University of Cape Town

Faculty of Education

SECONDARY SCHOOL SCIENCE PUPILS' RANKINGS OF SCIENCE AND TECHNOLOGY RELATED GLOBAL PROBLEMS:

A Comparison of the responses of rural-Northern Sotho, urban-Xhosa and urban-English speaking pupils in South Africa to *Meeting Basic Needs* in the context of the 1994 Government White Paper on Reconstruction and Development

by

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SUMMARY

In 1984 Bybee used 262 science educators from 41 countries to develop an instrument for measuring their ranked priorities of science and technology related global problems. In 1995 the original Bybee scale was updated and clarified, and a new 15-item version, the Le Grange Global Priorities Instrument (LGPI) was piloted, refined and administered in fifteen schools to 946 secondary school pupils speaking three different home languages in two provinces in South Africa.

The study is an enlargement of the work of Bybee and Mau (1986); Bybee and Najafi (1986); Ndodana, Rochford and Fraser (1994); and Le Grange, Rochford and Sass (1995), and is carried out in the context of the new key programme of *Meeting Basic Needs* presented in Section 1.4.1 of the Government White Paper on the Reconstruction and Development Programme for the New South Africa which states:-

> The basic needs of people extend from job creation, land and agrarian reform to housing, water and sanitation, energy supplies, transport, nutrition, health care, the environment, social welfare and security (Government Gazette No. 16085, 23 November 1994:9).

The 946 pupils surveyed in this study in 1995 comprised 414 rural-Northern Sotho pupils (sample 1) from the Northern Province; 189 urban-Xhosa speaking pupils (sample 2) and 343 urban-English speaking pupils (sample 3) from the Western Cape.

The data was collected during the period January to July using convenient ten-minute slots as part of normal science/biology time-tabled periods of formal instruction, and 95% of the sets of data were complete and usable. The data were analysed using the Spearman rank correlations and Mann-Whitney U-tests for the purpose of disclosing significant similarities and differences between the regional responses to the LGPI items. Test-retest correlations of $r = 0.93$ ($n = 58$) and $r = 0.93$ ($n = 11$) were obtained for the LGPI instrument as a whole using smaller samples of available students in 1995.

On items 2 to 15 the 414 Northern Sotho pupils' responses and the 189 Xhosa pupils' responses correlated highly significantly: rho = 0.71 ($n = 14$), $p = 0.01$; which is noteworthy for two disparate groups of pupils speaking two quite different languages, and living 1800 kilometres apart. However, on item 1, *the provision of mass housing*, the priorities of the two samples were widely different, (rural-Northern Sotho pupils ranking it fourteenth; urban-Xhosa ranking it first).

Mann-Whitney U-tests also disclosed significant differences in the score distributions between the samples on several other items, which may be a local reflection of regional preferences. However, the responses of the English-speaking sample to the whole 15-item LGPI did correlate significantly with those of the Xhosa-speaking sample ($r = 0.58$) and also with those of the North Sotho sample ($r = 0.54$), despite the occurrence of some statistically significant differences in the score distributions on several individual items in the LGPI.

The results show that the four global problems top-ranked by all three samples were *human health and disease*; *fresh water supplies; world hunger and food supplies*; and *population growth*. These four items relate to basic human needs for long and short-term survival. These findings provide preliminary empirical support, from nearly 1000 high school pupils, for the Gazetted Key Programme 1.4.1 set out in the new South African Government's policies of its 1995 Reconstruction and Development Programme. The study also tentatively supports current claims by science and biology educators that science curricula might be more environmentally oriented, relevant to societal needs and designed with a core-plus-options model to cater for cultural and regional diversities.

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LIST OF ABBREVIATIONS

AEC	Atomic Energy Corporation
ANC	African National Congress
DBSA	Development Bank of Southern Africa
LGPI	Le Grange Global Priorities Instrument
MW	Megawatts
RDP	Reconstruction and Development Programme
STS	Science-Technology-Society

CHAPTER 1

INTRODUCTION

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INTRODUCTION

1.1 Statement of the problem

> *It is science alone that can solve the problems of hunger and poverty, of insanitation and illiteracy, of superstition and deadening custom and tradition, of vast resources running to waste, of a rich country inhabited by starving people. Who indeed could afford to ignore science today? At every turn we have to seek its aid. The future belongs to science and those who make friends with science.*
>
> Jawaharlal Nehru (1889 - 1964)
> First Prime Minister of the Free India

The discoveries of science and technology have benefited humanity. The discovery of the drug Penicillin has saved millions of lives (Perutz, 1989:149); smallpox has been eliminated in all countries; scarlet fever is easily cured by antibiotics; and vaccination programmes in all countries have kept out common infectious diseases such as measles, diptheria, whooping cough and poliomyelitis (Robertson, 1995). Applications of pesticides and fertilizers have enabled us to grow more food than ever before. The nutrition and health of children has led to an increase in life expectancy of humans in even the poorest countries of the world. For example, the United Nations Organisation estimates the life expectancy at birth in sub-Saharan Africa to have increased from 40 years in 1960 to 51 years in 1985 (Metcalfe, 1995). The discovery of electricity makes it possible to cool and warm buildings, to run industries and to move from place to place more efficiently. George Marx (1994:6) states:

> In the second half of the twentieth century, modern science and its offspring - high technology - accelerated further the pace of history. Internal combustion (cars and aeroplanes), telecommunications (radio, television, telephone, fax and electronic mail), and computers and contraceptives have produced, within years, more lasting changes in the political-ethical-social web than any ideology, philosophy or religion could achieve in the previous centuries.

Despite the advances of science and technology, today, in the 1990s, parts of our globe are under threat of destruction due to problems such as population explosion, global warming, the hole in the ozone layer, desertification and deforestation, and so on. Modern science has lowered death rates from disease, only to leave us faced with a population explosion.

Pesticides and fertilizers enable us to grow more food, but they can also kill birds and fish and pollute our water and food. The generation of electricity has many benefits for humans, but also sometimes pollutes our air, water, and threatens our health. While technology solves many problems, it also creates new ones requiring more elaborate and expensive technology.

The environmental crisis facing some parts of our planet, together with new diseases such as AIDS and old diseases such as tuberculosis, threaten to reverse the declining mortality. Thus new challenges face different people in different regions of the world.

It is science, and science and technology education, that will play a pivotal role in meeting these new challenges. However, it is not science or science education *per se* that will save us, but science and science education of the right kind.

It is science for global sustainability, yet a science that is relevant to basic needs of local communities, that is needed in schools. School science must engender in pupils both the ability to *think globally and to act locally*. But what is the current state of science curricula in South Africa?

Science curricula in South African schools are sometimes perceived as largely irrelevant to the majority of pupils who move into non-academic and non-science careers when they leave school (Watson, 1990; Schreuder, 1991; Spargo, 1995 and Doidge, 1995). Possibly this occurs when classroom teachers omit the applications of theories to successful inventions and endeavours. Schreuder pointed out that some biology education in South Africa in 1991 served very little purpose other than preparing academically those pupils who would follow courses at tertiary institutions where the subject was a requirement. As little has changed concerning the content of the biology curriculum, in 1995, the 1991 scenario largely holds true. According to Spargo (1995:2) many teachers believe that the concentration on 'pure' science in schools has led to the perception among pupils that physical science, in particular, is a difficult subject, and that the relative unpopularity of science in many schools is an automatic consequence.

