school, directly influence the academic performance of learners. This became evident from the post-test and the self-assessment rubrics, since the girls who scored higher marks for the test and the written assignment indicated to have a positive attitude towards science.

6.5 Limitations

The following limitations manifested throughout the study:

6.5.1 Developmental limitations

- This unit was practically orientated, and the learners were not used to practical work. Difficult as it is to believe, this was their first experience with practical experiments in the classroom. According to one of the teachers the reason for the absence of practical work can be contributed to a lack of laboratories and apparatus at the school. This resulted in more demonstration experiments from the teachers than planned which had the effect that the girls did not have enough opportunities to conduct the experiments individually.
- The girl-friendly learning support material was limited to no more than a unit, and was not applied to the whole curriculum.
- The study focussed on girls, the researcher therefore did not determine what influence the girl-friendly unit had on the attitude of boys towards science.

6.5.2 Implementational limitations

- The researcher recognised the fact that literature clearly states that no curriculum can be "teacher proof" (Cuban, 1993). However, although all three of the teachers attended a workshop on girl-friendly classroom practice and teaching strategies, the teachers did not always follow the prescribed teaching strategies as advised. They furthermore did not always implement the girl-friendly unit according to the requirements of the LSM.
- An additional problem that arose during the implementation of the girl-friendly science unit was the lack of proper planning and presentation by one of the teachers. This confirmed literature that a lack of proper planning and preparation can have a negative influence on the attitude and behaviour of learners in the class situation (Abdullah, 2001).
- Another important problem that manifested during the implementation phase of the unit was the lack of enough time to complete it. The teachers attribute it to the demanding full programme of extra

curricular activities, such as the various school sports during the year. In addition, they argued that although it is a noble idea to implement a girl-friendly unit, there is already too little time to cover all of the topics traditionally taught in the science class.

6.5.3 General limitations

- One of the teachers (Teacher 2) was also the Head of Department of Sports. This posed a problem, since it kept him busy with administrative tasks, and therefore he could not fulfil his academic duties properly.
- The learners were only in Grade 5 in the GET-phase, and as mentioned earlier, young children often provide answers that they think the teacher wants to hear and not always a true reflection of their own opinion. This manifestation is also true for self-reporting data generation instruments (Klawe & Phillips, 1994).
- Two of the teachers were male teachers and it was difficult to convince them to buy into the concept of *girl-friendly science.*
- Although the researcher instructed the teachers to deliberately concentrate on involving girls in the science lessons, it did not mean that the boys had to be ignored altogether. All three of the teachers did not comprehend to this principle and therefore did not pay any attention to the boys.
- As mentioned above, the fact that the study focussed on girls had a negative effect on the attitude of the boys and on one of the male teachers. One of the teachers even thought that the girl-friendly unit was a form of reverse discrimination.
- The reaction of the boys towards the girl-friendly unit posed an added problem. Some of them reacted negatively towards some of the activities. As a result, the teacher did not always insist on their participation as he/she already had enough trouble with some of the boys' discipline.

6.6 Recommendations

If this program Mining of Metals would be implemented next year as an ongoing action research project, I would like to make the following suggestions on how to positively influence the attitude of girls towards science.

6.6.1 Recommendations for future research

- It is recommended that research should be conducted to find out which educational practices promote a positive attitude amongst girls.
- Publicise science role models who counteract the stereotypes and whose stories are examples of career success and leadership positions.
- Future research on the influence of a girl-friendly unit on the attitude of boys towards science should be conducted.
- Further research needs to be conducted on why fewer girls considered their science teacher as a role model after the implementation of the girl-friendly unit.
- Further research needs to be conducted on whether it is possible for young girls (Grade 5) to consider a male teacher as a role model.

6.6.2 Methodological recommendations

- Teachers, both male and female, should be made aware of the impact of their attitudes and teaching practices on the educational outcomes by gender. Few studies have been conducted to address this issue in depth.
- Teachers should not only use the whole-class discussion format in the science class. Many students, including girls, are more comfortable speaking up in small group settings or when working in pairs (Sadker and Sadker, 1994).
- Teachers should be encouraged to use learning material that celebrates the accomplishments of women. Girls and women should be portrayed in non-stereotypical ways in science books. The National Equity Resource Centre in the U.S. conducted a survey on 1 000 different textbooks in 1999. According to the report published by the centre (1999) the situation are problematic. Less than three percent of the content in the textbooks focused on women, 75% of the illustrations depicted males.

- Teachers need to be trained in gender-sensitivity methodologies. This can only be achieved if we incorporate gender-sensitivity training for teachers in the pre-service and in-service training programmes.
- We need to increase the number of female science teachers in an attempt to rectify the under representation of women in science.
- Learners should be exposed to prominent women in the field of science who can act as possible role models to girls; this will result in a positive attitude of girls towards science.
- The unit should not be referred to as girl-friendly to prevent a negative reaction from boys and male teachers.
- More time should be allocated for the completion of the unit.
- The emphasis on fostering girl-friendly science cannot take place in one or two classrooms, but must permeate the academic culture of a school (Lumsden, 1994).

6.7 Conclusion

It can be concluded that two main aspects, namely a girl-friendly unit (Learning support material) and the implementation (classroom practice of the teachers) of the unit had an effect on the attitude of girls towards science.

With regards to the girl-friendly unit, the results of the empirical study suggested that the girl-friendly learning support material had a positive effect on the attitude of girls-towards science. The results of the study confirmed the statement by Baker & Leary (1995) that science should be meaningful to young women. The girls appreciated the opportunity to do hands-on science in a girl-friendly manner. According to the teachers it provided a context and rationale for learning facts and theories and furthermore connected science to the everyday lives of girls. In addition, it seemed that the girls also enjoyed the idea that scientific knowledge was closely linked to important societal issues (such as economical impact of mining vs. the social impact of mining). It also presented the girls with real-world problems that can be solved by an entire class. They were furthermore exposed to female role models and were presented with opportunities to explore different careers in science.

However, the learning material was not the only factor that had an influence on the attitude of girls towards science. According to the girls, the teachers' behaviour and classroom practice had an even greater influence on their attitude towards science. The observations of the three different teachers revealed that two of the three teachers were still discriminating against girls in a very subtle manner. The fact that one of the teachers felt that the girl-friendly unit were a form of reverse discrimination filtered through to the boys which in turn posed some disciplinary problems.

Finally, the challenge to influence the attitude of girls positively towards science, appear to be more than merely implementing a girl-friendly unit. Teachers, administrators, and school communities should all work together to promote the development of girl-friendly science in order to encourage girls to take science subjects. Only when women participate fully as active learners in the classroom, as researchers in the laboratory, as science teachers and lecturers, as scientific leaders in society and as policy makers, they will feel equal partners in a technological society.

REFERENCES

Abdullah, M. H.(2001). *Self-directed learning.* ERIC Digest. Bloomington, IN: ERIC Clearinghouse on Reading, English, and Communication.

Acker, S., & Oatley, K. (1993). *Gender issues in education for science and technology: Current situation and prospects for change.* Canadian Journal of Education, 18, 225-272 .

Adhiambo, O. 1995. *Girls and schools in Sub-Saharan Africa: From Analysis to Action.* Washington D.C: The World Bank.

Alvermann, D. E., & Hynd, C. R. 1989. *Effects of prior knowledge activation modes and text structure on nonscience majors' comprehension of physics.* Journal of Educational Research, 8(2), 97-102.

Amara, J.M. 1987. *Indigenous Technology of Sierra Leone and the Science Education of Girls.* International Journal of Science Education, 9(3) p 317 – 324.

American Association of University Women. 1991. *Summary: Short changing girls, short changing America.* Washington D.C.

Anderson, Levitt, K., M., & Bloch, A., & Soumare, 1994. *"Inside Classrooms in Guinea: Girls' Experiences."* Washington D.C: The World Bank.

Ausubel, D. P., Novak, J. D., & Henesian, H. 1978. *Educational psychology: A cognitive view.* New York, NY: Holt, Rinehart and Winston.

Ausubel, D. P. 1963. *The psychology of meaningful verbal learning.* New York, NY: Grune & Stratton.

Ausubel, D. P. 1966. *An evaluation of the BSCS approach to high school biology.* The American Biology Teacher, 27, 176-186.

Baker, D., & Leary, R. 1995. *Letting Girls speak out about science.* Journal of Research in Science and Teaching Vol. 32 No. 1 January 1995.

Baker, R.W., & Siryk, B. 1989. *Student adaptation to college questionnaire (SACQ)* Los Angeles: Western Psychological Services.

Banks, James. 1988. *Multiethnic Education Theory and Practice, Second Edition.* Allyn and Bacon, Inc., Boston.

Barr, R., & Dreeben, K. 1983. *How schools Work: Chicago, Ill,* University of Chicago Press.

Bellew, R., & King, E. 1991. *Promoting Girls' and Women's Education: Lessons From the Past.* Policy, Research and External Affairs, WPs 715. Washington D.C: The World Bank.

Bauersfeld, H. 1995. *The emergence of mathematical meaning: Interaction in classroom cultures* (pp. 271-289). Hillsdale, NJ: Lawrence Erlbaum Associates.

Barr, R. B. & Tagg, J. (1995, November/December). *From teaching to learning--a new paradigm for undergraduate education.* Change Magazine, 27 (6): 12-25.

Becker, J.R. *Differential Treatment of Females and Males inMathematics Classes* Journal for Research in Mathematics Education, Vol. 12, pp. 40-53 (1981).

Berger, P. L. 1979. *The heretical imperative: Contemporary possibilities of religious affirmation.* Garden City, NY: Anchor Press.

Berger, P., & Luckmann, T. 1967. *The social construction of reality.* New York, NY: Doubleday.

Bengu, S. 1997. *Curriculum 2005 and its objectives.* Cape Town: ANC newsletter.

Boaler, J. 1998. *Open and Closed Mathematics: Student Experiences and Understandings.* Journal for Research in Mathematics Education 29(1): 41-62.

Brannen, J. 2005. *Biographical Interviews Report: UK Social Services,* Thomas Coram Research Unit.

Brewer, J.,& Hunt, A. 1989. *Multimethod research: A synthesis of styles.* Newbury Park, CA: SAGE Publications.

Brock, C., & Cammish, N.K. 1991. *Factors Affecting Female Participation in Education in Six Developing Countries.* London: ODA.

Britton, J., & Gilmour J., *The Weakest Link,* Science Council of Canada, Ottawa, 1978.

Canadian Initiative on Social Statistics. 1991. Social Sciences and Humanities Research Council of Canada.

Capra, F. 1982. *The turning point: Science, society, and the rising culture.* New York, NY: Simon and Schuster.

Cazden, C. *Review of Research in Education* No. 16. P153 - 222. Washington D.C: American Educational Research Association.

Chandrasekhar, M., Phillips, K. A., Litherland, R., & Barrow, L. H. 1999. *Science interests and experiences for high school girls in a summer integrated program.* Boston, MA: National Association for Research in Science Teaching.

Chisholm, L.; McKinney, C. 2003. *Reforms, innovations and approaches used to work with teachers to use them as change agents and facilitators* *of gender equality in different countries: strengths and limitations.* EFA Global Monitoring Report 2003/4.

Cheek, D.W. 1992. *Thinking Constructively about Science, Technology, and Society.* Albany, NY: Albany State University of New York Press.

Clark, M.L. 1991. *Social identity, peer relations, and academic competence of African American adolescents.* Education and Urban Society, 24(1), 41-52.

Clewell, Beatrice Chu & Andersen, Bernice. *Women of Colour in Mathematics, Science and Engineering: A Review of the Literature.* Centre for Women Policy Studies. Washington, D.C., 1991.

Cobern, W. W. 1992. Contextual constructivism: *The impact of culture on the learning and teaching of science.* In K. G. Tobin (editor), *Constructivist perspectives on science and mathematics education.*
Cobern, Wm. W. 1994. *World view, culture, and science education.* International Science Education, 5(4), 5-8.

Colclough, C., Lewin, K.M. 1993. *Educating All the Children: Strategies for Primary Schooling in the South.* Oxford: Clarendon Press.

Craig, J. 1992. *Comparative African Experiences in Implementing Educational Policies.* Discussion Paper No. 83. Washington D.C. The World Bank.

Cresswell, J.W. 2003. Research *Design: Qualitative, Quantitative and Mixed Methods Approaches.* United States: Sage Publications.

Croft, A.C. 2000. *A guide to the establishment of a successful mathematics learning support centre*, Int. J. of Math. Educ. in Sci. & Tech. Vol. 31, No. 3 pp431-446

Crombie, G. 1999 *Research on Young Women in Science,* Promoting High Technology for Girls. Oxford.

Creswell, J. W.1994. *Research design: Qualitative and quantitative approaches*. Thousand Oaks, CA: Sage.

Chisholm, L. 2000. *A Curriculum for the Twenty First Century: Report of the Review Committee on Curriculum 2005* (presented to Prof Kader Asmal, Minister of Education. 31May 2000

Cuban, L. 1993. *The Lure of Curricular Reform and its Pitiful History*. Phi Delta Kappan, 182-185.

C2005: Revised National Curriculum Statement: Grade 4-6 (schools): intermediate Phase. Pretoria: Department of Education. 2004.

Dave, L.: 1988. *Science as a Process: An Evolutionary Account of the Social and Conceptual Development of Science.* Chicago: The University of Chicago Press.

Davidson, K (1995) *Education in the Internet: Linking theory to Reality*, Ontario Institute for Studies in Education.

Denno, D. 1981. *Early Cognitive Functioning: Sex and Race Differences.* Paper presented at the Annual Meeting of the American Psychological Association.

Dever, M. 2001. *'I don't know where this will take me'. Rethinking study/work relationships for women's studies students*. Women's Studies Quarterly, 30, 3/4, 256-269.

Driver, R. 1989. Students' conceptions and the learning of science: Introduction. International Journal of Science Education, 11(5): 481-490.

Driver, R. & Easley, J. 1978. Pupils and paradigms: a review of literature related to concept development in adolescent science students. Studies in Science Education, 5, 61-84.

Education White Paper 3 (1997). A Programme for the Transformation of Higher Education. Department of Education, Pretoria. (also available on Government Publications web site).

Eshewani, G.S. 1982: *A Study of Women's Access to Higher Education with Special Reference to Science and Maths Education*. Working Paper 5003. Nairobi: Kenyatta University, Bureau of Educational Research.

Eltis, K. 1995, *Focusing on Learning: Report of the Review of Outcomes and Profiles in New South Wales Schoolin,*. Department of Training and Education Coordination, Sydney.

Fischer, G. 1998. *Beyond 'Couch Potatoes': From Consumers to Designers*. Paper presented at the 3rd Asia Pacific Computer Human Interaction Conference, Kanagawa, Japan.

Frieze, I. H., Whitley, B. E., Hanusa, B. H., & McHugh, M. C. (1982). *Assessing the theoretical models for sex differences in causal attributions for success and failure. Sex Roles*, 8 (4), 333-343.

Franklin S, 2002. *Supporting student learning: the use of computer-based formative assessment modules*, British Journal of Educational Technology, 33 pp515-523,

FAWE, 1994. Girls *Education: An Agenda for Change*. Forum for African Women Educationist, Nairobi.

Gardener, M. 1990. *Towards a Scientific Practice of Science Education*. Lawrence Erlbaum Associated, New Jersey,

Gathu,K. 1998. *The Search For Gender Sensitive Curriculum And School Practices: Future Directions* . African Council for Communication Education:Nairobi. 9. (3).

Gergen, K.J. 1997. *Constructing constructionism: Pedagogical potentials, Issues in Education:* Contributions from educational psychology, 3(2), 195-202.

German, P. J. 1994. *Testing a model of science process skill acquisition: An interaction with parents' education, preferred language, gender, science attitude, cognitive development, academic ability and biology knowledge.* Journal of Research in Science Teaching, 31(7), 749-783.

Gilligan, C. 1982. *In a Different Voice.* Cambridge, MA: Harvard University Press.

Gorman, M. E. (2004). Collaborating on Convergent Technologies: Education and Practice. In M. C. Roco & C. D. Montemagno (Eds.), The coevolution of human potential and converging technologies (Vol. 1013, pp. 25-37). New York: The New York Academy of Sciences.

Grant, G. *Review of Research in Education* No. 17. P269 - 334. American Educational Research Association, Washington D.C.

Guzzetti, B.J., Hynd, C.R., Skills, S.A., Williams, W.O. 1995. *Improving Science texts: Students speak out.* Journal of Reading No. 38 P 656 - 663.