A recent reform movement spreading across the world is the science-technology-society approach (STS), which seeks to answer the call for *relevance* and preparation for citizenship

(Doidge, 1995:109). One of the approaches to curricula of the STS movement is an *issue-based* approach, in lieu of the mere studying of 'scientific' facts. With reference to biology curricula, Doidge (1995:110) raises an important question, whether biological facts or relevant issues are of most worth to pupils in South Africa:

> A glimpse into the lives of secondary school biology pupils finds them struggling through the complexities of the Krebs cycle, osmotic potential, striated muscle structure and the development of the female prothallus in the megaspore on the ovuliferous scale of an alien plant. 'Vital' information such as the position of the female opening on the ventral surface of the earthworm, leaf shapes, cell types in Hydra and the life cycle of the frog is force-fed to pupils who are exhausted and struggle to concentrate because of pregnancy, tuberculosis, chronic bronchitis and asthma caused by air pollution, chronic bilharzia and other parasitic infections such as roundworms and hookworms, and undernutrition because crops will no longer grow on barren lands. What knowledge is most worth? An endless catalogue of biological facts **or** issues such as human health and disease, world hunger and food resources, land use and desertification, air pollution and CO_2 levels, dumping of hazardous substances, scarce water resources which are polluted and disease-ridden, population growth and biotechnology?

Recently Hattam (1994:45) has advocated that science education, "needs to be constructed as a study of global issues in which 'scientific' knowledge is examined in social context". Hattam states that the STS topics and themes in the article of Bybee and Mau (1986) are very useful for studying science as contextual knowledge. The themes presented in this work by Bybee and Mau (1986) have now been updated and modified in 1995 in South Africa, and incorporated into a new intrument, the Le Grange Global Priorities Instrument (LGPI), which requires respondents to rank the relative importance of 15 items. Many of the themes incorporated in the LGPI are also pertinent to the key programme of *Meeting Basic Needs* of the 1995 Reconstruction and Development Programme (RDP) for the new South Africa.

South Africa, detaching itself from an Apartheid legacy, is a heterogeneous nation of many cultures and languages. Therefore the basic needs of South Africans vary greatly in terms of context, such as geographical location or urban and rural settings. The Northern Province, for example, is the most rural province in South Africa. The urbanisation rate of this province is only 12 percent, and it has the highest human fertility rate in the country of 5.8. The Western Cape on the other hand has a high urbanisation density of 95.1 percent and has the lowest fertility rate of 2.7 in the country (Harber and Ludman, 1995: 363-363).

In the 1994 RDP *Policy Framework Document* of the African National Congress (ANC), it is stated that less than half of the South African rural population has a safe and accessible water supply; that land is one of the most basic needs of rural dwellers; and that rural women in particular face the heavy burden of collecting wood, which is an inefficient and unhealthy fuel (pages 28,19,31).

It is therefore clear that regional science and technology programmes, curricula and examinations must be designed to meet the diverse needs of the different societies of the South African nation. Lewin (1993:6) states:

> In the poorest countries, where prospects for industrialisation are long term, basic human needs - clean water, adequate nutrition, shelter, etc. - may be most effectively addressed by disseminating science/technology more widely and placing the emphasis of school education on this. Conversely, where technology transfer at higher levels of sophistication is favoured as a development strategy, science education can play another role.

In the light of the above, gathering clear data on how current science pupils in the Northern Province and the Western Cape Province prioritise the relevance and local importance of fifteen pertinent science and technology related global problems may contribute to providing empirical evidence for the support of RDP policies, as well as offering recommendations for the development of future science curricula in South Africa.

1.2 Purpose of the study

This study seeks to measure one aspect of the current science-technology-society debate in South Africa, namely, the perceived relative importance of the global problems, currently established as major by wide consensus, in the domain of science and technology.

A comparison is made of the mean numerical rankings of fifteen pertinent science and technology related global priorities among three samples: 414 rural-Northern Sotho speaking secondary school science pupils; 189 urban-Xhosa speaking secondary science pupils and 343 urban-English speaking secondary science pupils, all of whom were surveyed during the period January to July 1995.

1.3 Origin and background of the research

The study is an enlargement of the work of Bybee and Mau (1986); Bybee and Najafi (1986); Ndodana, Rochford and Fraser (1994); Le Grange, Rochford and Sass (1995); and Le Grange, Rochford and Paulsen (1995), and is carried out against the background of the key programme of *Meeting Basic Needs* stated in Section 1.4.1 of the Government White Paper on the Reconstruction and Development Programme for the New South Africa:-

> The basic needs of people extend from job creation, land and agrarian reform to housing, water and sanitation, energy supplies, transport, nutrition, health care, the environment, social welfare and security" (Government Gazette No. 16085, 23 November 1994).

It also contextualises a perceived need for more modern science and technology curricula, developing an inter-disciplinary, integrated and environmental approach to science education at the secondary level (Clacherty, 1990; Watson, 1990; Schreuder, 1991; Spargo, 1995 and Doidge, 1995).

It is in this context that this survey therefore measures, compares and contrasts the perceived global problems of rural and urban high school science pupils in the domain of science-technology-environmental education for the turn of the century.

1.4 Importance of the research problem

In a democratic, scientifically and technologically based society it is important for all citizens to be as scientifically and technologically literate as possible. South Africa's historic entry into a democratic dispensation in April 1994 makes scientific literacy an important goal for all its citizens. One of the ways in which scientific and technological literacy can be acquired is by the introduction of science-technology-and-society themes, particularly school science curricula (De Boer, 1991:178). Research on how science and technology related global problems are perceived and prioritised by future citizens currently studying science in school is therefore particularly relevant in South Africa at this point.

The Government of National Unity will continue to invest in both human and material resources in its Reconstruction and Development Programme. From money appropriated by

Parliament, through savings by the departments, R2.5 billion was allocated to the RDP fund in the 1994/95 budget. This amount will be progressively increased to R12.5 billion in the budget year 1998/99 (Government Gazette No. 16085, 23 November 1994:14). On 10 October 1995 the Reconstruction and Development Programme department announced that 614 municipal infrastructure projects had been launched at a cost of 752 million rand (Cohen, 1995). These projects will affect the lives of 3.6 million people and includes the provision of water, sewerage, electricity, roads and rehabilitating municipal services (*Ibid*). According to the Minister without Portfolio, Jay Naidoo, a further R750m could be allocated to kickstart the local authorities established after the November elections (*Ibid*). This current research attempts to provide some initial supporting evidence for justifying this policy.

A third important factor - and an issue that requires urgent redress in South Africa - is the existence of urban-rural imbalances. In meeting the basic needs of South Africa's people there are sharp differences between people living in urban and rural areas. It is estimated that there are at least 17 million people surviving below the Minimum Living Level in South Africa, and of these at least 11 million live in rural areas (*RDP base document*, 1994). Research to establish whether any significant urban-rural differences occur in perceived priorities for tackling global problems may prove useful in seeking recommendations or solutions to redress imbalances in the above mentioned area.

At present South Africa is in a state of transition. We have an interim government, an interim constitution and interim science syllabuses. This implies that new science curricula will soon be implemented in South African schools. This interim period presents an ideal and important opportunity to decide priority areas for inclusion in future science curricula. Two of the key principles of the Education and Training Policy stated in the most recent Government White Paper on Education and Training are: an appropriate mathematics, science and technology education; and environmental education, involving an inter-disciplinary, integrated and active approach to learning at all levels and programmmes of the education and training system. The view that environmental education must be integrated into all school subjects is supported by Myburgh (1994) and Joubert and Steenkamp (1995). Research in the area of prioritisation of global problems related to South African science and technology (many being environmental problems) is therefore fully justifiable.

As we approach the end of the twentieth century, our world is rapidly moving towards becoming a single global community. In his seminal work **Science Research Policy in South Africa: A Discussion Document for the Royal Society of South Africa**, Professor George Ellis (1994:10) states:

> The world has been shrinking with the increasing power of technology, and in the 21st century we will essentially be looking at a single global community, the 'global village'. Already we know instantly what is happening anywhere in the world, droughts in Somalia are seen in the living rooms in the USA, floods in Pakistan are seen by Peruvians. Economically the world is becoming more interlinked: we are all affected by the global economy. We also recognise global commons - the oceans and the atmosphere, and pollution by one or more nations can become a global affair (viz. ozone depletion). There is a growing awareness of the interconnectedness of everything, and that the natural resources of the earth are not limitless.

Thus research on the prioritisation of global problems is particularly important and relevant at this point.

1.5 The aims of the research are:-

- To measure, compare and contrast the perceived priorities of global science-technology-society problems in 1995, among rural-Northern Sotho speaking science pupils, urban-Xhosa speaking science pupils and urban-English speaking science pupils.

- To explain the significance of any high rank-order correlations which might occur on the new LGPI among the three samples.

- To discuss, in terms of the 1994 Government White Paper on South Africa's new Reconstruction and Development Programme, any empirically established areas of agreement or areas of different prioritisation among the three samples.

- To establish whether there are any statistically significant differences in prioritisation between rural and urban samples of pupils.

- To link the findings obtained with South African pupils in 1995 with the related earlier findings on the Bybee scale reported with South African science and biology teachers in 1993, focusing on areas of agreement and areas of different prioritisation.

- To make recommendations for altering the content and wording of the LGPI scale itself for use with English second language and rural pupils.

1.6 Hypotheses

Six null hypotheses are tested in this study. Three hypotheses test whether significant correlations exist between samples with regard to their mean rankings of global problems on the LGPI as a whole. The other three hypotheses test whether any significant differences exist in the score distributions between samples on each one of the fifteen major global problems.

1.7 Clarification of terms

Science-technology-society (STS) describes the latest effort to provide a real-world context for the study of science, and for the pursuit of science itself. It focuses upon current issues and attempts at their resolution as the best way of preparing people for current and future citizenship (Ost and Yager, 1993:282).

Science in this study includes the subjects biology, general science and physical science currently taught in South African schools.

The meaning of **global problems** related to science and technology are defined in the Le Grange Global Priorities Instrument (LGPI) presented in Table 1.1 on page 9.

The Le Grange Global Priorities Instrument (LGPI) is a 15-item *rank-order scale* modified and adapted from Bybee (1984) and Ndodana et al. (1994) and is used for measuring how science and technology related global problems are ranked in order of their perceived importance.

Table 1.1
The **LGPI** (The Le Grange Global Priorities Instrument)

RANKING OF SCIENCE AND TECHNOLOGY - RELATED GLOBAL PROBLEMS

What do you see as the most important global problems related to science and technology for the human race? Rank the following from 1 to 15 (with 1 indicating your top priority). Insert your numbers in the appropriate brackets.

GLOBAL (WORLD) PROBLEM

[ ] **THE PROVISION OF MASS HOUSING FOR HUMAN BEINGS** (homes for all including garbage collection and sewage disposal, shelter, protection, street lighting, social services such as police force and postmen).

[ ] **UNSAFE SUBSTANCES** (waste dumps, poisonous chemicals, lead paints, electromagnetic wave radiation, e.g. ultraviolet radiation from the sun and microwave oven radiation).

[ ] **HUMAN HEALTH AND DISEASE** (catching and non-catching disease such as AIDS, exercise, mental health, stress, noise, diet and nutrition).

[ ] **MINERAL RESOURCES** (non-fuel minerals, metallic and non-metallic minerals, mining, technology, low grade deposits, recycling, refuse).

[ ] **FRESH WATER SUPPLIES** (waste disposal, river mouths, water supply and distribution, ground water contamination, fertilizer contamination, waste water treatment, prediction and control of floods and droughts).

[ ] **POPULATION GROWTH** (increase in world population, immigration, living space, town planning).

[ ] **EXTINCTION OF PLANTS AND ANIMALS** (fewer types of animals remaining, over-fishing, pollution and reduction of life in the oceans, wildlife protection).

[ ] **ENERGY SHORTAGES** (human manufactured fuels, solar power, fossil fuels, fewer resources, conservation, oil production).

[ ] **WAR TECHNOLOGY** (nerve gas, nuclear developments, nuclear weapons threat).

[ ] **AIR POLLUTION** (acid rain, CO_2, depletion of ozone layer, smoky smog, global warming).

[ ] **WORLD HUNGER AND FOOD SUPPLIES** (food production, crops and agricultural methods).

[ ] **BAD LAND USE** (soil erosion, reclaiming of land, city spread and growth, wildlife habitat loss, removal of forests, spreading of deserts, increase in the salt content of soils).

[ ] **NUCLEAR POWER STATIONS** (nuclear waste management and disposal, cost of construction, safety, sabotage).

[ ] **USE AND ABUSE OF TECHNOLOGY** (the electronic information explosion, education and the distribution of knowledge, genetic engineering, worldwide communication networks, job creation, indoctrination by television, the rapid sharing of controversial information by satellite).

[ ] **IGNORANT DECISION MAKERS** (scientifically and technologically illiterate community leaders, science and the humanities as two different cultures).

* Adapted, modified and updated from Bybee (1984) and Ndodana et al. (1994)

1.8 Limitations of the study

In this investigation data gathering was limited to convenient and accessible samples of rural-Nothern Sotho speaking science pupils from the former Lebowa Education Department; urban-Xhosa speaking pupils from the former Department of Education and Training; and urban-English speaking pupils from the former Administration, House of Representatives.

The number of STS global problems investigated was limited to 15, even though some pupils may have perceived additional STS issues as of major importance. The limitations of the research instrument itself and of the research method employed in this investigation are discussed in greater detail in Chapter 5.

1.9 The assumptions of the study

The study assumes that the respondents are in an informed position to make comparisons in prioritising science and technology related global problems. It is also assumed that the order of the items on the LGPI will not affect the way respondents rank items. It is further assumed that the fact that two of the samples were English second language speakers will not necessarily or appreciably affect the way science and technology related problems are prioritised.