Hammersley, M., & Atkinson, P. 1995. Ethnography. *Principles in practice (2nd. ed.)* New York: Routledge.

Hull, G. 1997. *Research with Words. Cambridge, MA: National Center For the Study of Adult Learning and Literacy* (NCSALL), Focus on Basics, Volume 1, Issue A, p. 13-16.

EDDI 2000 *Mission Statement* Hampton University http:/www.hamptonu.edu/tags/usaid_mission.htm

Frieze, I. H., & Hanusa, B. H. 1984. Women scientists: Overcoming barriers. Advancements in Motivation and Achievement, 2, 139-163

Hammrich, P. L. 1998. *What science standards say: Implications for teacher education.* Journal of Science Teacher Education, 9, (3), 165-186.

Hawkins, D. 1978. *Critical Barriers to Science Learning.* Outlook, 3, 3-25.

Heeter, C. 1994. *Comparing Child and Adult Reactions to Educational VR.* Paper presented at the Meckler Virtual Reality '94 Conference, San Jose, California.

Heller, R.S. & Martin, C.D. 1994. *Attracting young minority women to engineering and science: Necessary characteristics for exemplary programs. IEEE Transactions on Education*, 37:1, p. 8-12.

Hersey, P., & Blanchard, D.H. 1988. *Management of Organizational Behavior*. Prenctice Hall: New Jersey.

Herz, B.K., Subbarao, M., Habib, & Raney, L. 1991. *Letting Girls Learn: Promising Approaches in Primary and Secondary Education*. Discussion paper No. 133. Washington D.C: World Bank.

Hoffman, Bob 1995. Distance Education: The Elusive Definition. *The Distance Educator*, Vol 1, #1.

Hopkins, D.; Ainscow, W. & West, M. 2000. *School Improvement in and Era of Change*, London: Cassell

Hyde, K. 1993. *Gender Streaming as a Strategy for Improving Girls' Academic Performance: Evidence from Malawi*. University of Malawi. Centre for Social Research.

Hyde, K. 1991. *Regional Study of Female Participation in Education.* Journal of Research in Science Teaching Vol. 20. P131 - 140.

Jacklin, C.N. 1992. *The Psychology of Gender.* Vols. 1-4. Edward Elgar: Hants.

Stockard, J. 1980. *Sex Equality in Education*. New York: Centre for Educational Policy and Development Study, University of Oregon

Jimenez, E., Lockeed, M., Paqueo, V. 1988. *The relative effi ciency of public schools in developing countries.* Policy Planning And Research Working Papers No. 72. The World Bank, Washington, DC.

Jonassen, D. 1994. *Thinking technology.* Educational Technology, 34(4), 34-37.

Johnson, E. D. 1967. *An analysis of factors related to teacher satisfaction-dissatisfaction.* Doctoral dissertation, Auburn University,

Kahle, J.B., Lakes, M.K. 1983. *The Myth of Equality in Science Classrooms.* Journal of Research in Science Teaching Vol. 20. P131 - 140.

Kahle, J.B. 1988. *Gender and science education II. In P.J. Fensham (ed.),* Development and dilemmas in science education. New York: Falmer Press.

Kahle, J.B. 1994. *Research on gender issues in the classroom. In D. Gabel (*New York: Macmillan.

Kalia, N. N. 1980. *Images of men and women in Indian textbooks. Comparative Education Review,* 24(2), 209-223.

Kant, E. 1982. *Kant's kritik of judgment.* London: Macmillan & Company.

Kemmis, S. 1988. *Action Research in Retrospect and Prospect.* The Action Research Reader, 3rd edn. Deakin University Press, Geelong, Victoria.

Kelly, G.P. & Elliot,C.M. 1982. *Women's Education in the Third World: Comparative Per-spectives.* Albany: State University of New York Press.

Kelly, A., Whyte, J., & Smail, B. 1984. *Girls into science and technology. Final report* (ERIC Document Reproduction Service No. ED 250 203). Manchester, England: GIST, Department of Sociology

Kelly, G.J.; Carlsen, W.S., & Cunningham, C.M. 1993. Science education in sociocultural context: Perspectives from the sociology of science. Science Education, 77(2), 207-220.

King, E. 1991. *Educating Girls and Women: Investing in Development. Population and Human Resources Development*. Washington D.C: World Bank.

King, E.M., Hill Anne, M. (Eds) 1993. *Women's Education in Developing Countries: Barriers, Benefits and Policies*. Washington D.C: The World Bank.

Klawe M. M. and Phillips, E. A classroom study: Electronic games engage children as researchers, in CSCL 1995, Bloomington, Indiana, 1995, pp. 209-213

Knuth, R. A. ; Jones, B. F., & Baxendale, S. 1991. *What does research say about science?* Oak Brook: NCREL .

Lafrance, T. 1991. *School for scandal: different experiences for females and males,* Gender and Education, 3(1), pp. 3-13.

Lagoke, B.A. 1992. *Analogical linkages from socio-cultural Environment and biology concept attainment by secondary school students using a constructivist framework.* PhD Thesis. Ahmadu Bello University, Zaria, Nigeria.

Larkin, J. 1994. *Walking through Walls: The Sexual Harassment of High-school Girls*. Gender and Education. 6(3) P263 - 280.

Lather, P. 1986. *Research as praxis.* Harvard Educational Review, 56(3), 257-277. EJ 342 119.

Laurel, R.W. 1977. *The Dynamics of Sex and Gender. A Sociological Perspective*. Chicago U.S.A. Rand McNally College Publishing Co.

Lawrence, H. Summers. 1994. *Investing in All the People: Educating Women in Developing Countries*. EDI Seminar paper No. 45. Washington D.C: The World Bank.

Le Compte, M.D., & Schencul, J.J. 1999. *Desighning and conducting ethnographic research.* Ethnographer's Toolkit, Number1 Walnut Creek, C.A. Altamira.

Le Compte, M.D., Preissle, J., & Tesch, R. 1993. *Ethnography and qualitative design in educational research (2nd ed.)*. San Diego, CA. Academic Press.

Lewis, M. 1986. *Girls' Education in Kenya: Performance and Prospects.*

Linn, M. C., & Hyde, J. S. 1989. *Gender, mathematics, and science.* Educational Researcher, 18, 17-27.

Lockheed M.E.; Verspoor & Associates. 1991. *Improving Primary Education in Developing Countries.* Washington D.C.: The World Bank.

Lockheed, et al 1989. *Family Effects on students' Achievement in Thailand and Malawi.* Sociology of Education. 62(4) P239 - 256.

Lockheed, M.E., Komenan, A. 1988. *School Effects on Student Achievement in Nigeria and Swaziland.*

Longbottom D. 2002, *The Need for Education and Training in the Use of the EFQM Model for Quality Management in Higher Education Institutions*, Quality Assurance in Education. p. 26-36.

Lumsden, L.S. 1994. *Student motivation to learn*. ERIC Digest, N. 92.

Maccia, E.S., Coleman, M.A. & Sheiel, T.M. 1975. *Women and Education*. Illinois U.S.A. Charles C. Thomas Publisher.

Mahlase S, 1997. *The Careers of Women Teachers under Apartheid* SAPES Books: Harare.

Matkin, G.S., & Fritz, S.M. 2004. *Teaching critical thinking in an introductory leadershipcourse utilizing active learning strategies: A confirmatory study*. College Student Journal, 38(3), 482-493.

Mbilinyi, M. and Mbughuni P. (eds) 1991. *Education in Tanzania with a Gender Perspective*. Summary Report. Dar-es-salaam / Stockholm: SIDA.

Mbilinyi, D.A. & Omari, C. 1996. *Gender Relations and Women's Images in the Media,* Dar es Salaam University Press, Dar es Salaam, p. 93-94.

Merriam, S.B. 1998. *Qualitative research and case study applications in education.* San Francisco: Jossey-Bass.

Morley, R. E. 1991. *Alternative education. Dropout prevention research reports.* Clemson, S.C.: National Dropout Prevention Center. ERIC Document Reproduction Service No. 349 652

Novak, J. D. 1977. *A theory of education.* Ithaca, NY: Cornell University Press.

Obura, A 1991. *Changing Images. Portrayal of Girls and Women in Kenyan Textbooks*. Nairobi: ACTS Press.

Oakes, J. 1992. *Grouping students for instruction. In M.C. Alkin (Ed.),* Encyclopedia of Educational Research, 6th Edition (pp. 562-568). New York: Macmillan.

Oka, T., & Shaw, I. 2000. *Qualitative research in social work.*

Orenstein, P. 1994. *Schoolgirls: Young Women, Self-Esteem, and the Confidence Gap.* New York: Doubleday.

Piaget, J. 1972. *Science of education and the psychology of the child* (Rev. ed.). New York: Viking.

Phillips, D., & Burbules, N. 2000. *Postpositivism and educational research.* Lanham, MD: Rowman & Littlefield.

Popper, K. 1976. *Unended quest: an intellectual autobiography.* Open Court Publ., La Salle.

Posner, G. J., Strike, K. A. Hewson, P. W. & Gertzog, W. A. 1982. *Accomodation of a scientific conception: Toward a theory of conceptual change*. Science Education, 66, 211-227.

Riddell, S. 1992 *Gender and the Politics of the Curriculum.* London: Routledge

Rogan, J. M. 2004. *Innovation in South African Science Education (Part I)*: Science teaching observed. Science Education 72(2): 225-236.

Rubin, H. J., and Rubin, I. S. 1995. Qualitative interviewing the Art of hearing data. Thousand Oaks, CA: Sage

Seeman, M. 1974. *Alienation, membership, and political knowledge: A comparative study*. Public Opinion Quarterly, 30, 353-367

Strommen, E. F., & Lincoln, B.1992. *Constructivism, technology and the future of classroom learning.* Education & Urban Society, 16 (4), 466-477

Sue V. Rosser. 1990. *Female-Friendly Science: Applying Women's Studies Methods and Theories to Attract Students.* New York: Pergamon Press.

Sarah, G.B. 1991. *Education in the Developing World: Conflict and Crisis.* U.K: World University Service.

Sadker , D. 1996. *Gender equity: Still knocking at the classroom door.* Equity and Excellence in education, 33(1), 80-83

Soloway, E. 1996. *Teachers are the key.* Communications of the ACM, XXXIX (6), 11-14

Stromquist, N. P. 1997. Increasing girls' and Women's Participation in Basic Education UNESCO/IIEP.

Spradley, J.P. 1980. *Participant observation.* New York: Holt, Rinehart and Winston.

Spradley, J.P. 1980. *The ethnographic interview.* Ft. Worth, T.X: Harcourt Brace Jovanovich College Publishers.

Stake, R.E. 2000. *Case studies.* Thousand Oaks, CA: Sage.

Stake, R. E. 2000. Case studies. In N. K. Denzin & Y. S. Lincoln (Eds.), *Handbook of qualitative research (2nd ed., pp. 435-454).* Thousand Oaks, CA: Sage.

Stake, R.E. 1995. *The art of case study research*. Thousand Oaks. C.A.: Sage.

Szpitun, L. 1999. *Women do math*. Womens' Education. New York: Holt, Rinehart and Winston.

Sukhnandan, L. 1999. *An Investigation into Gender Differences in Achievement Phase 1: A review of recent research and LEA information on provision*. Slough: NFER.

Sukhnandan, L., Lee, B. & Kellehr, S. 2000. *An Investigation into Gender Differences in Achievement: Phase 2: school and classroom strategies.* Slough: NFER.

Sutton, R.E. 1991. *Equity and Computers in the Schools: A decade of Research*. Review of Educational Research vol. 61 P475 - 503.

Tannen, D. 1986. *That's not What I Meant!* New York: Ballantine Books.

Tannen, D. 1991. *You Just Don't Understand.* London: Virago.

Todd, E. A. 1965. *Curriculum Development and Instructional Planning.* Nederland, TX.

Tobin, K. & Garnett, P. 1987. *Gender related differences in science activities.* Science Education, 71(1), 91-103.

Truell, G. F. 1981. *Coaching and Counseling : Key Skills for Managers.* PAY Publications, Buffalo, New York.

UN. 2000. *The World's Women 2000*: Trends and Statistics. New York: UN .

UNESCO; WHO ; UNICEF. 1992. *Comprehensive science education : suggested guidelines for action /* Geneva, Switzerland : World Health Organization, 51 p. : 16 boxes WHO/UNESCO/UNICEF/92.2

Vetter, B.M. 1992. *What Is Holding Up the Glass Ceiling? Barrier to Women in the Science and Engineering Workforce.* Occasional Paper 92-3. Washington, DC: Commission on Professionals in Science and Technology.

Vetter, B.M. 1990. *Women in Science and Engineering: An Illustrated Progress Report.* Occasional Paper 90-4. Washington, DC: Commission on Professionals in Science and Technology.

Von Glasersfeld, E. 1996.*Introduction: Aspects of constructivism. In C. Fosnot (Ed.)*, Constructivism: Theory, perspectives, and practice, (pp.3-7). New York: Teachers College Press.

Wilson, B. G. 1997. The postmodern paradigm. In C. Dills and A. Romiszowski (Eds.), *Advances in instructional design.* Englewood Cliffs .NJ: Educational Technology Publications.

Yager, R. 1991. *The constructivist learning model, towards real reform in science education.* The Science Teacher, 58 (6) , 52-57.

Yager, R. E. 2000. The history and future of science education reform. *The Clearing House*, 74(1), 51-4.

Youri, P. 1993. *Female Adolescent Health and Sexuality Study in Kenyan Secondary Schools*: African Medical and Research Foundation.

Zuber-Skerrit, O. 1992. *Action Research in Higher Education: Examples and reflections*, Kogan Page, London.

APPENDIX

MINING OF METALS

TABLE OF CONTENT

APPENDIX A

CURRICULUM UNIT

a. UNIT PLANS

TOPIC: MINING OF METALS

GRADE: 5

GROUPING: HETEROGENEOUS

SUMMARY OF THE ACTIVITIES:

Activity 1

- Learners conduct an investigation on occurrence of metal mines in Gauteng and adjacent provinces.
- Learners conduct an investigation on the employment of women in mines.

Type of activity:	➢ *Theoretical Research* (See Aktiwiteit 1)
Teaching strategy:	➢ The search for local mines makes teachers and learners aware of the resources to be found in their environment and acknowledges the importance of the local context and community. ➢ The investigation on women in mines makes learners aware of the importance of women in the mining context and community
Critical or Developmental Outcomes:	➢ *Critical Outcome 1:* Learners should be able to identify and solve problems and make decisions using critical and creative thinking
Learning Outcome:	➢ *Learning Outcome 3:* The Nature of Science and its relationship to Technology, Society

	and the Environment
Assessment Standard:	➢ Evaluate knowledge claims and science's inability to stand in isolation from other fields.
Type of Assessment:	➢ Formative Assessment
Assessment Method:	➢ Educator assessment
Assessment Technique:	➢ Research assignment marked by the teacher according to a rubric ➢ Content based work sheet marked by the educator according to a memorandum
Time:	➢ 4 days -homework

Activity 2:

➢ Learners choose a prominent women in the mining industry and conduct an investigation (based on the example "Assessing the ability to inquire" – Chapter 5 of the USA Standards) on the following:

- Type of occupation that this woman has.
- Can this woman be considered as prominent in science?
- Would you regard this woman as a rolemodel?
- Employment of women in the specific mine
- Occupational hazards for women in mining
- Different methods of mining.

Type of activity:	➢ *Practical and Theoretical Research* (See: Aktiwiteit 2)
Teaching strategy:	➢ By choosing to investigate their own mine learners are involved in co-creating instruction and all instructional experiences with their teachers and others in their learning communities. After the learners have done some research they go on a field trip that serves to stimulate and/or reinforce classroom learning.
Critical or Developmental Outcomes:	➢ *Critical Outcome 3:* Learners should be able to organise and manage themselves and their activities responsibly and effectively. ➢ *Critical Outcome 4:* Learners should be able to collect, analyse, organise and critically evaluate information
Learning Outcome:	➢ *Learning Outcome 3:* The Nature of Science and its relationship to Technology, Society and the Environment
Assessment Standard:	➢ Evaluate knowledge claims and science's inability to stand in isolation from other fields.
Type of Assessment:	➢ Summative Assessment
Assessment Method:	➢ Educator assessment
Assessment Technique:	➢ Portfolio:

	Marked by the teacher according to a rubric to assess the factual knowledge gained during the learning event.
Time:	➢ 1 week-homework With daily feedback on progress in the classroom.

Activity 3

Learners will:

- ➢ Compare the properties (conductivity, hardness, malleability, ring) of metals with other metals and with non-metals
- ➢ Organize the properties (conductivity, hardness, malleability, ring) of metals

Type of activity:	➢ *Classroom-based experiments* (See Aktiwiteit 3)
Teaching strategy:	➢ An introduction to practical science lessons by hands-on experiments. Using materials the user is familiar with, builds up confidence in experimental work. This could lead to more sophisticated experiments later on.
Critical or Developmental Outcomes:	➢ *Critical Outcome 4:* Learners should be able to collect, analyse, organise and critically evaluate information.
Learning Outcome:	➢ *Learning Outcome 1:* Practical Scientific Inquiry and problem solving skills

Assessment Standard:	➢ Plan and conduct a scientific investigation to collect data systematically with regard to accuracy, reliability and the need to control one variable
Type of Assessment:	➢ Diagnostic Assessment
Assessment Method:	➢ Educator assessment
Assessment Technique:	➢ Continuous assessment of the groups throughout the experiment by means of observation sheets to assess the laboratory skills applied. ➢ Content based work sheets marked by the educator according to a memorandum
Time:	➢ 3 x 45min periods

Activity 4:

➢ Revision of the Periodic Table:

- *Ability to identify metals and non-metals using the periodic table.*
- Ability to recognize groups of metals with similar properties and to predict reactions.

Type of activity:	➢ *Classroom-based activities* (See Aktiwiteit 4)
Teaching strategy:	➢ Educator practices integrate learning and motivational strategies to help learners become self-directed learners.
Critical or Developmental Outcomes:	➢ *Developmental Outcome 1:* Learners should be able to reflect on and explore a variety of strategies to learn more effectively. ➢ *Critical Outcome 7:* Learners should be able to demonstrate an understanding of the world as a set of related systems by recognising that problem solving contexts do not exist in isolation.

Learning Outcome:	➢ *Learning Outcome 2:* Constructing and Applying Scientific Knowledge.
Assessment Standard:	➢ Recall and state basic prescribed scientific knowledge ➢ Express and explain prescribed scientific theories and models by indicating some of the relationships of different facts and concepts with each other. ➢ Apply scientific knowledge in familiar, simple contexts
Type of Assessment:	➢ Diagnostic Assessment
Assessment Method:	➢ Peer and Self-Assessment ➢ Educator assessment
Assessment Technique:	➢ Self and Peer –assessment by means of a rubric. ➢ Content based work sheet marked by the educator according to a memorandum
Time:	➢ 3 x 45min periods

Activity 5

Learners will:

➢ Organize the properties (conductivity, hardness, malleability, ring) of metals

➢ Critically evaluate properties so that usages of metals could be predicted.

Type of activity:	➢ *Classroom/ homework assignment* & *Discussion* (See Aktiwiteit 5.1)
Teaching strategy:	➢ Learners investigate metals and their different properties by conducting group research assignments.
Critical or Developmental Outcomes:	➢ *Critical Outcome 4:* Learners should be able to collect, analyse, organise and critically evaluate information.
Learning Outcome:	➢ *Learning Outcome 1:* Practical Scientific Inquiry and problem solving skills

Assessment Standard:	➢ Plan and conduct a scientific investigation to collect data systematically with regard to accuracy, reliability and the need to control one variable
Type of Assessment:	➢ Formative Assessment
Assessment Method:	➢ Peer Assessment ➢ Authentic Assessment
Assessment Technique:	➢ Research assignment assessed by the teacher according to a rubric ➢ Content based work sheet marked by the educator according to a memorandum
Time:	➢ 1 day- homework

Activity 6.1

Learners conduct an investigation into the making of different alloys – a mixture of metals that are used in the kitchen.

Type of activity:	➢ *Practical experiments* (See Aktiwiteit 6.1)
Teaching strategy:	➢ Learners investigate alloys and their different properties by conducting group experiments.
Critical or Developmental Outcomes:	➢ *Critical Outcome 1:* Learners should be able to identify and solve problems and make decisions using critical and creative thinking.
Learning Outcome:	➢ Optional Learning Outcome: Investigation of the alloying, hardening and the crystalline structure of metals
Assessment Standard:	➢ Plan and conduct a scientific investigation to collect data systematically with regard to accuracy, reliability and the need to control one variable
Type of Assessment:	➢ Formative Assessment
Assessment Method:	➢ Educator Assessment
Assessment Technique:	➢ Continuous assessment throughout the activity according to laboratory skills used/gained by means of

	observation sheets. ➢ Content based work sheet marked by the educator according to a memorandum
Time:	➢ *2 x 45min periods*

Activity 6.2

Learners investigate several alloys, used in the making of jewellery and there properties

Type of activity:	➢ *Practical experiments* (See Aktiwiteit 6.2)
Teaching strategy:	➢ Learners investigate alloys and their different properties by conducting group experiments.
Critical or Developmental Outcomes:	➢ *Critical Outcome 3:* Learners should be able to organise and manage themselves and their activities responsibly and effectively
Learning Outcome:	➢ Optional Learning Outcome: Investigation of the alloying, hardening and the crystalline structure of metals
Assessment Standard:	➢ Plan and conduct a scientific investigation to collect data systematically with regard to accuracy, reliability and the need to control one variable
Type of Assessment:	➢ Formative Assessment
Assessment Method:	➢ Educator Assessment
Assessment Technique:	➢ Continuous assessment throughout the activity according to laboratory skills used/gained by means of observation sheets. ➢ Content based work sheet marked by the educator according to a memorandum
Time:	➢ 2 x 45min periods

Activity 7

Learners carry out practical tests on reduction of metal oxides with carbon.

Type of activity:	➢ *Demonstration experiments* (See Aktiwiteit 7)
Teaching strategy:	➢ Educator demonstrates laboratory methods of extracting the metals form the ore (of the mine they investigated, where possible) and communicate what they have learned about mining by doing this
Critical or Developmental Outcomes:	➢ *Critical Outcome 7:* Learners should be able to identify and solve problems and make decisions using critical and creative thinking.
Learning Outcome:	➢ Optional Learning Outcome: Electrolysis for refining/extracting copper or other metals.
Assessment Standard:	➢ Apply scientific knowledge in familiar, simple contexts.
Type of Assessment:	➢ Formative Assessment
Assessment Method:	➢ Authentic Assessment
Assessment Technique:	➢ Continuous assessment throughout the experiment according to skills used/gained by means of observation sheets. ➢ Content based work sheet marked by the educator according to a memorandum
Time:	➢ 5 x 45min periods

Activity 8

Learners participate in a debate on the environmental impact of mining vs. the socio-economic impact of mining.

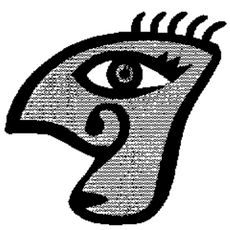
Type of activity:	➢ *Debate* (See Aktiwiteit 8)
Teaching strategy:	➢ Learners explore the values of the social justice for mining as well as ecological impact of mining, enabling them to exercise judgment on moral and ethical issues, and to develop a commitment to the core values shared by most humans.
Critical or Developmental Outcomes:	➢ Developmental Outcome 2: *Learners should be able to participate as responsible citizens in the life of local, national and global communities.* ➢ Developmental Outcome 3: Learners should be able to be culturally and aesthetically sensitive across a range of social contexts.
Learning Outcome:	➢ Learning Outcome 3: The Nature of Science and its relationship to Technology, Society and the Environment
Assessment Standard:	➢ Evaluating the impact of science on the environment development and sustainable development
Type of Assessment:	➢ Summative Assessment
Assessment Method:	➢ Group and Self-Assessment ➢ Authentic Assessment
Assessment Technique:	➢ Self- assessment of performance as a group member. ➢ Peer - assessment by means of a democratic vote on the outcome of the debate.
Time:	➢ 3 x 45min periods

APPENDIX A
CURRICULUM UNIT

b. LEARNING MATERIAL

TOPIC: MINING OF METALS
GRADE: 5
GROUPING: HETEROGENEOUS AND HOMOGENEOUS
LANGUAGE: AFRIKAANS

Aktiwiteit 1: *Klasaktiwiteit + Navorsingsopdrag*
Mynbou in Suid-Afrika



"Hi daar, julle.

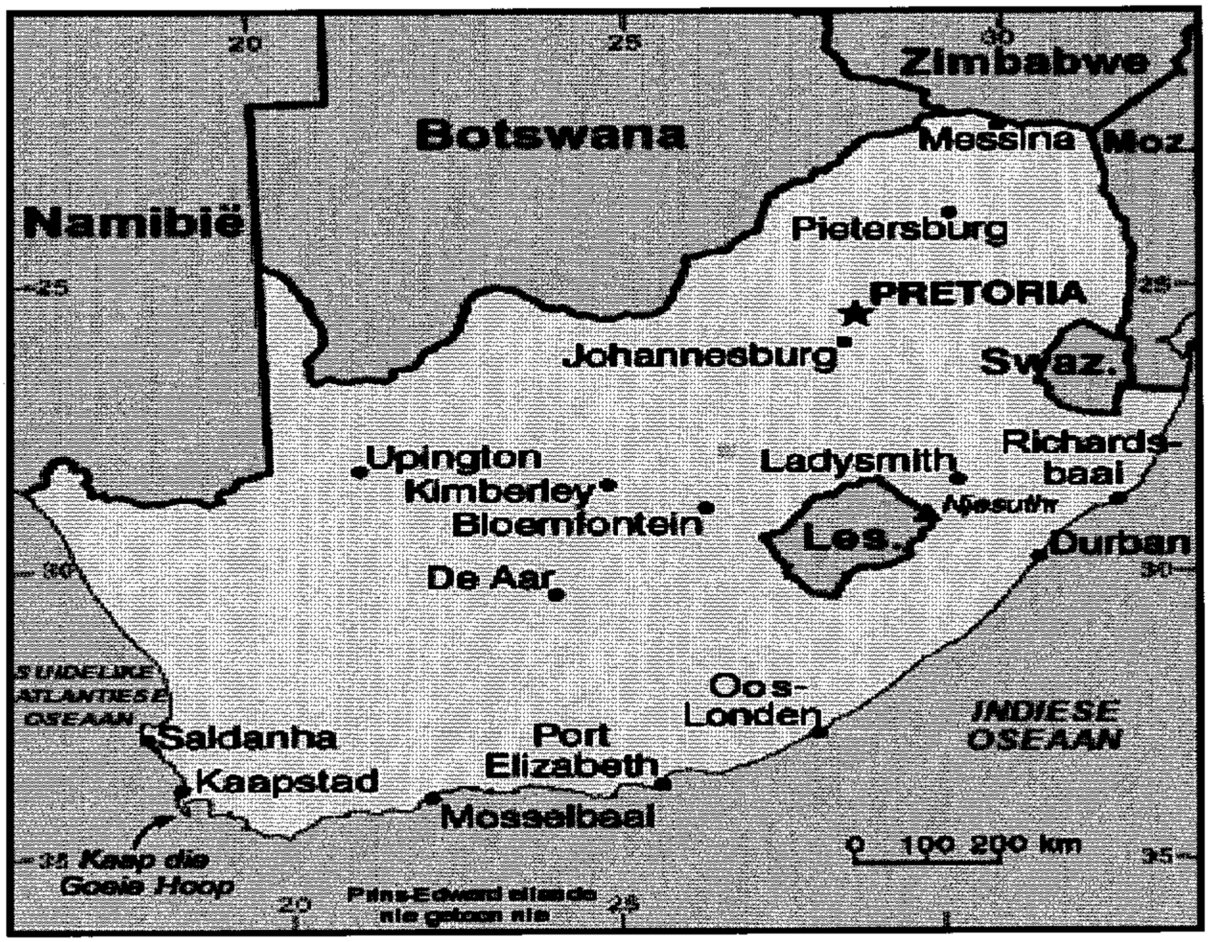
My naam is *Wysneus.* Ek het gehoor dat jy 'n baie slim Graad 5 is. Ek doen navorsing oor die *Myn van Metale* en het jou hulp nodig. Al wat jy hoef te doen, is om 'n paar vrae te beantwoord.

Soos julle reeds weet, bly ons in 'n wonderlike land. Suid-Afrika is een van die mineraalrykste lande te wêreld. Minerale word gewoonlik uit die grond gehaal/ontgin. Om dit te kan doen het ons myne nodig."

Opdrag:

- Gaan lees na oor mynbou in Suid-Afrika en beantwoord dan die volgende vrae:

1.1 Dui op die gegewe kaart die verskillende plekke aan waar metale ontgin word.



1.2 Omkring agt metale wat in Gauteng en aangrensende provinsies gemyn word op die onderstaande woordspeletjie.

- Woorde kan vertikaal, horisontaal, diagonaal sowel as van voor na agter loop.

G	O	U	D	G	Y	R	S	P	E	Z	K	L	M	D
T	U	M	B	F	D	L	T	C	X	V	X	W	Y	A
S	B	H	L	I	G	D	L	N	T	D	P	S	T	F
P	S	D	T	D	P	F	T	T	S	T	T	L	K	P
L	U	H	H	T	L	L	P	G	T	E	L	O	H	M
A	P	L	K	R	I	W	R	K	R	P	I	P	A	K
T	L	P	P	O	F	N	D	H	P	L	P	N	R	H
I	J	Y	R	P	A	Q	L	L	H	Q	G	Y	F	F
N	T	E	E	A	E	S	P	P	G	A	R	K	P	K
U	R	Q	R	T	C	P	T	T	A	W	Q	O	G	T
M	I	U	P	G	H	L	R	N	L	S	W	P	R	W
P	P	F	K	W	R	F	S	G	T	T	S	E	Y	A
K	T	P	D	Q	O	G	S	I	L	W	E	R	Q	R
Y	K	U	P	A	O	H	R	U	J	Y	T	T	W	S
S	D	J	F	L	M	R	P	R	K	U	W	G	H	P

2 Watter tipe metaal word by elk van die onderskeie plekke ontgin?

- Johannesburg: ....
- Rustenburg: ....
- Thabazimbi: ....
- Brits: ....
- Phalaborwa: ....
- Postmansburg:..
- Bela-Bela:...

- Verklaar m.b.v die woordeboek die volgende terme:

2.1 Ontgin:

....

2.2 Erts:

....

2.3 Allooi:

....

2.4 Mynmetode:

....

2.5 Oopgroefmyn:

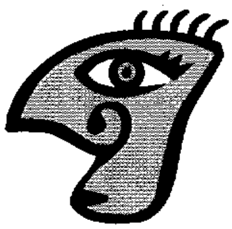
....

2.6 Mineraalryk:

....

Aktiwiteit 2: *Navorsingsopdrag.*

Myn van Metale



"Jy weet by nou al waar myne wat metale ontgin in Suid – Afrika voorkom. Het jy al ooit gewonder hoe ons hierdie metale uit die grond kry?"

- Verdeel m.b.v die onderwyser in groepies van 3.
- Kies dan m.b.v die onderwyser 'n myn waaroor jou groep verdere navorsing gaan doen.

Opdrag:

2.1 Versamel dan in groepsverband inligting /prente wat die volgende vrae sal beantwoord:

- Waar kom die myn voor?
- Watter soort metaal word daar ontgin?
- Hoe word die betrokke metaal vanuit die erts ontgin?
- Watter mynmetode word gebruik?
- Hoeveel vrouens is in diens van die myn?
- Die risiko's verbonde aan mynbou vir vroue

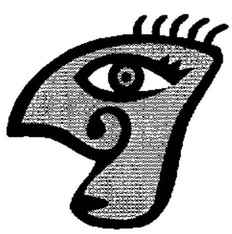
2.1 Stel in groepsverband 'n portfolio saam wat bogenoemde inligting bevat.

- Elke groep hoef net een portfolio in te gee.
- Dui duidelik die naam van al die lede van die groep aan, asook die taak wat elke lid verrig het.

Elke groep sal ook die geleentheid kry 'n mondelinge voorlegging van die opdrag te doen.