1.10 Research approach

The data was collected during time-tabled periods of formal instruction by means of the LGPI (The Le Grange Global Priorities Instrument), a 15 item instrument designed for use by science educators, undergraduate engineering students, undergraduate business/marketing students and secondary school pupils who are English first or second language speakers. The data collection was efficient, requiring a period of about five to ten minutes as part of the normal schedule of the students' timetabled period of instruction.

The mean rankings for the fifteen items rated by the three samples will be analysed by comparisons of Spearman's rank order correlation coefficients. Significant differences in the overall prioritisation of the fifteen items by rural and urban samples will be analysed by Mann-Whitney U-tests for non-normally distributed data.

1.11 Organisation of the remainder of the research

Chapter two

In this chapter the theory of ranking priorities as a research tool is discussed. The chapter also reviews the relevant theories, principles and concepts underpinning global problems related to science and technology, together with previous research findings.

Chapter three

This chapter presents the research method, including a description of the samples, the measuring instrument and the method of data collection.

Chapter four

The presentation of the results, and summary of the findings of the research, are reported in this chapter.

Chapter five

In this chapter the empirical research findings of the study are discussed.

Chapter six

This chapter formulates and presents conclusions, recommendations and implications of the study for further research.

1.12 Chapter summary

In this introductory chapter the research problem has been clarified, and its background and significance have been stated. The aims of the research and key terms have been clarified, the assumptions of the study stated and the limitations of the research mentioned.

In the next chapter the relevant literature will be reviewed and the theoretical framework for the thesis provided.

CHAPTER 2

LITERATURE REVIEW

CHAPTER 2
LITERATURE REVIEW

This chapter is divided into three sections. In SECTION 2.1 a review is presented of the theoretical bases for employing *rank-order scales* in educational research.

In SECTION 2.2 a summary is presented of *related research findings* which set the present study of global priorities in STS in context. They show how it links up with and extends the knowledge reported in the previous work.

Finally, in SECTION 2.3, a theoretical basis is presented for justifying the final selection, modification and inclusion of each one of the 15 items which comprise the 1995 LGPI instrument employed in this study. It is shown how each item is relevant to the principles and clauses in recent government policy documents of the Reconstruction and Development Programme in the new South Africa.

2.1 The use of rank-order scales in educational research

In this study a *rank-order* scale is used to obtain survey responses. A *rank-order scale* is an example of a comparative rating scale. Comparative rating scales rely on respondents to make *relative* judgements. The *rank-order scale* is the most common comparative rating scale, and is a type of ordinal scale (Fink and Kosecoff, 1985:35).

Rank-order scales have been used effectively in science education research covering diverse topics. For example, in 1978 Gould reported a striking consistency in the rankings of the *aims of science practical work* among sixth form physics teachers (n = 221), chemistry teachers (n = 220) and biology teachers (n = 214).

In a second study in 1987 Okebukola found that, on the whole, a good measure of agreement existed between teachers' and students' rankings of the relative importance of *most factors affecting students' performance in practical chemistry*. The value of Wilks Lambda associated with the one discriminant function separating the perceptions of the two groups on the performance measure was found to be 0.13. The chi-square value obtained was 1.13 ($p > 0.05$), supporting the hypothesis that perceptions of the teachers and students regarding the relative importance of the factors to students' performance in practical chemistry were not statistically different.

In a third study in 1988 Gayford investigated a total of 447 teachers' perceptions of the relative importance of the aims and purposes of practical work in biology. In all samples the highest ranked position was given to the development of observational and descriptive skills. However, other aims were assigned different rank orders among the various samples surveyed.

In a fourth study in 1995 Ost used a *rank-order scale* to establish the perceived risk for selected activities and technologies by *women voters*, *college students* and *experts*. Highly significant correlations were found between the three disparate groups, ranging from rho = 0.59 to 0.84 ($n = 30$), which is significant at the level $p = 0.01$.

Oppenheim (1992:250) points out that a ranking approach is often used in everyday life. For example, children may be ranked from top to bottom in a class; athletes or horses may be placed in the order in which they finish a race; pop charts may rank musical recordings in sequence of their popularity, and so on. However, a ranking scale tells us nothing about the *magnitude* of the differences between ranks; the 'distance' between ranks two and three, for example, may be very large, but between ranks five and six it may be minute. Ranking records the order or sequence, but the *size* of the rank interval is usually unknown and unlikely to be equal (*Ibid*).

According to Babbie (1973:150), the task of rank ordering of responses is often difficult for respondents, since they may have to read and reread the presented list several times. As a result, under normal survey conditions, the task of putting ten items in rank order is probably as much as can be asked from respondents (Oppenheim, 1992:250).

Babbie (1973:151) says the following should be noted when using *rank-order scales*:

instructions should indicate a different type of answer *format* to be used (for example, blanks instead of boxes); instructions should indicate *how many* answers are to be ranked (for example, all, first and second, first and last, most important and least important), and the *ordering* of ranking (for example, 'place a 1 beside the most important, a 2 beside the next most important, and so forth').

Because *rank-order scales* are not equal interval scales, and because data produced by *rank-order scales* are not normally distributed, non-parametric statistical methods must be used to analyse the data. For example, Gould (1978) and Gayford (1988) used Kendall's coefficient of concordance (W) to compute rank correlation coefficients; and Ndodana, Rochford and Fraser (1994), and Le Grange, Rochford and Sass (1995) used Spearman's rank correlations to compute rank correlation coefficients. The non-parametric Kolmogorov-Smirnov two-sample test was used by Gayford (1988) to indicate significant differences between rankings made by samples.

2.2 Previous research findings on the prioritisation of STS global problems

In 1984 Bybee used 262 science educators from 41 different countries to develop an instrument for measuring their ranked priorities of science and technology related global problems. The science educators indicated that *world hunger*, *population growth*, *air quality*, *water resources*, *war technology* and *human health* were the most important global problems (Bybee and Mau, 1986). The choice by science educators of *world hunger*, *population growth*, *air quality*, *water resources* and *war technology* as top-ranked items was independently replicated by United States college students (n = 216) also surveyed in 1983 and 1984 (Bybee and Najafi, 1986).

The college students, however, ranked *human health and disease* low down as their ninth priority (on average) on the 12-item scale. The mean differences in prioritisation of *human health and disease* by science educators and college students might be ascribed to the fact that the science educators represented individuals from both first and third world contexts, whereas the college students were samples from a first world context in Minnesota, Colorado and Iowa in the United States where human health was not a major concern at the time. The majority (more than 50%) of science educators and college students predicted that top-ranked items - *world hunger*, *population growth*, *air quality*, *water resources* and *war technology* - would be worse by the year 2000 (Bybee and Mau, 1986; Bybee and Najafi, 1986). However, the majority of science educators and college students forecasted that human health and disease problems would be improved by the year 2000.

Almost a decade later Ndodana, Rochford and Fraser (1994) surveyed Cape Town science educators (n = 76) and University of Cape Town chemical engineering students (n = 129) using the Bybee scale, and compared these findings with those of the international science educators (n = 262) surveyed by Bybee in 1984. It was found that the rank-order correlation between the 1993 engineering undergraduates' priorities and the 1984 international science educators' priorities was 0.65. The correlation was 0.85 between the 1993 engineering undergraduates' ratings and the 1993 Cape Town science educators' ratings. These are significantly high correlations reflecting a large degree of consistency over a ten-year period on the same set of issues (Ndodana, Rochford and Fraser, 1994:246).