Aktiwiteit 3: *Praktiese Eksperimente*

Eienskappe van metale



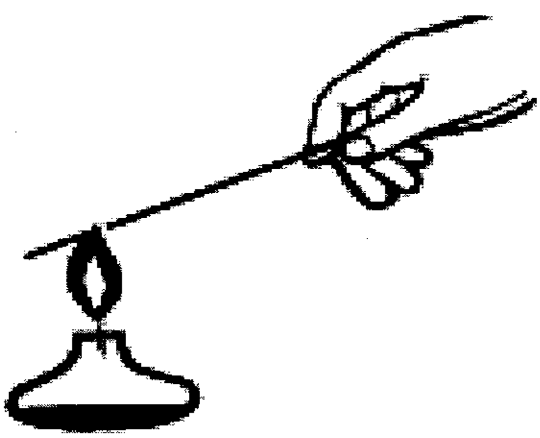
"Ons gaan nou 'n paar eksperimente doen om agter te kom watter eienskappe metale het. Onthou om die instruksies noukeurig te volg en daarna die vrae te beantwoord!"

- Verdeel in groepe van vier
- Seuns en dogters apart
- Elkeen in die groep kry 'n beurt om 'n eksperiment te doen

3.1 VERHITTING VAN VASTE STOWWE

Opdrag:

a) Neem al die objekte wat aan jou verskaf word.
b) Hou dit een vir een in 'n vlam.



VRAE

3.1.1 Wat gebeur met die objek?

....

....

3.1.2 Watter objekte word die gouste warm?

....

....

3.1.3 Kan jy dalk jou antwoord verklaar?

....

....

....

Gevolgtrekking:

- Warmte het van die vlam deur die metaal na jou hand versprei of beweeg.
- Ons sê dat die warmte deur middel van geleiding deur die metaal voortgeplant is.
- Ons sê ook dat metale goeie geleiers van warmte is.
- Gedurende geleiding word warmte van die warmer deeltjies in die stof na die naburige kouer deeltjies oorgedra sonder dat die deeltjies self beweeg.

3.2 GELEIDING VAN HITTE

Opdrag:

a) Neem 'n ysterstaaf
b) Verhit die ysterstaaf oor 'n oop vlam.
c) Druk dit teen 'n koue stuk metaal.

VRAE

3.2.1 Wat gebeur met die koue stuk metaal?

....

3.2.2 Wat kan ons hieruit aflei?

....

....

Gevolgtrekking:

As 'n warm metaal 'n koue een aanraak, word die warmte deur **geleiding** voortgeplant.

3.3 IS METALE GOEIE GELEIERS VAN HITTE?

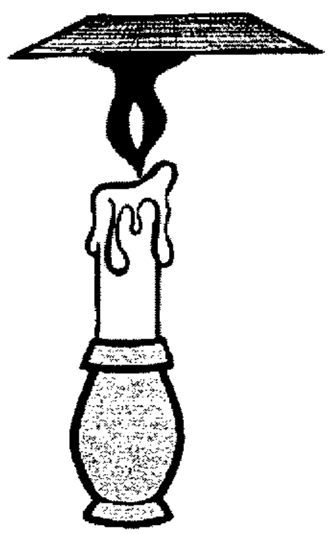
Wat jy nodig het:

- Kers
- Kopergaasdraad

Opdrag:

a) Plaas 'n kers regop in 'n houer en steek dit aan die brand.

b) Laat sak nou 'n kopergaasdraad oor die vlam totdat dit feitlik die kers raak.



VRAE

3.3.1 Wat gebeur met die vlam?

....

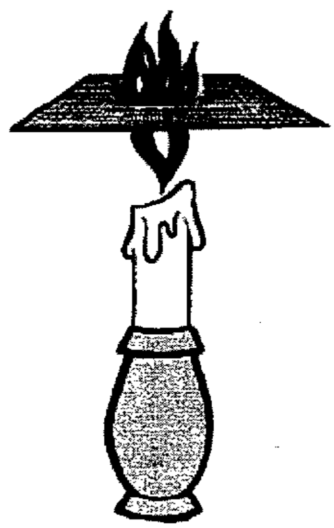
3.3.2 Brand die vlam bokant die gaasdraad?

....

3.3.3 Kan jy miskien jou antwoord verklaar?

....

c) Hou nou 'n brandende vuurhoutjie bokant die gaasdraad en die vlam.



VRAE

3.3.4 Brand die kersvlam nou bokant die gaasdraad?

....

3.3.5 Kan jy dalk jou antwoord verklaar?

....

Gevolgtrekking:

1. Die kopergaasdraad gelei die warmte so vinnig weg dat die gasse van die kers te koud is om bokant die gaasdraad te brand.
2. Kopergaasdraad is 'n goeie geleier van warmte.

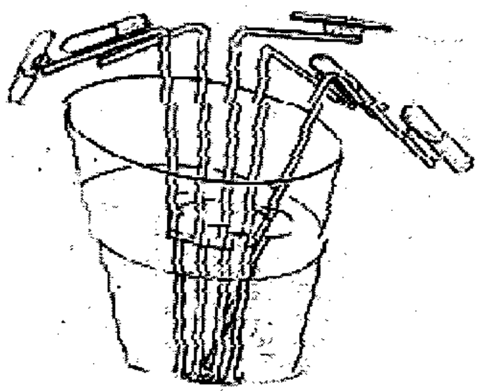
3.4 GELEI ALLE METALE WARMTE EWE VINNIG?

Wat jy nodig het:

- Plastiek bekertjie
- Ketel
- Verskillende gemerkte metaal-draadjies
- Botter
- Skuifspelde
- Water

Opdrag:

a) Neem 'n plastiek bekertjie.
b) Plaas die gemerkte draadjies in die bekertjie.
c) Gebruik botter om die skuifspelde op die draadjies vas te plak
d) Gooi nou m.b.v jou onderwyser, die bekertjie vol kookwater sodat die ente van die draadjies bedek is.



VRAE

3.3.6 Op watter draadjie smelt die botter die vinnigste?

....

3.3.7 Watter draadjie volg na hierdie een?

....

3.3.8 Wat gebeur met die skuifspelde?

....

3.3.9 Watter draadjie gelei warmte die beste?

....

Gevolgtrekking:

1. Metale gelei warmte goed.
2. Verskillende metale gelei warmte nie ewe vinnig nie.
3. Koper is 'n beter geleier van warmte as yster.

- Ons sê dat **metale goeie geleiers** van warmte is, omdat *hulle warmte maklik gelei.*
- Ons sê dat **nie – metale swak geleiers** van warmte is, omdat *hulle warmte nie maklik gelei nie.*

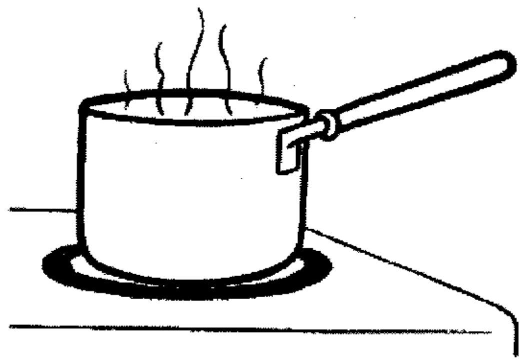
3.5 PROBEER DIE VOLGENDE:

Voeg nog 'n paar name van goeie en swak geleiers van warmte by die lys hieronder.

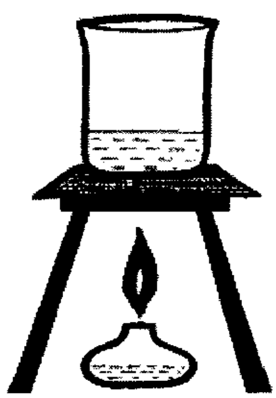
Goeie geleiers	Swak geleiers
1. Koper	5. Papier
2. Yster	6. Hout
3. Aluminium	7. Glas
4.	8.
5.	5.
6.	6.

Voorbeelde waar ons gebruik maak van metale as goeie geleiers van warmte.

1. Die warm plate van stowe word van metaal gemaak deurdat metaal 'n goeie geleier van warmte is.
2. Kookgereedskap en warmwatersilinders word van aluminium, staal of koper gemaak om sodoende die warmte vinnig te gelei.



3. Gaasdraad word onder glashouers wat verhit word, gebruik. Aangesien dit so 'n goeie geleier van warmte is, versprei dit warmte só vinnig dat die glas nie bars nie.



VRAE

3.5.1 Voltooi die volgende sin:

Warmte word deur metale voortgeplant deur middel van:

....

3.5.2 Voltooi die volgende tabel deur **ja** en **nee** in die regte kolom te skryf.

Stof	**Goeie geleier van warmte**	**Swak geleier van warmte**
Silwer	Ja	Nee
Hout		
Asbes		
Yster		
Plastiek		
Glas		
Koper		

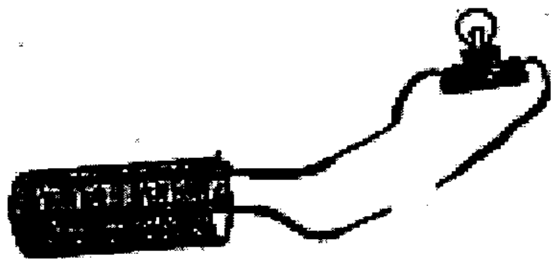
3.4 GELEIDING VAN ELEKTRISITEIT

Wat jy nodig het:

- 1 sel
- 3 verbindingsdrade
- Gloeilamp
- Metaal-lepel
- Plastiek-lepel
- Vuurhoutjie
- Skuifspeld
- Stukkie karton

Opdrag:

a) Skakel m.b.v jou onderwyser 'n gloeilamp, 'n sel, 3 verbindingsdrade soos op die skets of stel die apparaat op soos in skets aangedui m.b.v. onderwyser.

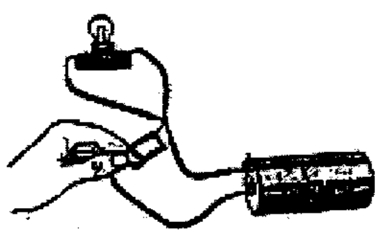


b) Gebruik kleefband om die draadjies aan die sel te koppel.

c) Verbind die twee los punte om te kyk of die gloeilampie gloei.

d) Plaas nou die onderstaande voorwerpe een vir een tussen die los punte.

- Metaal-lepel
- Plastiek-lepel
- Vuurhoutjie
- Skuifspeld
- Stukkie karton



VRAE:

3.4.1 Hoe weet jy wanneer 'n voorwerp elektrisiteit gelei?

....

3.4.2 Voltooi die tabel deur **ja** en **nee** in die regte kolom te skryf.

Stof	**Goeie geleier van elektrisiteit**	**Swak geleier van elektrisiteit.**
Metaal-lepel	Ja	Nee
Plastiek-lepel		
Vuurhoutjie		
Skuifspeld		
Karton		

Aktiwiteit 4: *Klasaktiwiteit*

Die Periodieke Tabel

"Jy het nou 'n paar eksperimente met metale/ nie- metale gedoen. Jy kon seker agterkom dat sekere stowwe, dieselfde eienskappe deel."

Opdrag:

4.1 Maak 'n lys van die kenmerke wat jy dink by metale voorkom.

....

....

....

....

....

" 'n Baie slim man met die naam van Mendeleev het 'n kaart opgestel van alle suiwer stowwe wat in die natuur voorkom. Hy het ook agter gekom dat sekere stowwe dieselfde eienskappe deel. Hy het toe die stowwe wat dieselfde eienskappe deel saam- gegroepeer. Elke stof het toe ook 'n naam asook 'n afkorting gekry. Die meeste van hierdie afkortings is van die Latynse name vir hierdie stof afgelei. Hierdie lys word die Periodieke tabel – genoem."

Opdrag:

- Kyk of jy die metale op die Periodieke tabel kan herken.

4.2.1 Hoeveel metale kom op die Periodieke tabel voor?

....

- Kyk nou of jy die metale wat in Gauteng en aangrensende provinsies gemyn word, kan herken.

4.2.2 Watter simbole word vir elk van die metale gebruik?

....

....

....

....

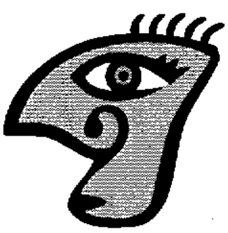
....

....

....

Aktiwiteit 5: *Navorsingsopdrag*

Die gebruike van Metale.

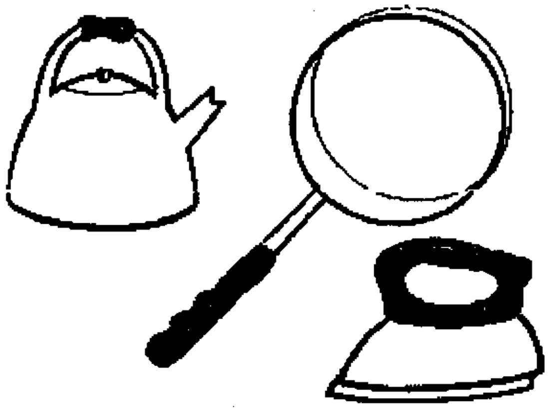


"Jy weet nou al *waar* en *hoe* metale in Suid – Afrika ontgin word. Maar het jy al ooit gewonder *waarom* ons dan so baie metale benodig?"

Opdrag:

- Verdeel weer in jou groepie en gaan dan na die mediasentrum om navorsing oor die verskillende gebruike van metale te doen.

5.1 Skryf 'n paragraaf in groepsverband (+/- 1 bl. lank) oor verskillende gebruike van metale.



5.2 Noem 10 gebruiksartikels in die huis wat van metale gemaak word en noem ook die name van die metale so ver as moontlik.

....

....

....

....

....

5.3 Beantwoord dan 'n groepsverband die volgende vrae. Besluit onderling wie watter vraag gaan doen. Elke groep hoef net een opdrag in te handig.

A) Van watter metaal word messe gemaak?

....

B) Waarom word messe van dié spesifieke metaal gemaak?

....

C) Waarom maak ons nie messe van koper nie?

....

D) Waarvan word muntstukke gemaak?

....

E) Waarom behoort ons nie muntstukke van yster te maak nie?

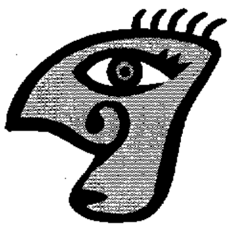
....

F) Waarom word potte en panne van metale gemaak?

....

Aktiwiteit 6: *Praktiese Eksperimente*

Allooie



Jy het nou al agter gekom watter eienskappe metale het. Jy weet ook nou waarom metale van waarde is vir ons. Maar het jy geweet dat ons van hierdie suiwer metale kan meng om nuwe stowwe te vorm? So 'n nuwe stof/ mengsel word dan 'n allooi genoem."

Opdrag:

- Vergelyk die volgende metale t.o.v buigbaarheid en hardheid met mekaar.

Vlekvrye staal
Sink
Koper
Geelkoper

6.1 Klassifiseer die stowwe volgens suiwer metale en allooie.

Suiwer Metale	**Allooie**

a) Watter van bogenoemde stowwe is die hardste?

....

b) Watter gevolgtrekking kan jy maak?

....

- Besoek jou naaste juwelierswinkel en vind die volgende uit:

6.2 Maak 'n lys van die allooie wat in juwele gebruik word?

....

....

....

....

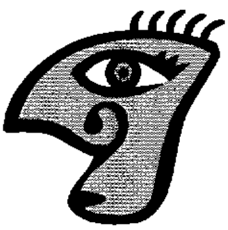
6.3 Waarom word daar nie juwele van suiwer metale soos bv. Suiwer goud gemaak nie?

....

....

Aktiwiteit 7.1: *Demonstrasie eksperiment*

Elektrolise



"Kom ons kyk of dit moontlik is om 'n suiwer metaal uit 'n verbinding te onttrek."

Opdrag:

- Kyk aandagtig na die eksperiment wat jou onderwyser vir jou gaan demonstreer en beantwoord dan die daaropvolgende vrae.

7.1.1 Wat gebeur met die koolstofstawe?

....

7.1.2 Wat noem ons hierdie proses?

....

7.1.3 Watter gevolgtrekking kan jy t.o.v die proses maak?

....

7.1.4 Waarom gebruik ons 'n reostaat?

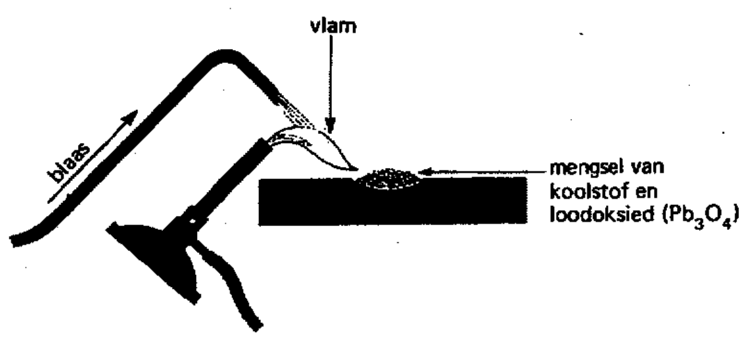
....

Aktiwiteit 7.2: *Demonstrasie eksperiment*

Reduksie van metale

Opdrag:

- Observeer die volgende eksperiment en beantwoord dan die vrae.
  - 'n Koolstofblok waarin daar 'n gaatjie gemaak is.
  - Plaas dan loodoksied binne in die gaatjie.
  - Verhit die mengsel met 'n blaasvlam.



7.2.1 Wat gebeur met die loodoksied?

....

7.2.2 Watter gas word vrygestel?

....

7.2.3 Wat was die katalisator?

....

7.2.4 Watter stof bly oor in die gaatjie?

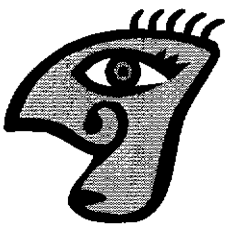
....

7.2.5 Watter gevolgtrekking kan ons uit die eksperiment maak?

....

Aktiwiteit 8: Debat

Sosio- Ekonomiese impak vs. Omgewingsimpak van myne



"Jy weet nou al *waarom, hoe* en *waar* ons metale myn. Die mynbou verskaf ook werk aan baie mense, maar het jy al gedink dat dit dalk 'n impak op ons omgewing kan hê?"

Opdrag:

- Verdeel weer in jou groepie en gaan dan na die mediasentrum om navorsing oor die omgewingsimpak / sosio-ekonomiese impak van myne te doen.
- Die seuns doen navorsing oor die omgewingsimpak en dogters oor die sosio-ekonomiese impak van myne.

8.1 Berei 'n praatjie in groepsverband voor oor die omgewingsimpak / sosio-ekonomiese impak van myne.

- Elke groep sal die geleentheid gegun word om sy praatjie/standpunt te lewer.
- Daar sal ook geleentheid gegun word om vrae aan elke groep te stel.
- Elke groep sal dan sy standpunt moet verdedig.

APPENDIX A

CURRICULUM UNIT

c. MEMORANDUM: WORK SHEETS

TOPIC: **MINING OF METALS**

Aktiwiteit 1: *Klasaktiwiteit + Navorsingsopdrag*

Mynbou in Suid-Afrika

1.2.1 Omkring agt metale wat in Gauteng en aangrensende provinsies gemyn word op die onderstaande woordspeletjie.

- Woorde kan vertikaal, horisontaal, diagonal sowel as van voor na agter loop.

G	O	U	D	G	Y	R	S	P	E	Z	K	L	M	D
T	U	M	B	F	D	L	T	C	X	V	X	W	Y	A
S	B	H	L	I	G	D	L	N	T	D	P	S	T	F
P	S	D	T	D	P	F	T	T	S	T	T	L	K	P
L	U	H	H	T	L	L	P	G	T	E	L	O	H	M
A	P	L	K	R	I	W	R	K	R	P	I	P	A	K
T	L	P	P	O	F	N	D	H	P	L	P	N	R	H
I	J	Y	R	P	A	Q	L	L	H	Q	G	Y	F	F
N	T	E	E	A	E	S	P	P	G	A	R	K	P	K
U	R	Q	R	T	C	P	T	T	A	W	Q	O	G	T
M	I	U	P	G	H	L	R	N	L	S	W	P	R	W
P	P	F	K	W	R	F	S	G	T	T	S	E	Y	A
K	T	P	D	Q	O	G	S	I	L	W	E	R	Q	R
Y	K	U	P	A	O	H	R	U	J	Y	T	T	W	S
S	D	J	F	L	M	R	P	R	K	U	W	G	H	P

(8)

1.3 Watter tipe metaal word by elk van die onderskeie plekke ontgin?

- *Johannesburg: Goud*
- *Rustenburg: Platinum, Silwer*
- *Thabazimbi: Yster*
- *Brits: Chroom*
- *Phalaborwa: Koper*

- *Postmansburg: Mangaan*
- *Bela-Bela: Tin*

- **Verklaar m.b.v die woordeboek die volgende terme:**

1.4 **Ontgin:** *Begin om te eksploiteer*
1.5 **Erts:** *Metaalhoudende delfstof*
1.6 **Allooi:** *Mengsel van suiwer metale*
1.7 **Mynmetode:** *Metode waarop daar gemyn word.*
1.8 **Oopgroefmyn:** *Oop gat waar mynaktiwiteite beoefen word.*
1.9 **Mineraalryk:** *Grond wat baie metale bevat.*

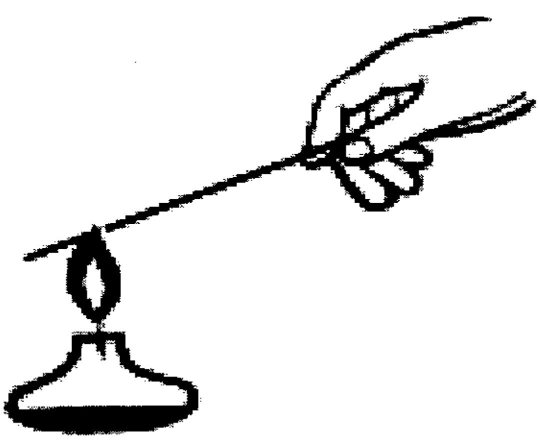
Aktiwiteit 3: *Praktiese Eksperimente*

Eienskappe van metale

3.1 VERHITTING VAN VASTE STOWWE

Opdrag:

d) Neem al die objekte wat aan jou verskaf word.
e) Hou dit een vir een in 'n vlam.



VRAE

3.1.1 Wat gebeur met die objek?

- *Word geleidelik warm vanaf punt tot by hand.*

3.1.2 Watter objek word die gouste warm?

- *Koperdraad*

3.1.3 Kan jy dalk jou antwoord verklaar?

- *Warmte het van die vlam deur die metaal na jou hand versprei of beweeg.*
- *Ons sê dat die warmte deur middel van geleiding deur die metaal voortgeplant is.*
- *Ons sê ook dat koper 'n goeie geleier van warmte is.*

3.2 GELEIDING VAN HITTE

Opdrag:

a) Neem 'n ysterstaaf
b) Verhit die ysterstaaf oor 'n oop vlam.
c) Druk dit teen 'n koue stuk metaal.

VRAE

3.2.1 Wat gebeur met die koue stuk metaal?

- *Word ook warm.*

3.2.2 Wat kan ons hieruit aflei?

- *As 'n warm metaal 'n koue een aanraak, word die warmte deur geleiding voortgeplant.*

3.3 IS METALE GOEIE GELEIERS VAN HITTE?

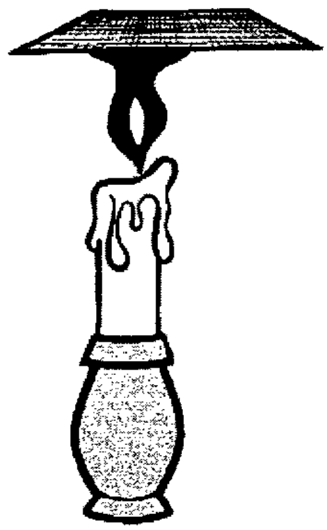
Wat jy nodig het:

- Kers
- Kopergaasdraad

Opdrag:

a) Plaas 'n kers regop in 'n houer en steek dit aan die brand.

b) Laat sak nou 'n kopergaasdraad oor die vlam totdat dit feitlik die kers raak.



VRAE

3.3.1 Wat gebeur met die vlam?

➢ *Die vlam gaan nie deur nie.*

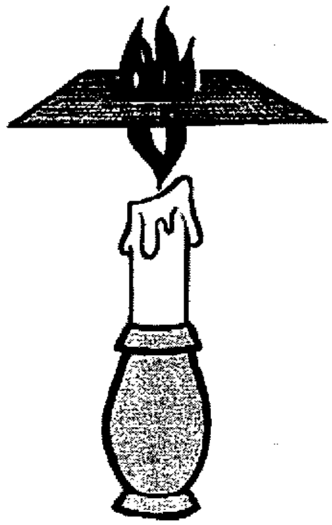
3.3.2 Brand die vlam bokant die gaasdraad?

➢ *Nee*

3.3.3 Kan jy miskien jou antwoord verklaar?

➢ *Die kopergaasdraad gelei die warmte te vinnig weg*

b) Hou nou 'n brandende vuurhoutjie bokant die gaasdraad en die vlam.



VRAE

3.3.4 Brand die kersvlam nou bokant die gaasdraad?

- *Nee.*

3.3.5 Kan jy dalk jou antwoord verklaar?

- *Die kopergaasdraad gelei die warmte so vinnig weg dat die gasse van die kers te koud is om bokant die gaasdraad te brand.*

3.4 GELEI ALLE METALE WARMTE EWE VINNIG?

Wat jy nodig het:

- Plastiek bekertjie
- Ketel
- Verskillende gemerkte metaal-draadjies
- Botter
- Skuifspelde
- Water

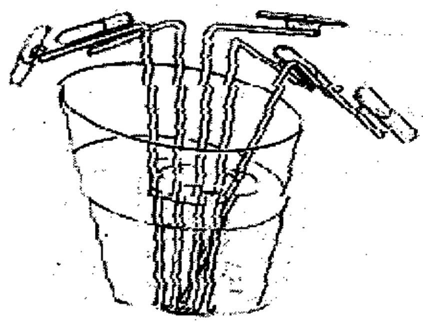
Opdrag:

a) Neem 'n plastiek bekertjie.

b) Plaas die gemerkte draadjies in die bekertjie.

c) Gebruik botter om die skuifspelde op die draadjies vas te plak

b) Gooi nou m.b.v jou onderwyser, die bekertjie vol kookwater sodat die ente van die draadjies bedek is.



VRAE

3.4.1 Op watter draadjie smelt die botter die vinnigste?

➢ *Koper*

3.4.2 Watter draadjie volg na hierdie een?

....

3.4.3 Wat gebeur met die skuifspelde?

➢ *Hulle val af soos wat die botter smelt.*

3.4.4 Watter draadjie gelei warmte die beste?

➢ *Koper.*

3.5 PROBEER DIE VOLGENDE:

Voeg nog 'n paar name van goeie en swak geleiers van warmte by die lys hieronder.

Goeie geleiers	Swak geleiers
Koper Yster Aluminium ➢ *Staal* ➢ *Sink* ➢ *Silwer*	Papier Hout Glas ➢ *Karton* ➢ *Plastiek* ➢ *Asbes.*

VRAE

3.5.3 Voltooi die volgende sin:

Warmte word deur metale voortgeplant deur middel van:

➢ *Geleiding*

3.5.4 Voltooi die volgende tabel deur **ja** en **nee** in die regte kolom te skryf.

Stof	**Goeie geleier van warmte**	**Swak geleier van warmte**
Silwer	➢ *Ja*	➢ *Nee*
Hout	➢ *Nee*	➢ *Ja*
Asbes	➢ *Nee*	➢ *Ja*
Yster	➢ *Ja*	➢ *Nee*
Plastiek	➢ *Nee*	➢ *Ja*
Glas	➢ *Nee*	➢ *Ja*
Koper	➢ *Ja*	➢ *Nee*

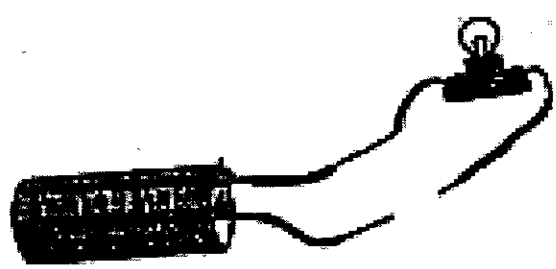
3.4 GELEIDING VAN ELEKTRISITEIT

Wat jy nodig het:

- 1 sel
- 3 verbindingsdrade
- Gloeilamp
- Metaal-lepel
- Plastiek-lepel
- Vuurhoutjie
- Skuifspeld
- Stukkie karton

Opdrag:

e) Skakel m.b.v jou onderwyser 'n gloeilamp, 'n sel, 3 verbindingsdrade soos op die skets.

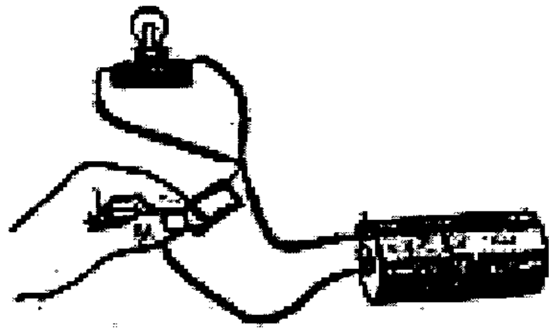


f) Gebruik kleefband om die draadjies aan die sel te koppel.

g) Verbind die twee los punte om te kyk of die gloeilampie gloei.

h) Skakel nou die onderstaande voorwerpe een vir een tussen die los punte.

- Metaal-lepel
- Plastiek-lepel
- Vuurhoutjie
- Skuifspeld
- Stukkie karton



VRAE:

3.4.1 Hoe weet jy wanneer 'n voorwerp elektrisiteit gelei?

- *Die gloeilamp sal brand wanneer die voorwerp elektrisiteit gelei.*

3.4.2 Voltooi die tabel deur *ja* en *nee* in die regte kolom te skryf.

Stof	Goeie geleier van elektrisiteit	Swak geleier van elektrisiteit.
Metaal-lepel	➢ *Ja*	➢ *Nee*
Plastiek-lepel	➢ *Nee*	➢ *Ja*
Vuurhoutjie	➢ *Nee*	➢ *Ja*
Skuifspeld	➢ *Ja*	➢ *Nee*
Karton	➢ *Nee*	➢ *Ja*

Aktiwiteit 4: *Klasaktiwiteit*

Die Periodieke Tabel

Opdrag:

4.1 Maak 'n lys van die kenmerke wat jy dink by metale voorkom.

- *Kan Warmte gelei*
- *Kan elektrisiteit gelei*
- *Kan buig*

4.2.1 Hoeveel metale kom op die Periodieke tabel voor?

- *84*

- Kyk nou of jy die metale wat in Gauteng en aangrensende provinsies gemyn word, kan herken.

4.2.2 Watter simbole word vir elk van die metale gebruik?

- *Goud: Au*
- *Silwer: Ag*
- *Yster: Fe*
- *Chroom: Cr*
- *Mangaan: Mn*
- *Koper: Cu*
- *Platinum: Pt*
- *Tin: Sn*

Aktiwiteit 5: *Klasaktiwiteit*

5.3 Beantwoord dan 'n groepsverband die volgende vrae. Besluit onderling wie watter vraag gaan doen. Elke groep hoef net een opdrag in te handig.

A) Van watter metaal word messe gemaak?

- *Vlekvrye staal*

B) Waarom word messe van dié spesifieke metaal gemaak?

- *Omdat dit baie hard is en nie kan roes nie.*

C) Waarom maak ons nie messe van koper nie?

- *Omdat koper te sag is.*

D) Waarvan word muntstukke gemaak?

- *Nikkel, Geelkoper*

E) Waarom behoort ons nie muntstukke van yster te maak nie?

- *Want dit sal roes.*

F) Waarom word potte en panne van metale gemaak?

- *Omdat metale hitte goed gelei.*

Aktiwiteit 6: *Praktiese Eksperimente*

Allooie

- **Vergelyk die volgende metale t.o.v buigbaarheid en hardheid met mekaar.**

Vlekvrye Staal

Sink

Koper

Geelkoper

6.1 Klassifiseer die stowwe volgens suiwer metale en allooie.

Suiwer Metale	**Allooie**
➢ *Koper*	➢ *Vlekvrye Staal*
➢ *Sink*	➢ *Geelkoper*

6.2 Watter van bogenoemde stowwe is die hardste?

- *Vlekvrye Staal*

6.3 Watter gevolgtrekking kan jy maak?

- *Jy kan 'n metaal harder maak deur 'n allooi daarvan te maak.*

6.4 Uit watter suiwer metale bestaan ons R2 muntstuk?

- *Nikkel + Koper*

6.5 Uit watter suiwer metale bestaan vlekvrye staal?

- *Yster + Nikkel + Chroom*

6.6 Waarom behoort ons land staal goedkoop te vervaardig? (Dink aan waar die metale gemyn word.)

- *Al die elemente wat in staal gebruik word kom in ons land voor.*
- *Ons land het groot hoeveelhede ystererts.*
- *Yster word maklik gemyn*
- *Steenkool is goedkoop.*

Aktiwiteit 7: *Praktiese Eksperimente*

Elektrolise

Opdrag:

- Kyk aandagtig na die eksperiment wat jou onderwyser vir jou gaan demonstreer en beantwoord dan die daaropvolgende vrae.