However, whereas the international science educators and College students ranked *human health and disease* sixth and ninth respectively in 1984, the Cape Town science educators ranked this problem first and the undergraduate engineering students ranked it third in 1993. This shift in ranking may indicate that the South African perception that *human health and disease* could be a worse problem by the year 2000 runs against the trend forecast by international science educators and college students surveyed in 1984. However, evidence from larger samples is required to support this.

War technology, over a 10-year period, was re-ranked from third (college students) and fifth (international science educators) to the eleventh and twelth positions assigned respectively by Cape Town science educators and undergraduate chemical engineers at the University of Cape Town.

Using feedback commentary from Cape Town samples in 1994, a modified and updated version of the Bybee scale, the LGPI, was administered to Peninsula Technikon business/marketing students (n = 78) and to University of Cape Town engineering students (n = 214) in 1995. The rank-order correlation between the engineering students' priorities and the business/marketing students' priorities was 0.90, which indicates a substantial area of agreement in terms of the country's current economic and practical needs (Le Grange, Paulsen and Rochford, 1995).

A recent study submitted for publication by Le Grange, Rochford and Sass (1995) has compared the mean rankings of male and female engineering students as well as male and female business/marketing students. Whereas the male engineering students rank *air pollution* concerns as their fourth priority, the female engineering students rank it only ninth. Among the business/marketing students, the concern for *extinction of species* is ranked eighth by the females but only fifteenth by the males. Whereas the male engineering students rank *world hunger* as their sixth priority, the female engineering students rank it third. Males and females in both samples agree on a high prioritisation for the *provision of mass housing*, *population growth*, *fresh water supplies* and *human health and disease* (Le Grange, Rochford and Sass, 1995). In this study the rank-order correlation between the engineering students' priorities and the business/marketing students' priorities is 0.93. The correlation between 187 male engineering students' and 27 female engineering students' rankings is 0.91. Between the 27 male and 51 female business/marketing students, the rank correlation is 0.85. These three correlations are consistent with reliability coefficients obtained for the LGPI itself, namely r = 0.93 with high school science students over a 24 hour period (n = 58) and r = 0.93 over a two week period (n = 11) with a sample of postgraduate science teachers-in-training.

The female students correlate 0.92 across the fields of study, indicating a strong gender consensus between females in two disparate academic disciplines. By contrast, the male students correlate only 0.78 across the faculties of engineering and business/marketing.

In summary, to date the LGPI has been established as a reliable and convenient instrument, the items of which have produced many consistent findings, but some pertinent differences across disciplines and gender were found in multicultural contexts. It might therefore be useful to establish preferences of respondents in *urban versus rural contexts* as well as priorities of respondents from varying socio-economic backgrounds to see whether it will yield similar sets of preferences and patterns of responses.

2.3 Theoretical basis for selection of the 15 LGPI items

In the work of Ndodana et al (1994:246) it was reported that 20 engineering lecturers in 1993 identified several important issues that needed to be included in any updated version of the 1984 Bybee scale. In 1995 the suggestions of these South Africans were used to modify and expand the Bybee scale. Three new items were added, and a number of additional sub-categories were more definitively circumscribed. The wording of the instrument was also simplified by a panel of twelve science and English teachers so that the instrument could be understood and administered not only to English second language speakers, but also to secondary school pupils as well.

In the follow-up sample of 20 lecturers in the Faculty of Engineering at the University of Cape Town in 1993, new priorities introduced included the provision of mass housing and infrastructure; sanitation; urbanisation; job creation; the abuse of high technology in communication; technological illiteracy among decision makers; abuse and reduction of oceanic resourses; photochemical smog; the prediction and possible control of droughts and floods; the demands on the human race of the information explosion; electromagnetic wave hazards and pollution; resource depletion; and education and the dissemination of knowledge (Ndodana et al, 1994:246). All these suggestions were incorporated either in the modified re-wording of existing items in the Bybee scale, or as new items separately added.

The three entirely new items that were included in the modified Bybee scale are presented in Table 2.1 below.

Table 2.1
Three new items included in the LGPI in 1995

THE PROVISION OF MASS HOUSING FOR HUMAN BEINGS (Homes for all including garbage collection and sewage disposal, shelter, protection, street lighting, social services such as police force and postmen).
USE AND ABUSE OF TECHNOLOGY (the electronic information explosion, education and distribution of knowledge, genetic engineering, worldwide communication networks, job creation, indoctrination by television, the rapid sharing of controversial information by satellite).

IGNORANT DECISION MAKERS (scientifically and technologically illiterate community leaders, science and the humanities as two different cultures).

Each of the original 12 items of the Bybee scale, together with their new versions in the LGPI, are presented in Table 2.2 below.

Table 2.2
The 12 original items on the 1984 Bybee scale and their 1995 modified versions in the LGPI.

ORIGINAL ITEM	NEW VERSION OF ITEM
HAZARDOUS SUBSTANCES (waste dumps, toxic chemicals, lead paints)	**UNSAFE SUBSTANCES** (waste dumps, poisonous chemicals, lead paints, electromagnetic wave radiation, e.g. ultraviolet radiation from the sun and microwave oven radiation)
HUMAN HEALTH AND DISEASE (infectious and non-infectious diseases, stress, noise, diet and nutrition, exercise, mental health)	**HUMAN HEALTH AND DISEASE** (catching and non-catching disease such as AIDS, exercise, mental health, stress, noise, diet and nutrition
MINERAL RESOURCES (non fuel minerals, metallic and non-metallic minerals, mining, technology, low-grade deposits, recycling, refuse)	**MINERAL RESOURCES** (non-fuel minerals, metallic and non-metallic minerals, mining, technology, low grade deposits, recycling, refuse)
WATER RESOURCES (waste disposal, estuaries, supply, distribution, ground water contamination, fertilizer contamination)	**FRESH WATER SUPPLIES** (waste disposal, river mouths, water supply and distribution, ground water contamination, fertilizer contamination, waste water treatment, prediction and control of floods and droughts)
POPULATION GROWTH (world population, immigration, carrying capacity, foresight capability)	**POPULATION GROWTH** (increase in world population, immigration, living space, town planning)
EXTINCTION OF PLANTS AND ANIMALS (reducing genetic diversity, wildlife protection)	**EXTINCTION OF PLANTS AND ANIMAL** (fewer types of animals remaining, overfishing, pollution and reduction of life in the oceans, wildlife protection).
ENERGY SHORTAGES (synthetic fuels, solar power, fossil fuels, conservation, oil production)	**ENERGY SHORTAGES** (human manufactured fuels, solar power, fossil fuels, fewer resources, conservation, oil production)