7.1.1 Wat gebeur met die koolstofstawe?

- *Dit vorm 'n koperneerslag by die een staaf. By die ander staaf word 'n gas vrygestel.*

7.1.2 Wat noem ons hierdie proses?

- *Elektrolise*

7.1.3 Watter gevolgtrekking kan jy t.o.v die proses maak?

- *Jy kan elektriese energie gebruik om metale uit erts te ontgin.*

7.1.4 Waarom gebruik ons 'n reostaat?

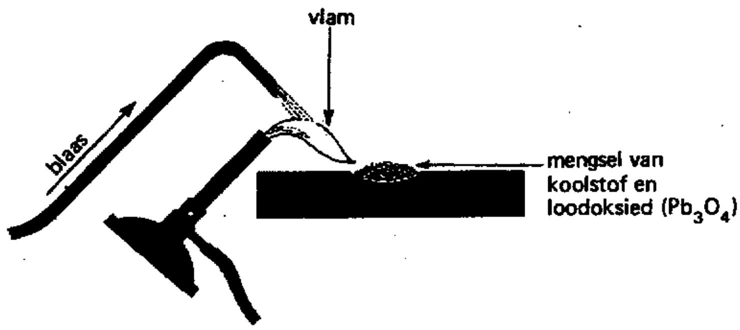
- *Om die stroom te beheer.*

Aktiwiteit 7.2: *Demonstrasie eksperiment*

Reduksie van metale

Opdrag:

- Observeer die volgende eksperiment en beantwoord dan die vrae.
  - 'n Koolsofblok waarin daar 'n holtetjie gemaak is.
  - Plaas dan loodoksied binne in die holtetjie
  - Verhit die mengsel met 'n blaasvlam.



7.2.1 Wat gebeur met die loodoksied?

- *Dit vorm 'n rooiwarm loodballetjie.*

7.2.2 Watter gas word vrygestel?

- *Koolstofdioksied*

7.2.3 Wat was die katalisator?

- *Koolstof*

7.2.4 Watter stof bly oor in die gaatjie?

- *Lood*

7.2.5 Watter gevolgtrekking kan ons uit die eksperiment maak?

- *Ons kan reduksie gebruik om metale uit erts te ontgin.*

d. ASSESSMENT PLAN: MINING OF METALS

Nr.	Activities	Type of Assessment	Assessment Method	Assessment Technique	Critical or Developmental Outcomes	Learning Outcome	Assessment Standard
1	➢ *Learners conduct an investigation on the occurrence of metal mines in Gauteng and adjacent provinces.*	➢ Formative Assessment	➢ Educator assessment	➢ Research assignment marked by the teacher according to *Rubric 1* ➢ Content based work sheet marked by the educator according to a memorandum	➢ ***Critical Outcome 1:*** Learners should be able to identify and solve problems and make decisions using critical and creative thinking	➢ ***Learning Outcome 3:*** The Nature of Science and its relationship to Technology, Society and the Environment.	➢ Evaluate knowledge claims and science's inability to stand in isolation from other fields.
2	*Learners choose a prominent women in the mining industry and conduct an investigation (based on the example "Assessing the ability to inquire" –Chapter 5 of the USA Standards) on the following:* ➢ What kind of work does this women do? ➢ Why can the women be considered as prominent in science?	➢ Summative Assessment	➢ Educator assessment	➢ Portfolio: marked by the teacher according to Rubric 2 to assess the factual knowledge gained during the learning event.	➢ ***Critical Outcome 3:*** Learners should be able to organise and manage themselves and their activities responsibly and effectively. ➢ ***Critical Outcome 4:*** Learners should be able to collect, analyse, organise and critically	➢ ***Learning Outcome 3:*** The Nature of Science and its relationship to Technology, Society and the Environment.	➢ Evaluate knowledge claims and science's inability to stand in isolation from other fields.

	➢ Would you regard this woman as a role model? ➢ Different methods of mining used at that particular min				evaluate information		
3.	*Learners will:* ➢ Compare the properties (conductivity, hardness, malleability, ring) of metals with other metals and with non-metals ➢ Critically evaluate the properties of metals so that usages could be predicted and validate the predictions with real life examples by means of an oral presentation.	➢ Diagnostic Assessment ➢ Formative Assessment	➢ Educator assessment	➢ Continuous assessment of the groups throughout the experiment by means of observation sheets to assess the laboratory skills applied. ➢ Content based work sheet marked by the educator according to a memorandum	➢ ***Critical Outcome 4:*** Learners should be able to collect, analyse, organise and critically evaluate information.	➢ ***Learning Outcome 1:*** Practical Scientific Inquiry and problem solving skills.	➢ Plan and conduct a scientific investigation to collect data systematical y with regard to accuracy, reliability and the need to control one variable ➢ Seek patterns and trends in the information collected and link it to existing scientific

							knowledge to help draw conclusions
4	➢ *Revision of the Periodic Table:* • Relative charge and mass of protons, neutrons, and electrons. • Relative size and position of protons, neutrons, and electrons. • The use of proton number to place an element. • Meaning and differences between the relative atomic mass and atomic number. • Ability to identify metals and non-metals using the periodic	➢ Diagnostic Assessment	➢ Peer and Self-Assessment ➢ Educator assessment	➢ Self-assessment by means of *Self-Assessment Rubric 1*. ➢ Content based work sheet marked by the educator according to a memorandum	➢ *Developmental Outcome 1:* Learners should be able to reflect on and explore a variety of strategies to learn more effectively. ➢ ***Critical Outcome 7:*** Learners should be able to demonstrate an understanding of the world as a set of related systems by recognising that problem solving contexts do not exist in isolation.	➢ ***Learning Outcome 2:*** Constructing and Applying Scientific Knowledge.	➢ Recall and state basic prescribed scientific knowledge ➢ Express and explain prescribed scientific theories and models by indicating some of the relationships of different facts and concepts with each other. ➢ Apply scientific knowledge in familiar, simple contexts

	table. • Ability to recognize groups of metals with similar properties and to predict reactions.						
5	*Learners will:* ➢ Organize the properties (conductivity, hardness, malleability, ring) of metals	➢ Formative Assessment	➢ Educator assessment	➢ Research assignment assessed by the teacher according to a *Rubric 3* ➢ Group Assessment of oral presentation by means of Rubric ➢ Content based work sheet marked by the educator according to a memorandum	➢ ***Critical Outcome 4:*** Learners should be able to collect, analyse, organise and critically evaluate information.	➢ ***Learning Outcome 1:*** Practical Scientific Inquiry and problem solving skills.	➢ Seek patterns and trends in the information collected and link it to existing scientific knowledge to help draw conclusions
6.1	➢ *Learners conduct an investigation into the making of alloys – a mixture of metals.*	➢ Formative Assessment	➢ Educator Assessment	➢ Continuous assessment throughout the activity according to laboratory skills	➢ *Critical Outcome 1:* Learners should be able to identify and solve problems	➢ *Optional Learning Outcome:* Investigation of the	➢ Plan and conduct a scientific investigation to collect data

				used/gained by means of observation sheets. ➢ Content based work sheet marked by the educator according to a memorandum	and make decisions using critical and creative thinking.	alloying, hardening and the crystalline structure of metals	systematically with regard to accuracy, reliability and the need to control one variable
6.2	➢ *Learners investigate several alloys and there properties*	➢ Formative Assessment	➢ Educator Assessment	➢ Continuous assessment throughout the assessment according to laboratory skills used/gained by means of *Observation Sheet 1* ➢ Content based work sheet marked by the educator according to a memorandum	➢ ***Critical Outcome 3:*** Learners should be able to organise and manage themselves and their activities responsibly and effectively.	➢ *Optional Learning Outcome:* Investigation of the alloying, hardening and the crystalline structure of metals	➢ Plan and conduct a scientific investigation to collect data systematically with regard to accuracy, reliability and the need to control one variable
7.1	➢ *Learners carry out practical tests on reduction of metal oxides with carbon.*	➢ Formative Assessment	➢ Authentic Assessment	➢ Continuous assessment throughout the experiment according to skills used/gained by means of *Observation Sheet 1.*	➢ ***Critical Outcome 7:*** Learners should be able to identify and solve problems and make decisions using critical and creative	➢ *Optional Learning Outcome:* Electrolysis for refining/extracting copper or other metals.	➢ Apply scientific knowledge in familiar, simple contexts.

				➢ Content based work sheet marked by the educator according to a memorandum	thinking.		
7.2	➢ *Learners observe practical tests on the electrolysis for refining/ extracting copper and other metals.*	➢ Formative Assessment	➢ Peer Assessment	➢ Peer Assessment of the laboratory work by means of a *Self-Assessment Rubric 2.* ➢ Content based work sheet marked by the educator according to a memorandum ➢ Continuous assessment throughout the assessment according to laboratory skills used/gained by means of *Observation Sheet 1*	➢ ***Critical Outcome 7:*** Learners should be able to demonstrate an understanding of the world as a set of related systems by recognising that problem solving contexts do not exist in isolation	➢ *Optional Learning Outcome:* Electrolysis for refining/extracting copper or other metals.	➢ Interpreting data to draw conclusions.
8.	➢ *Learners participate in a debate on the environmental impact of mining vs. the socio-economic impact of mining*	➢ Summative Assessment	➢ Group and Self-Assessment ➢ Authentic Assessment	➢ Self-assessment of performance as a group member by means of *Self-Assessment Rubric 2.*	➢ *Developmental Outcome 2:* Learners should be able to participate as responsible citizens in the life of local,	➢ *Learning Outcome 3:* The Nature of Science and its relationship to Technology,	➢ Evaluating the impact of science on the environment development and sustainable

				➢ Peer - assessment by means of a democratic vote on the outcome of the debate.	national and global communities. ➢ *Developmental Outcome 3:* Learners should be able to be culturally and aesthetically sensitive across a range of social contexts.	Society and the Environment.	development
*	➢ *All the work sheets will be marked by the educator according to a memorandum to assess the factual knowledge and will count as a "traditional" summative test.*	➢ Summative Assessment	➢ Educator Assessment	➢ Written work sheets marked by the educator according to a memorandum to assess the factual knowledge gained during the module	➢ ***Critical Outcome 1:*** Learners should be able to identify and solve problems and make decisions using critical and creative thinking.	➢ ***Learning Outcome 2:*** Constructing and Applying Scientific Knowledge.	➢ Apply scientific knowledge in familiar, simple contexts

APPENDIX B

ANALYSIS AND RESULTS OF LEARNING SUPPORT MATERIAL

1.1 Analysis of learning material

The purpose of this study is to determine whether the implementation of a girl-friendly science curriculum will have an effect on the attitude of girls towards science. To accomplish this I had to develop the learning material for the girl-friendly science unit.

In order to determine whether the girl-friendly unit was practical and plausible, the complete unit was handed to three different science teachers for implementation. This enabled me to make an objective and comprehensive analysis of the practical feasibility of the unit. The lesson plans were verified by the Head of Department to ensure the correct standard. The science teachers were asked to write a report on how they experienced the unit.

According to Rogan (2004) good assessment is characterised by a number of features. The way in which the curriculum is assessed will determine how it is implemented. Hence assessment criteria should not be seen as an add-on once the curriculum is already designed, but part and parcel of the design process. Most importantly, the assessment instruments (summative tests, assignments, projects, etc.) and techniques need to be valid. These assessment instruments need to be applied for its designed purpose. The assessment instruments also need to be reliable and accurate. In order to determine whether the various instruments for this particular girl-friendly unit were valid, I did a complete analysis of the summative test as well as the written assignment, to reflect on their worth as a whole.

1.2 Analysis of summative test

The learners wrote a "traditional" summative test at the end of the unit. The different science educators marked all the questions according to a memorandum to assess the factual knowledge. The results of the summative test and group assignments were correlated with the results of the attitude questionnaire and were used as a method of triangulation, to obtain a better picture of the attitudes of the girls towards science.

A) Analysis of the following items on the summative test:

Question	Measure knowledge, understanding, and skills.	Concurrent learner measurements.	Provide the opportunity to demonstrate competence
3.1	✓	✓	✓
3.2	✓	✓	✓
3.3	✓	✓	✓

B) Item Analysis

In order to determine whether the summative test was reliable I applied the Kuder-Richardson 20 formula, since the summative test items required only a wrong (0) or correct (1) score. There were 25 items in the summative test. I analysed the results of the different classes.

C) Sampling

I chose the 10 highest scorers and the 10 lowest scorers from a class (my register class)

N = 33

n = 10

D) Methodology

Item discriminability:

The lower scorers and higher scorers out of a class of 33 were identified. Usually take the bottom 27% as having low scores and the top 27 % as having high scores this is the optimum point at which differentiation and reliability are matched (Kelley, 1939). I took 5 items from the "summative test" and measured the proportion of low scorers answering the question correctly and the proportion of high scorers who answered the question correctly. I then subtracted the proportion of low scorers from the proportion of high scorers and this gives us the measure of discrimination. The higher the figure the better the item discriminability

E) Reflection on the item analysis of the summative test

Items 1 and 3 had the highest measure of discrimination (80% and 70%). The difficulty level of item 5 was the highest (60%). Item 4 and 2 followed with the same difficulty level of 57%. Item 1 had a difficulty level of 54%. Although item 3 had the lowest difficulty level (27%) and therefore was the question the learners had the most difficulty with, it discriminated very well. Generally I am satisfied with the discrimination index and the level of difficulty of the five items. It might be a good idea to revise item 4, since it had the lowest discrimination index and was not that difficult.

1.3 Analysis of the group assignment

The results of the summative test and group assignments were correlated in order to determine in which one of the aforementioned the girls performed best. These findings were then correlated with the results of the attitude questionnaire and were used as a method of triangulation, to obtain a better picture of the attitudes of the girls towards science.
In terms of this specific task the following guidelines were followed to establish criterion-referenced validity.

- Is the purpose of the task stated in a clear and concise fashion?
- Is it clear from a list of objectives what the task measures?
- Does the set of objectives measured by the task serve as a representative set from some content domain of interest?
- Are the task items in an appropriate format to measure the objectives they were developed to measure?

- Are the task items free of bias (gender, ethnicity, religion, or socio-economic status)?
- Are the task directions clear?

Item	High prers per 27% U (nH=10)	Middle prers 46% M Nm=13	Low prers Lower % L (nL=10)	Discrimination (U-L)/½(nH+	Difficulty (U+M+L)/T
1	10	6	2	0,8	0.54
2	8	7	4	0.4	0.57
3	7	2	0	0.7	0.27
4	8	6	5	0.3	0.57
5	10	6	4	0.6	0.60

A) Description of how the learners performed on the assignment:

Activity 2:

➢ Learners choose a prominent women in the mining industry and conduct an investigation (based on the example "Assessing the ability to inquire" – Chapter 5 of the USA Standards) on the following:

- What kind of work do these women do?
- Why can the women be considered as prominent in science?
- Would you regard this woman as a role model?
- Different methods of mining used at that particular mine?

Learners were assessed according to a rubric, which was handed to them together with the assignment.
The assessment mark of the task was reworked to a percentage.
The results were as followed:

	Gender	Assignment Y
1	F	87
2	F	68
3	F	90
4	F	90
5	M	80
6	M	95
7	M	90
8	F	68
9	F	75
10	F	90
11	F	90
12	M	90
13	M	68
14	F	75
15	F	90
16	F	95
17	F	95
18	F	95
19	M	81
20	M	68
21	M	75
22	M	81
23	F	95
24	F	95
25	F	81
26	M	75
27	F	95
28	F	95
29	F	95
30	F	95
31	F	95
32	F	95
33	F	95
34	M	56
35	F	95
36	M	81

B) Description of how the learners performed on the assignment according to the rubric

Learner	Title Page	Content Questions answered correctly	Extra	Pictures	Verbal presentation	Bibliography	Total Score (24)	%
A	2	2	2	1	2	1	10	41.6
B	4	2	4	4	3	1	18	75
C	4	2	0	3	2	0	11	46
D	3	2	2	4	3	0	14	58
E	4	2	3	3	3	0	15	62.5

C) Performance Grid:

- **Rating Scale:**

0 = Not acceptable; 1 = Need Improvement; 2 =Acceptable; 3 = Good;
4 = Excellent

I randomly chose five learners from one class (my register class)
N = 33

N = 5

D) Reflection on group assignment

From the above it is evident that the girls performed better in the assignment than the boys. However, all the learners struggle to answer the questions sufficiently. A major problem that exists among learners is their inability to interpret, edit and apply information accumulated from the various sources. In the first instance learners did not know where and how to start their search for information. Secondly, the fact that almost all information on the topic is only available in English proved to be another problem. Learners also struggle to distinguish essential and relevant information from learning material that was not particularly relevant or apt for purposes of the specific assignment. In the final instance, the assignment proved that learners were not able to draft proper lists of references. It is presumed that the latter problem is directly attributable to the fact that learners have never been taught how to draw up such a list.

E) Suggestions for improvement

- The assignment should provide clear and extensive guidelines to assist learners on how the task need be approached.
- The educator should act as a facilitator to assist learners in their search for relevant information.
- Due to the young age of the learners the educator should ensure in advance that sufficient material for purposes of the assignment exist in the learners' language of choice.

- Learners must be taught how to draw a proper list of references.

1.5 Analysis and comparison of summative test and group assignment

A) Methodology

In order to correlate the results of the summative test and the assignment I applied the *z* summative test. Z scores indicate the number of standard deviations that a particular raw-score is above or below the mean of the raw-score distribution.

B) Index of symbols

X -Test score (expressed in percentage)
Y - Assignment score (expressed in percentage)
M_x - Mean of the test = 72.44
M_y - Mean of the assignment =85.53
SD_x - Standard deviation of the test
SD_y - Standard deviation of the assignment
r_{xy} - Correlation
N - Total number of learners

The formula for the z score is

$$Z = \frac{X-M}{SD}$$

The following formulas were applied in calculating the Z scores:

$$Zx = \frac{X-M_x}{SDx}$$

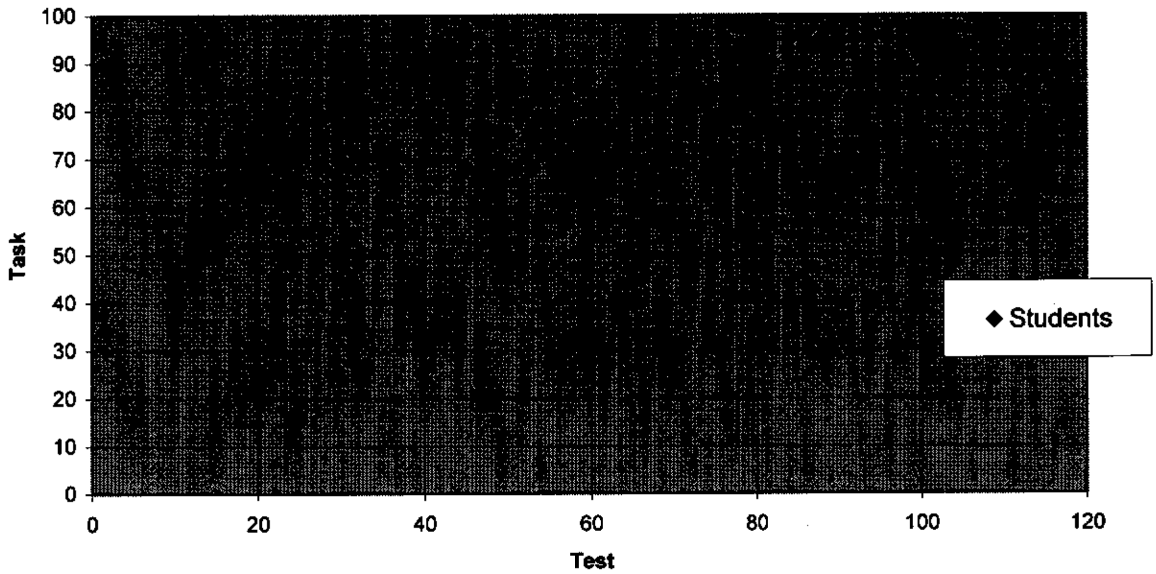
$$Z_y = \frac{Y-M_x}{SD_y}$$

The formula correlation coefficient is

$$R_{xy} = \underline{\sum Z_x Z_y}$$

Learner	Test X	z_x= (X-72.44)/16.24	Assignment Y	z_y= (Y-85.53)/10.61	zx*zy
1	60	-0.77	87	0.14	-0.11
2	45	-1.69	68	-1.65	2.79
3	82	0.59	90	0.42	0.25
4	86	0.83	90	0.42	0.35
5	58	-0.89	80	-0.52	0.46
6	76	0.22	95	0.89	0.19
7	86	0.83	90	0.42	0.35
8	50	-1.38	68	-1.65	2.29
9	62	-0.64	75	-0.99	0.64
10	72	-0.03	90	0.42	-0.01
11	70	-0.15	90	0.42	-0.06
12	98	1.57	90	0.42	0.66
13	53	-1.20	68	-1.65	1.98
14	64	-0.52	75	-0.99	0.52
15	98	1.57	90	0.42	0.66
16	96	1.45	95	0.89	1.29
17	92	1.20	95	0.89	1.07
18	86	0.83	95	0.89	0.74
19	68	-0.28	81	-0.43	0.12
20	51	-1.32	68	-1.65	2.18
21	50	-1.38	75	-0.99	1.37
22	62	-0.64	81	-0.43	0.28
23	90	1.08	95	0.89	0.96
24	94	1.33	95	0.89	1.18
25	62	-0.64	81	-0.43	0.28
26	50	-1.38	75	-0.99	1.37
27	66	-0.40	95	0.89	-0.36
28	88	0.96	95	0.89	0.85
29	86	0.83	95	0.89	0.74
30	82	0.59	95	0.89	0.52
31	74	0.09	95	0.89	0.08
32	84	0.71	95	0.89	0.63
33	90	1.08	95	0.89	0.96
34	50	-1.38	56	-2.78	3.85
35	76	0.22	95	0.89	0.19
36	52	-1.26	81	-0.43	0.54
Total	2609	0.00	3079	-0.01	29.85
Average	72.44		85.53		
Std.dev	16.24		10.61		
		Correlation coefficient	0.8292765		

C) Scattergram

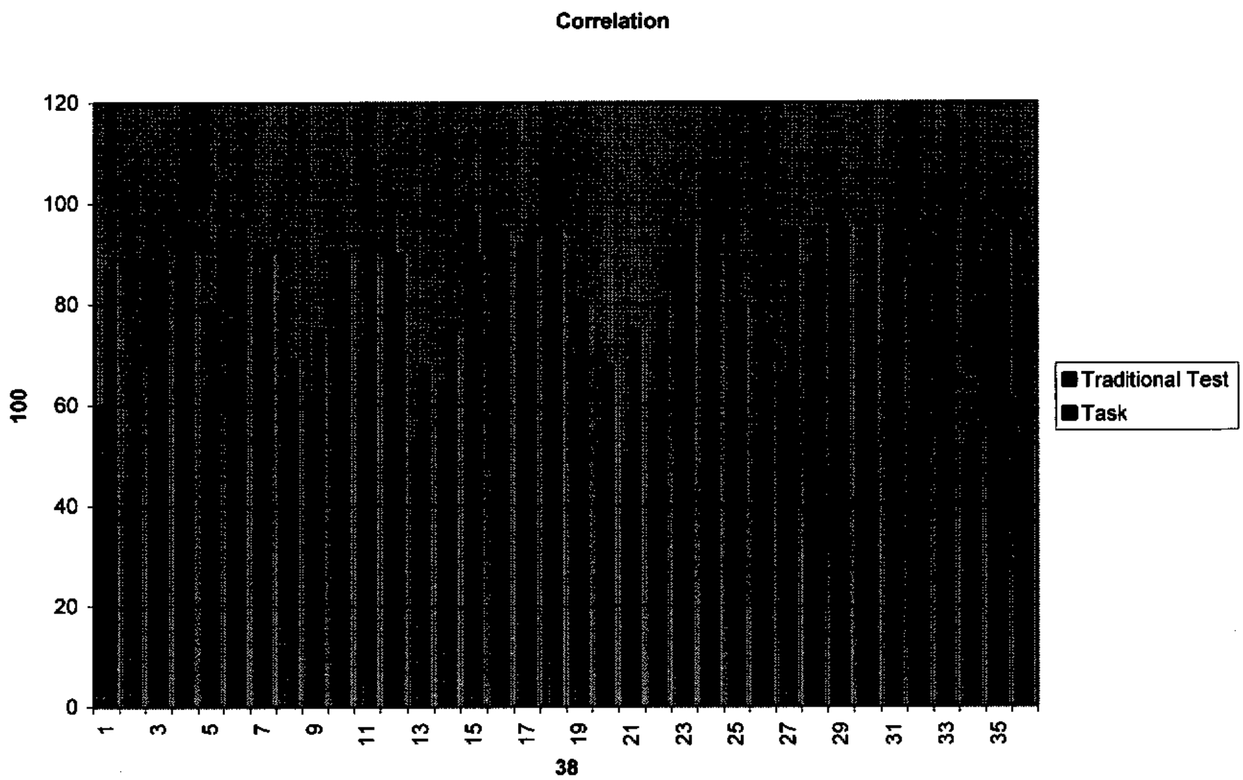


Positive correlation

Test: Assignment

r= 0.8292765

D)Correlation between summative test results and the assignment results



E) Reflection on correlation of summative test and task

With reference to the above results and scattergram diagram it can be seen that the performance in the summative test and the assignment correlates positively. The pattern was repeated: The learners who achieved the best test results also performed better in the assignment. In general the learners achieved better results in the summative tests. Furthermore, the girls achieved better results than boys in both the summative test and the group assignment.

This discrepancy might be attributed to the following:

- The summative test consists of concise questions, which requires short and brief answers that only count 1 mark each.
- Learners have previously been confronted with the answers to the questions asked in the summative test.

- The teacher conducted proper preparation for the summative test in the classroom.
- Learners had the opportunity to study for the test.
- Learners are inspired and motivated by the possibility to achieve good results, which are generally easier to attain in summative tests.
- Learners are not yet familiar with conducting proper research.
- Assignments require a higher level of cognitive thinking and creativity.

1.6 Reliability of summative test

In order to determine whether the summative test was reliable I applied the Kuder-Richardson 20 formula, since the summative test items required only a wrong (0) or correct (1) score. There were 25 items in the summative test. I analysed the results of a different class of 36 learners (N=36).

* = Correct answer

$KR_{20} = \{n/(n-1)\}* \{\{SD^2-\sum pq\}/SD^2\}$

$=0.99$

Covariance

$= SD^2-\sum pq$

$= 107.97$

Outline of the results

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36		p	q	pq	
1	*		*	*		*	*	*	*		*	*			*	*	*	*	*	*		*	*	*	*		*	*	*	*	*	*	*	*		*	28	0.78	0.22	0.17	
2			*	*	*	*	*	*		*		*	*	*	*		*		*	*	*	*	*	*		*	*	*	*		*		*		*		25	0.69	0.31	0.21	
3			*	*	*	*	*		*	*	*	*		*	*	*	*	*	*		*		*	*	*	*		*		*	*	*	*	*	*	*	28	0.78	0.22	0.17	
4	*		*				*			*		*	*	*	*	*	*	*		*	*	*	*	*	*		*	*	*	*		*	*			*	24	0.67	0.33	0.22	
5			*	*	*	*	*	*	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	32	0.89	0.11	0.10	
6		*		*	*	*	*		*	*	*	*	*	*	*	*	*	*	*		*		*	*				*	*		*	*	*	*	*		26	0.72	0.28	0.20	
7	*	*	*	*	*		*	*		*	*	*	*		*	*	*	*						*	*	*	*	*	*	*	*	*			*	*	26	0.72	0.28	0.20	
8			*	*	*	*	*		*	*		*		*	*	*		*	*	*	*		*		*					*			*				19	0.53	0.47	0.25	
9	*		*	*	*		*	*	*		*	*	*		*	*	*	*	*		*		*	*			*	*	*	*	*	*	*	*	*	*	28	0.78	0.22	0.17	
10	*					*	*		*	*	*	*	*	*	*	*	*		*			*	*	*		*	*	*	*		*	*	*		*		24	0.67	0.33	0.22	
11	*	*	*	*	*	*	*			*		*			*	*	*	*	*	*		*	*	*	*				*	*		*	*	*	*		25	0.69	0.31	0.21	
12			*	*		*	*	*	*	*	*	*	*	*	*	*	*	*			*	*		*	*	*	*	*	*	*	*		*	*	*		28	0.78	0.22	0.17	
13	*			*	*	*		*	*		*	*		*	*	*	*	*		*	*	*	*	*			*	*	*		*	*	*		*	*	26	0.72	0.28	0.20	
14		*	*	*			*	*		*		*	*	*	*	*	*	*	*				*	*	*				*	*		*	*	*	*		23	0.64	0.36	0.23	
15	*	*	*	*	*	*	*		*	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*		*	*	*	*				30	0.83	0.17	0.14	
16			*			*		*	*	*		*		*	*	*	*					*	*	*	*	*	*	*	*	*	*		*		*	*	23	0.64	0.36	0.23	
17	*	*	*	*	*	*	*				*	*	*	*	*	*	*	*	*		*		*	*	*			*	*	*	*	*	*	*	*	*	29	0.81	0.19	0.16	
18	*	*	*	*	*	*	*	*	*	*	*	*			*	*		*		*	*	*	*	*		*		*	*	*		*		*			26	0.72	0.28	0.20	
19				*		*		*	*	*		*	*		*	*	*	*	*				*	*	*		*	*	*	*	*	*	*		*	*	24	0.67	0.33	0.22	
20	*	*	*	*		*	*			*	*	*	*	*	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	32	0.89	0.11	0.10	
21	*	*	*	*	*		*	*	*		*	*		*	*	*	*	*	*		*	*	*	*				*	*	*		*	*		*	*	27	0.75	0.25	0.19	
22	*	*	*	*	*	*	*		*	*	*	*			*	*	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	*		*		30	0.83	0.17	0.14	
23	*	*	*	*	*	*	*	*		*	*	*	*	*	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		33	0.92	0.08	0.08	
24			*	*		*	*		*		*	*			*	*	*	*	*			*	*	*			*	*	*	*	*	*	*				22	0.61	0.39	0.24	
25	*		*	*			*				*	*		*	*	*	*	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	28	0.78	0.22	0.17	
	15	11	21	22	15	19	22	13	16	18	18	25	13	16	25	24	23	22	17	13	16	16	23	24	16	13	17	22	22	21	19	21	23	13	19	13				4.60	SUMpq

F. Reflection on reliability of measurement

From the above results there is a high reliability (r=0.99), which could be attributed to having 25 items.

APPENDIX C

SELF-ASSESSMENT RUBRICS

RUBRIC 1

Werkskema: Navorsingsopdrag

Groep:

____

Aktiwiteit:

____

Name van Lede:

a ________________________
b ________________________
c ________________________

Datum van inhandiging;

____

Inhoud	Punte-telling	Punt
Akkuraatheid	5	
Volledigheid	10	
Opdrag korrek uitgevoer	10	
Aanbieding van Materiaal		
Uitleg	5	
Netheid	5	
Organisasie van Idees	5	
Taalgebruik en Spelling	10	
Oorspronklikheid	10	
Prente	10	
Bronnelys	10	
Betyds ingehandig	10	
Mondelinge Verslag	10	
Bonus (Vroeër Ingehandig)	5	
Totaal		

RUBRIC 2

Portfolio Evaluasie vorm		
Naam:	**Datum:**	
Aktiwiteit:		
Geskrewe voorlegging	**Hoeveelheid**	**Punt**
Titel bladsy	5	
Inleiding	10	
Inhoud	30	
Slot	20	
Bronnelys	5	
Netheid	10	
Organisasie	20	
Inhoud		
Kommunikasie vaardighede	25	
Oorspronklikheid	25	
Akkuraatheid	20	
Gepastheid	30	
Kreatiwiteit	25	
Algemene Indruk	10	
Totale Punt	185	

Ander Kommentaar:

....

....

....

....

....

....

RUBRIC 3

Evaluering: Navorsingsopdrag

Aktiwiteit 5.