WAR TECHNOLOGY (nerve gas, nuclear developments, nuclear arms threat)	**WAR TECHNOLOGY** (nerve gas, nuclear developments, nuclear weapons threat)
AIR QUALITY AND ATMOSPHERE (acid rain, CO_2, depletion of ozone, global warming)	**AIR POLLUTION** (acid rain, CO_2, depletion of ozone layer, smoky smog, global warming)
WORLD HUNGER AND FOOD RESOURCES (food production, agriculture, cropland conservation)	**WORLD HUNGER AND FOOD SUPPLIES** (food production, crops and agricultural methods)
LAND USE (soil erosion, reclamation, urban development, wildlife habitat loss, deforestation, desertification, salinization)	**BAD LAND USE** (soil erosion, reclaiming of land, city spread and growth, wildlife habitat loss, removal of forests, spreading of deserts, increase in salt content of soils)
NUCLEAR REACTORS (nuclear waste management, breeder reactors, cost of construction, safety, terrorism)	**NUCLEAR POWER STATIONS** (nuclear waste management and disposal, cost of construction, safety, sabotage)

The importance and relevance of each one of the individual items on the LGPI are now discussed:

The provision of mass housing

The provision of mass housing is a area that requires urgent redress as part of the Reconstruction and Development Programme (RDP) in South Africa. According to the *RDP base document*[1] the lack of housing and basic services, particularly in urban townships and rural areas, has reached crisis proportions. In 1990 the urban housing backlog was conservatively estimated at 1.3 million units. If housing needs in the rural areas and hostels are included, the backlog rises to approximately three million units. To compound the problem an estimated 200 000 new households are added every year. One of the RDP's first priorities is to provide housing for the homeless (*RDP base document*, 1994:22). Since a rural sample and a sample of urban township pupils are included in the survey used in this dissertation, the item *provision of mass housing* is particularly relevant.

[1] The *RDP base document* as mentioned in the November 1994 White Paper on Reconstruction and Development refers to the Reconstruction and Development Programme policy framework document of the African National Congress (ANC) in March 1994.

Unsafe substances

According to the Department of Environmental Affairs, over 39 million tons of industry sourced solid and liquid waste and 15 million tons of municipal, or urban waste is generated annually in South Africa (Coetzee, Lukey and Cloete, 1994:4). In 1994 Coetzee et al (1994:4) claimed that there was no national policy on waste management and that it was important for the Government of National Unity to move towards a policy on waste management. One of the eight priorities towards the goal of clean industrial and domestic production put forward by Coetzee et al (1994:4) is public education on the links between a clean environment, human health and sustainable development. The *RDP base document* (1994:39) states that the first RDP strategy for protecting the environment is:

> A system of waste management with emphasis on preventing pollution and reducing waste through direct control, and on increasing the capacity of citizens and government to monitor and prevent the dumping of toxic wastes.

Human health and disease

In South Africa the current health services are claimed to be fragmented, inefficient and ineffective, and resources are grossly mismanaged and poorly distributed. This situation is particularly retrogressive in the rural areas (*RDP base document*, 1994:43).

The deepening AIDS crisis in South Africa is also an area of great concern. It is reported that one million South Africans are HIV positive (St Leger, 1995). According to Peter Doyle, an actuary with Metropolitan Life, 20 000 cases of full-blown AIDS could be expected in 1995 with 10 000 deaths - more than one every hour (*Ibid*). The *RDP base document* (1994:48) sees AIDS education for rural communities, and especially for women, as a priority. Thus the item *human health and disease* is particularly relevant, as many of the basic needs of the RDP such as nutrition, sanitation, water supplies, energy shortages and accomodation all impact on human health and disease.

Mineral resources

In terms of mineral resources South Africa is one of the richest countries in the world. According to the *RDP base document* (1994:99), mineral and mineral products are our most important source of foreign exchange, and the success of the RDP will depend, in part, on the ability of the mining sector to expand exports so that balance of payments constraints in the short and medium term can be avoided.

The *RDP base document* (1994:110) states that the RDP must attempt to increase the level of mineral benefication through appropriate incentives and disincentives in order to increase employment and add more value to our natural resources before export.

The activity of mining can be extremely destructive to sections of our natural environment. The RDP policy is to make the companies that derive the profits from mining responsible for all environmental damage. In addition, existing legislation must be strengthened to protect the environment and comprehensive environmental impact studies must be done before a new mine is established (*RDP base document*, 1994:101-102).

Fresh water supplies

Water as a natural resource is scarce, particularly in certain regions in South Africa. It is the goal of the RDP to make water available in a sustainable manner to all South Africans. In 1994 it was estimated that 12 million people in South Africa did not have access to clean drinking water and 21 million people did not have adequate sanitation (*RDP base document*, 1994:28). In rural areas the problem is particularly pronounced as less than half of the rural population has a safe and accessible water supply, and only one person in seven has access to adequate sanition (*Ibid*). Parts of the Northern Province entered their ninth consecutive year of drought in 1994 (South African Institute of Race Relations, 1995:53). It is therefore appropriate to survey a rural sample from the Northern Province and compare the relative degree to which the global water problem is perceived and prioritised, compared to that of urban samples from the Western Cape Province, a region not prone to droughts.

Population Growth

The Development Bank of Southern Africa (DBSA) gave the total population of South Africa as 40.7 mllion in 1993, comprising 76% African, 13% white, 8.5% coloured and 2.5% Asian (South African Institute of Race Relations, 1995:4-5). According to the October 1993 National Report on Population, the average annual population growth rate between 1985 and 1990 in South Africa was 2.3%. If this trend in population growth continues, it is estimated that the South African population will double in less than thirty years. (South African

Institute of Race Relations, 1995:6). This would pose an appreciable threat to the success of the RDP since an increase in population places a greater demand on all other basic needs such as housing, water supplies, energy supplies, human health and disease etc.

The Northern Province has the highest human fertility rate (5.8) and the Western Cape Province has the lowest fertility rate (2.7) in the country (South African Institute of Race Relations, 1995:7). It therefore is appropriate to establish whether pupils from the above two provinces perceive the importance of population growth as a global problem differently.

Extinction of plants and animals

The quality of life of human beings depends in part on understanding the importance of biodiversity and interspecies equity. In a recently released document of the Department of Environmental Affairs and Tourism on the integration of environmental education into formal education, biodiversity and interspecies equity are seen as forming an important part of the ethic of sustainability in South Africa:

> The health of ecosystems depends on the biodiversity of species and organisms. People should try and ensure the survival of all species and safeguard their habitats. Every form of life warrants respect and preservation regardless of its perceived value to people. All creatures should be treated decently and be protected from cruelty and suffering (Joubert and Steenkamp, 1995:9).

According to the *RDP base document* (1994:38) Apartheid legislation distorted access to natural resources, denying the majority of South Africans the use of land, water, fisheries, minerals, wildlife and clean air. In the document it is stated that the democratic government must ensure that all South African citizens, present and future, have the right to a decent quality of life through sustainable use of resources.

Energy shortages

According to the *RDP base document* (1994:31) although energy is a basic need and vital input into the informal sector, the vast majority of South African households and entrepreneurs depend on inferior and expensive fuels. The Minister of mineral and energy affairs, Mr Roelof (Pik) Botha, said in October 1994 that one third of South Africa's population relied on wood and dung for fuel and burnt 12 million tonnes of wood each year (South African Institute of Race Relations, 1995:44). An electrification programme, particularly in rural areas and urban townships, for improving the quality of life of all South Africans is therefore vital.