Groep: ……………… **Datum:** ……………………

Name van lede:

. ………………………
………………………
………………………

1	**2**	**3**	**4**	**5**
Nie Voldoende				*Uitstekend*

1) Dokumentasie is volledig	1	2	3	4	5
2) Informasie is korrek	1	2	3	4	5
3) Geskrewe werk is netjies	1	2	3	4	5
4) Spelling en taalgebruik	1	2	3	4	5
5) Informasie is logies afgeneem	1	2	3	4	5
6) Prente en kleurgebruik.	1	2	3	4	5
7) Bronnelys	1	2	3	4	5

Totale Punt: /35

SELF ASSESSMENT RUBRIC 1

Self-Assesering

Naam: .... **Datum:** ....

Aktiwiteit: ....

1. Ek het die aktiwiteit geniet.	☺	😐	☹
2. Ek het iets nuut bygeleer.	☺	😐	☹
3. Dit was vir my baie interessant.	☺	😐	☹
4. Ek het my bes gedoen.	☺	😐	☹
5. Ek verstaan die werk.	☺	😐	☹
6. Ek hou van wetenskap.	☺	😐	☹

SELF-ASSESSMENT RUBRIC 2

Self-Assesering t.o.v. Groepswerk

Aktiwiteit:

____

Groep:

____

Name van Lede:

a ________________________

b ________________________

c ________________________

- **Jy was lid van 'n groep**
- **Omkring die toepaslike**

1. Ek het ander aangemoedig	☺	😐	☹
2. Ek het my idees / inligting gedeel	☺	😐	☹
3. Ek het seker gemaak dat die ander lede van die groep weet wat om te doen.	☺	😐	☹
4. Ek het ander gehelp	☺	😐	☹
5. Ek het my deel gedoen	☺	😐	☹
6. Ek het na ander geluister	☺	😐	☹
7. Ek aanvaar raad van ander	☺	😐	☹
8. Ek het ander ondersteun	☺	😐	☹
9. Elkeen in die groep het sy deel gedoen	☺	😐	☹
10. Die groep het die opdrag korrek uitgevoer	☺	😐	☹

Beantwoord die volgende vrae:

11. Wat was elke lid se taak?

____

12. Watter probleme was daar binne die groep?

____

13. Wat sou jy volgende keer anders doen?

____

14. Hoe verskil groepwerk van werk wat jy alleen moet doen?

____

APPENDIX C

OBSERVATION SHEETS

OBSERVATION SHEET 1

Observasie van groepe: Eksperimente.

Aktiwiteit 4.1

Groep: ______________________________

Name van Lede:

a ______________________________

b ______________________________

c ______________________________

1 = Glad nie **2** = Selde **3** = Goed **4** = Uitstekend

	1	2	3	4
Konsentreer op taak				
Volg instruksies				
Toon goeie gedrag				
Respekteer mekaar se idees				
Al die lede werk saam				
Kommunikeer goed				
Verdeel taak gelyk				
Werk veilig				
Dogters voer die eksperiment uit				
Hanteer apparaat korrek				

OBSERVATION SHEET 2

Kontrolelys van Laboratorium Prosedures

______________________ ______________________

Naam **Datum**

____

Aktiwiteit

Sleutel: 1 = Glad nie 2 = Selde 3 = Deurlopend 1 2 3

	1	2	3
Instruksies gevolg			
Apparaat korrek gehanteer			
Apparaat deeglik skoongemaak			
Apparaat korrek weggepak			
Laboratorium area skoongehou			
Vermorsings skoongemaak			
Koöperasie met ander			
Tyd korrek aangewend			
Observasies neergeskryf			
Ander:			

Totaal: /30

Verslag: Laboratorium

Naam:

____

Datum:

____

Aktiwiteit:

____

	Uitstekend	Goed	Bevredigend	Onvoldoende
Volledigheid				
Akkuraatheid				
Organisasie				
Algemene Indruk				

Opmerking:

....

....

....

....

....

GRADE: 5

LEARNING AREA: SCIENCE

DATE: 04 - 02 – 2004

OBSERVER:

** Scale: 0 = Not applicable; 1 = Needs improvement; 2 = Acceptable, but certain aspects need to improve; 3 = Good; 4 = Excellent*

ASSESSMENT CRITERIA		**SCALE**
DEVELOPMENT	Introduction / creating a learning climate	
	Logical progression	
	Correct implementation of the girl-friendly unit	
	Resources: Exposure to female role models	
	Discipline	
	Girls are actively involved in science class.	
	Girls actively participate in the practical experiments.	
	Girls ask questions.	
	Girls are asked to answer.	
	Girls are involved in the set tasks.	
	Realisation of learning outcomes.	

APPENDIX E

OBSERVATION RECORD

Observation Record of Teacher 3

The teacher started the lesson about 7 minutes late; apparently he was delayed in the staff room. He took about another 10 minutes with routine administrative tasks, which included the collection of homework. He constantly interrupted the lesson with appeals to the learners to remain quiet and to take out their books.

After 17 minutes the lesson started Teacher 3 asked the learners whether they know what are the properties of metals. He then showed the learners different experiments relating to the properties of metals. He then explained the term and then asked some random questions in the class. The children then responded where he asked some of the prominent boys to respond.

He then told the children to write the experiments down in their workbooks under the heading of "Eienskappe van Metale" in their workbooks. Before all the learners were finished, the bell rang. The learners rushed to put away their books. He then greeted the learners and told them that it was homework.

APPENDIX F

QUESTIONNAIRES

QUESTIONNAIRE A

WETENSKAP-VRAELYS A

GRAAD 5

INSTRUKSIES:

- Beantwoord alle vrae
- Daar is geen *regte* of *verkeerde* antwoord nie.
- Wees absoluut eerlik.
- Merk jou antwoord duidelik, met 'n potlood in die toepaslike blokkie.

A. PERSOONLIKE INLIGTING:

GESLAG:	MANLIK/VROULIK
OUDERDOM:	... .
KULTUURGROEP:	....

QUESTIONNAIRE B

GRAAD 5

INSTRUKSIES:

- Beantwoord alle vrae
- Daar is geen *regte* of *verkeerde* antwoord nie.
- Wees absoluut eerlik.
- Merk jou antwoord duidelik, met 'n potlood in die toepaslike blokkie.

1. Hou jy van wetenskap?	JA	NEE
2.Is jy tevrede met die manier wat wetenskap tans in skole aangebied word?	JA	NEE
3.Sal jy eendag 'n wetenskap-gerigte beroep wil beoefen?	JA	NEE
4.Hoe sou jy jou ouers se houding teenoor wetenskap as vak, beskryf?	POSITIEF	NEGATIEF
5..Sou jy nogsteeds in wetenskap belang gestel het, al het jy 'n ander onderwyser?	JA	NEE
6.Hou jy van jou wetenskap onderwyser?	JA	NEE
7.Sou jy jou wetenskap-onderwyser as 'n rolmodel beskryf?	JA	NEE
8.Hoe sou jy jou huidige wetenskap-onderwyser se houding teenoor die leerders beskryf?	POSITIEF	NEGATIEF
9. Is jou huidige wetenskap-onderwyser manlik, of vroulik?	MANLIK	VROULIK
10. Verkies jy eerder 'n manlike, of 'n vroulike onderwyser?	MANLIK	VROULIK
11.Dink jy die wetenskap-leerplan fokus meer op die belangstellingsveld van seuns, of dogters?	SEUNS	DOGTERS
12.Doen julle groepwerk in die wetenskap-klas?	JA	NEE

13. Dink jy dat dogters soms onregverdig behandel word in die wetenskap-klas?	JA	NEE
14. Sou jy met wetenskap wou aangaan tot Gr.12?	JA	NEE

NB.

DIE BOGENOEMDE VRAELYSTE SAL VERTROULIK HANTEER WORD EN DIE INLIGTING SAL SLEGS VIR STATISTIESE DOELEINDES GEBRUIK WORD.

BAIE DANKIE VIR JOU HULP EN TYD!

QUESTIONNAIRE C

INSTRUKSIES:

- Hierdie vraelys word *slegs* deur **dogters** voltooi
- Beantwoord alle vrae
- Daar is geen *regte* of *verkeerde* antwoord nie.
- Wees absoluut eerlik.
- Merk jou antwoord duidelik, met 'n potlood in die toepaslike blokkie.

Item Nommer	Stelling	Antwoord
1	**Hoe sal jy jou algemene houding teenoor Wetenskap beskryf?**	
	Baie Positief	
	Positief	
	Gemiddeld	
	Negatief	
2	**Hoe sou jy jou algemene houding teenoor die Wetenskap – onderwyser beskryf?**	
	Baie Positief	
	Positief	
	Gemiddeld	
	Negatief	
3	**Sou jy wetenskap as pret beskou?**	
	Ja Beslis	
	Ja	
	Miskien	
	Glad nie	

4	**Dink jy almal moet wetenskap leer?**	
	Ja Beslis	
	Ja	
	Miskien	
	Glad nie	
5	**Wil jy graag baie meer van wetenskap leer?**	
	Ja Beslis	
	Ja	
	Miskien	
	Glad nie	
6	**Ek praat graag met my maats oor wetenskap.**	
	Ja Beslis	
	Ja	
	Miskien	
	Glad nie	
7	**Hoe sou jy jou houding teenoor die huidige wetenskap – kurrikulum beskryf?**	
	Baie Goed	
	Goed	
	Aanvaarbaar	
	Sleg	
8	**Sou jy eendag 'n Wetenskap – gerigte beroep wou beoefen?**	
	Baie Graag	
	Miskien	
	Nee	

9	**Ek onthou die meeste inligting wat ek in wetenskap leer.**	
	Ja Beslis	
	Ja	
	Miskien	
	Glad nie	
10	**Wetenskap leer my meer van vandag se lewe.**	
	Ja Beslis	
	Ja	
	Miskien	
	Glad nie	
11	**Wetenskap is belangrik vir 'n land se ontwikkeling.**	
	Ja Beslis	
	Ja	
	Miskien	
	Glad nie	
12	**Wetenskap is belangrik om eendag 'n goeie werk te kry.**	
	Ja Beslis	
	Ja	
	Miskien	
	Glad nie	
13	**Dit is belangrik dat ek Wetenskap verstaan.**	
	Ja Beslis	
	Ja	
	Miskien	
	Glad nie	

14	As ek sukkel met 'n wetenskap-probleem, sal ek aanhou totdat ek die regte antwoord het.	
	Ja Beslis	
	Ja	
	Miskien	
	Glad nie	
15	Ek geniet elke oomblik van wetenskap.	
	Ja Beslis	
	Ja	
	Miskien	
	Glad nie	

APPENDIX G

LETTERS OF CONSENT

Die Hoof

Laerskool Hennopspark
H/v Blackwood en Mopanieweg
Hennopspark
Centurion

08 September 2004

Geagte Meneer

DIE IMPAK VAN DOGER-VRIENDELIKE WETENSKAPKURRIKULUM EN OP DIE HOUDING VAN DOGTERS TEENOOR WETENSKAP.

Ek is 'n nagraadse student verbonde aan die Universiteit van Pretoria. Die impak van 'n doger-vriendelike wetenskapkurrikulum op die houding van dogters teenoor wetenskap, het tydens my studies groot belangstelling by my gewek. Dit is vir my duidelik dat die huidige Wetenskapkurrikulum in sekere opsigte onvoldoende is. 'n Enkele faset wat ek graag wil beklemtoon en onder die aandag van leerkragte bring, is die belangrikheid daarvan om dogters d.m.v. wetenskap te bemagtig. 'n Wetenskap-kurrikulum wat ook die belangstellingsveld van dogters dek, kan lei tot verhoogde belangstelling in wetenskap.

'n Paradigmaskuif op die gebied van aanbieding en klaspraktyk, kan 'n positiewe gevolg hê wat wyd kan uitkring met verreikende gevolge. Ten einde te bepaal of 'n doger-vriendelike wetenskapkurrikulum 'n impak op die houding van dogters teenoor wetenskap het, is dit nodig dat hierdie kurrikulum by 'n skool geïmplementeer word. Dit sal verkieslik wees indien die Gr. 5 wetenskap-leerkragte hierdie kurrikulum implementer. Hulle eie deelname is ook van belang. Daarom verneem ek graag of ek u goedkeuring kan verkry om bogenoemde navorsing by u skool te voltrek. van die die vraelyste kan versprei en laat voltooi.

Graag wil ek u ook verseker dat alle etiese kodes ten opsigte van wetenskaplike navorsing nagekom sal word.

Ek vertrou dat bogenoemde u gunstige oorweging sal geniet.

Die Uwe

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Fransie Smit
Tel. 082 3380040

08 September 2005

Geagte Ouer/Voog

DIE IMPAK VAN 'N DOGER-VRIENDELIKE WETENSKAPKURRIKULUM
OP DIE HOUDING VAN DOGTERS TEENOOR WETENSKAP.

Ek is 'n nagraadse student verbonde aan die Universiteit van Pretoria. Die impak van 'n doger-vriendelike wetenskapkurrikulum op die houding van dogters teenoor wetenskap, het tydens my studies groot belangstelling by my gewek. Dit is vir my duidelik dat die huidige Wetenskapkurrikulum in sekere opsigte onvoldoende is. 'n Enkele faset wat ek graag wil beklemtoon en onder die aandag van leerkragte bring, is die belangrikheid daarvan om dogters d.m.v. wetenskap te bemagtig. 'n Wetenskap-kurrikulum wat ook die belangstellingsveld van dogters dek, kan lei tot verhoogde belangstelling in wetenskap.

Om die navorsing te voltooi is dit nodig om onderhoude met die dogters te voer. Daar sal ook van u dogter verwag word om drie verskillende vraelyste te voltooi. Daarom verneem ek graag of ek u goedkeuring kan verkry om bogenoemde onderhoude met u dogter te voer, asook toestemming om die vraelyste te voltooi.

Graag wil ek u ook verseker dat alle etiese kodes ten opsigte van wetenskaplike navorsing nagekom sal word.

Ek vertrou dat bogenoemde u gunstige oorweging sal geniet.

Die Uwe

……………………………………………

Fransie Smit
Tel. 082 3380040

Me FA Smit
Green Oaks nr 47
Becksbergstr.
Lyttleton
Centurion
0181
10 Mei 2005

Wie dit mag aangaan

Hermee verleën ek goedkeuring dat Me F. Smit bogenoemde navorsing by die Laerskool Hennopspark mag doen en dat aan al die etiese vereistes voldoen is.

Die Uwe

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Mnr. DS van Heerden
Hoof

REPORTS BY TEACHERS

a) Report by Science teacher 1:

Verslag: Myn van Metale

Graad: 5

Die leerders vind die opdragte uitdagend, maar terselfde tyd verstaanbaar. Ek vind ook dat die leerders die aktiwiteite rondom die bespreking van mynbou in Suid-Afrika en die verskillende metale wat ontgin word, baie geniet. Die leerders doen ook baie moeite t.o.v die navorsing wat van hulle verwag word. Daar is ook baie inligting beskikbaar en die leerders geniet die eksperimente baie. Die gehalte was van 'n hoë standard. Dit was 'n voorreg om die geleentheid te hê om die eenheid te implementeer.

b) Report by Science teacher 2:

Verslag: Myn van Metale

Graad: 5

Die leerders geniet die aktiwiteite baie. Die werk oor die minerale in Aktiwiteit 1 en 2 was werklik 'n groot leerervaring. Die leerders het presies geweet wat van hulle verwag word en het effektief in groepe saamgewerk. Die leerders het meestal in homogene groepe saamgewerk en daar was oor die algemeen minder bakleiery tussen die groepe.

Die leerders geniet die eksperimente BAIE, maar die seuns was gou ongelukkig, omdat die dogters eerste die geleentheid gekry het om die eksperimente te doen en vrae te beantwoord.

Sommige seuns word só ongelukkig dat hulle negatief word en belangstelling verloor teenoor die werk.

Die leerders wat gewoonlik goed presteer het, omdat hulle alles uit hulle koppe uit geleer het, het swakker as gewoonlik presteer in dié toets, omdat dit meer prakties van aard was. Die leerders wat aandag gegee het in die klas, veral met die eksperimente, het baie goed presteer.
Die gemiddelde presteerders het ook beter gedoen as gewoonlik.

Al die baie eksperimente en praktiese werk verg egter baie tyd en die praktiese materiaal is nie altyd beskikbaar nie. Dit was egter 'n baie leersame ervaring en ek sal dit graag in die toekoms weer wil doen.