War technology

According to the *RDP base document* (1994:98) the democratic government in South Africa must redirect military/strategic production to civilian production. It is said that policies should encourage former organisations who developed weaponry to redirect their technologies in such a way that it is beneficial to civil society. It will be of interest to see whether school science pupils have similar perceptions of the importance of this issue.

Air pollution

The high incidence of respiratory illnesses may be ascribed to high levels of air pollution in South Africa. In 1994 deaths from respiratory disorders among African children were up to 270 times higher on the Witwatersrand than in western Europe. Respiratory illnesses such as pneumonia, which caused the second highest number of deaths among infants in South Africa, resulted from the use of domestic fuels such as coal and wood as a form of energy (South African Institute of Race Relations, 1995:45). The *RDP base document* (1994:38) states that high levels of air pollution were the result of environmental policies which did not adequately monitor or regulate the activities of local and transnational corporations. High levels of air pollution have an impact on health and therefore on the quality of life of people. Thus it is important, as part of the RDP, that air pollution levels are monitored consistently and effectively.

World Hunger

Thousands of South Africans are malnourished and many are hungary. The *RDP base document* (1994:41) states that:

> An enormous number of South African children under the age of 10 years are malnourished and/or stunted. Many thousands of adults, especially the elderly, are hungry, and millions of people, young and old, live in constant fear of being hungry.

Inadequate nutrition impacts, for example, on health, learning and productivity and it therefore needs to be addressed urgently. According to the *RDP base document* (1994:41):

> The RDP must ensure that as soon as possible, and certainly within three years, all persons in South Africa gets their basic nutritional requirement each day and that they no longer live in fear of going hungry.

The most important step towards food security is the creation of employment and economic growth in South Africa.

Nuclear power stations

During the period of 26 years from 1966 to 1992 the South African state had invested R14 600 million in running and capital expenses in the Atomic Energy Corporation (AEC) and its forerunners. One of the outcomes of this was the establishment of the 2000 MW Koeberg nuclear power station near Cape Town (Tegart, in FRD 1994:14). The role and expansion of such nuclear power stations in the South African context is uncertain. In 1994 the AEC was in the process of changing, on a planned basis, from a strategic to a commercially driven organisation. It will be independent of the state soon after the year 2000 (Tegart, 1994:14). This change may be an indication that the Government of National Unity will invest less and less money in nuclear energy capability.

Use and abuse of high technology

According to the *RDP base document* (1994:96) technology policy is a key component in both industrial and high-quality social and economic infrastructure. The document states that new legislation must ensure that agreements to import foreign technology include a commitment to educate and train local labour to use, maintain and extend technology (*RDP base document*, 1994:97).

Technology such as electronic mail, satellite imaging and remote sensing are important for science research in South Africa (Ellis, 1994:246-247). However, high technology can be abused, for example, pornography on the Internet.

Ignorant decision makers

One of the six principles of the RDP is that it is a people-driven process (Government Gazette No. 16085, 23 November 1994). For people to make decisions they must be informed concerning the issues of the day. In a technologically and scientifically based society it is important for people at all levels to be technologically and scientifically literate. For example, the problem of rapid population growth, which impacts on all of the other global problems listed in the LGPI, can be addressed only with the cooperation of all communities in South Africa. Ellis (1994:233) has stated that the public understanding of science is an important issue, in particular because of the need for an environmentally literate population.

2.4 Chapter summary

In this chapter a review has been made of (1) the theory and use of *rank-order scales* in educational research; (2) earlier research findings on perceived global priorities in STS; and (3) the theoretical justification for selection of the 15 items comprising the LGPI.

The next chapter will comprise a description of the **research method** employed for the study.

CHAPTER 3

RESEARCH METHOD

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3.1 Survey sampling

The research method used in this study is survey sampling. A survey is recognised as a direct way to obtain information concerning an identified topic (Fink and Kosecoff, 1985; Bybee and Mau, 1986). Butts (1983:188) has pointed out that the survey method is a rediscovered strategy for science education research. He said that in science and technology based democratic societies, surveys can yield important information for such communities. According to Ballantyne (1986:97) surveys allow widespread opinion to be ascertained and are a common and scientifically acceptable means of studying individuals under natural conditions.

In order to inform the research design, literature concerning the use of survey techniques was consulted (Babbie, 1973; Kalton, 1983; Fink and Kosecoff, 1985; Oppenheim, 1992; and Fowler, 1993). There are two basic survey designs: cross-sectional surveys and longitudinal surveys. A cross-sectional survey design is used in this study for purposes of description, as well as for the determination of relationships between variables at the time of the study. Random sampling was not done, and the sampling would best be described as nonprobability sampling. This type of sampling has a number of weaknesses which will be discussed under the **limitations of the research method** in chapter 6. The samples were convenient respondents in specific subject disciplines which facilitated the data gathering and therefore the research.

However, despite its shortcomings the method of sampling used is suitable for the purposes of a minor dissertation.

In this study the survey was administered during lessons directly to pupils. Few pupils completed the questionnaire incorrectly, the discarded questionnaires constituting less than 5 percent.

3.2 The setting of the survey

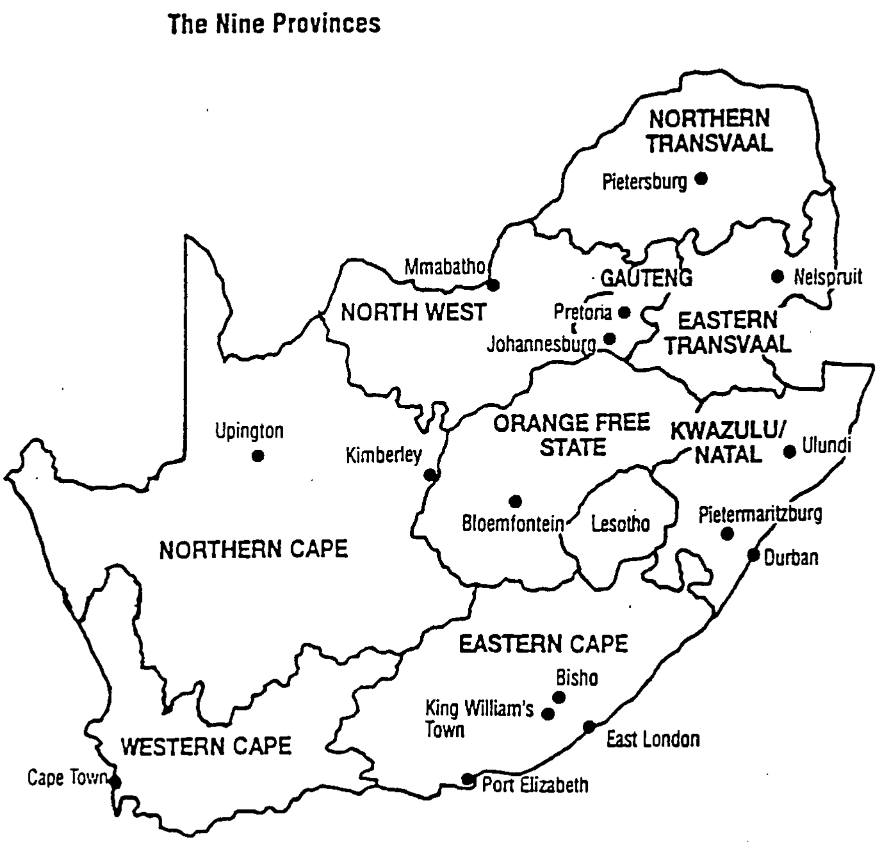
The survey was conducted in two provinces in South Africa: the Western Cape and Northern Province. The Northern Province is the most rural province in South Africa. The urbanisation rate is only 12 percent and its population growth rate was an exceptional high of 3.95 percent on average per year for the period 1985 to 1993. The Western Cape on the other hand has a high level of urbanisation (95.1 percent) and had a relatively low rate of population growth of 1.70 for the period 1985 - 1993 (Harber and Ludman, 1995:363-364).

A recent study done by the Graduate School of Business and the Institute for Future Research at the University of Stellenbosch shows that the Western Cape people live longer than other South Africans and have the best quality of life, whereas the worst quality of life is to be found in the hot, chronically drought-stricken expanses of the Northern Province (Weekend Argus, October 14/15 1995). Some of the reasons for the difference in quality of life are, for example: the Western Cape has an unemployment figure of 17.3 percent compared to 47 percent in the Northern Province; poor people (below the poverty line) account for 17.3 percent in the Western Cape while in the Northern Province 67.6 percent of people are "poor"; there are, on average, 672 people per doctor in the Western Cape, while every doctor in the Northern province has to look after an average of 7472 people; and each hospital bed in the Western Cape caters for 179 people per annum compared to 700 in the Northern Province (*Ibid*). The locations of the two provinces are presented in Figure 3.1 which follows on page 28.

3.3 Samples

The three main samples consist of Northern Sotho speaking-English second language biology pupils (n = 414) from a rural area in the Northern province, Xhosa speaking-English second language biology pupils (n = 189) from an urban area in the Western Cape and English first language speaking biology pupils from an urban area in the Western Cape (n = 343). All samples were tested during the period January - July 1995.

Figure 3.1
Geographical distribution of the nine provinces of the new South Africa[2].



Source: Harber and Ludman, 1995:276 (See footnote)

2 Subsequent to the publication of this map the names of the Northern Transvaal, Eastern Transvaal and the Orange Free State have respectively changed to the Northern Province, Mpumalanga and Free State.

Sample 1 (n = 414) comprised standard eight, nine and ten pupils, age range 15 to 18 at ten secondary schools of the former Lebowa Education Department. Intercorrelations among the standard 8, 9 and 10 classes yielded correlation coefficients ranging from 0.86 to 0.89, and the combined classes may therefore be regarded as one homogeneous sample in this study since the reliability coefficient of the LGPI instrument itself is of this order of magnitude.

Sample 2 (n = 189) consisted of standard 6, 7, 9 and 10 pupils, age range 13 to 18, at one former urban Department of Education and Training school. Intercorrelations among the different standard groups yielded correlation coefficients ranging from 0.89 to 0.96, and the combined classes may therefore probably be regarded as one homogeneous sample.

Sample 3 consisted of 343 pupils, age range 17 to 18, from mainly middle class backgrounds in their twelth grade (standard 10) at four Cape Town secondary schools. The schools were all from the former departmental administration House of Representatives. Intercorrelations among classes in the four different schools yielded correlation coefficients ranging from 0.90 to 0.95 and these pupils are therefore regarded as one sample in this study.

3.4 Reliability of the LGPI

Theory

The **reliability** of this test refers to the consistency with which it yields the same rank for an intact sample of individuals taking the test several times. In other words, the test is reliable if it consistently yields the same, or nearly the same, ranks over repeated administrations during which we would not expect the trait or response being measured to have changed. The consistency of a test is obtained by determining the reliability coefficient (r). The reliability coefficient (r) is obtained from the correlation coefficient, +1 being the perfect correlation, 0 being no correlation and -1 the strongest inverse correlation.

Procedures and properties of the instrument

The *test-retest* method was used to determine the reliability of the *LGPI*. The ranks of the mean scores of the test and retest were used to compute the Spearman rank correlation coefficient. According to Siegel and Castellan (1988:235), of all the statistics based on ranks, the *Spearman rank-order correlation coefficient* (*rho*) was the earliest to be developed and the best known at the time. They state that it is a requirement that both variables be measured on at least an ordinal scale.

The following *method* for the computing of Spearman rank correlation coefficients for the test/retest was used: A list of the 15 items on the LGPI was made; next to each item entry, the mean rank score of the first variable (*test*) and the mean rank score of the second variable (*retest*) were entered; the rank 1 was then assigned to the smallest *test* mean rank score and the rank of 15 to the largest mean rank score of the *test*; the same was done for the *retest*; the difference (d) between the *test* mean rank scores and the *retest* mean rank scores for each item was then computed; the value of d was squared for each item; a sum of the values of d^2 was then computed; finally the values $n = 15$ and Σd^2 were entered into the equation below, and Spearman rho calculated.

The mean scores and ranks of the test and retest performed with 58 secondary school pupils are presented in Table 3.1. on page 31.

The equation for calculating the Spearman rank correlation:

$$\text{Spearman rho} = 1 - \frac{6\ \Sigma d^2}{n\ (n^2 - 1)}$$

Where d = the difference between ranks
n = the number of items on the scale

In January 1995 a sample of 58 Cape Town secondary school students yielded ranks with a reliability coefficient of $r = 0.93$ when this intact group was retested after an interval of one day.

Table 3.1
The mean priority scores, and ranks of relative importance, of global problems in science and technology: Test-retest summary data obtained over an interval of one day with 16 year old high school science pupils in 1995.

	Test n = 58		Retest n = 58	
Global problem	**Mean priority score**	**Rank of relative importance**	**Mean priority score**	**Rank of relative importance**
Mass housing	9.9	10	9.9	9
Unsafe substances	6.5	7	6.8	7
Human health & disease	4.9	2	4.7	2
Mineral resources	11.0	15	10.2	11
Fresh water supplies	6.4	6	6.5	6
Population growth	5.8	5	5.2	4
Extinction of species	5.1	3	5.0	3
Energy shortages	10.4	11	10.0	10
War technology	10.5	12	11.1	15
Air pollution	5.4	4	5.5	5
World hunger	4.3	1	4.4	1
Bad land use	8.4	8	8.9	8
Nuclear power stations	9.8	9	10.3	12
High technology	10.6	13	10.8	14
Decision makers	10.9	14	10.7	13

Test/re-test reliability coefficient r = 0.93 (n = 58)

A test-retest method is the only appropriate technique for determining the reliability of a *rank-order scale* such as the LGPI. A nonparametric statistical method had to be used to determine the reliability coefficient because the data is in the form of ranked scores. Thus the Spearman rank correlation was chosen. The correlation coefficient of 0.93 indicates high consistency between the mean rank scores of the test and retest. When a intact pilot group of 11 Cape Town science teachers-in-training was retested with the LGPI over an interval of two weeks in August 1995, a reliability coefficient of $r = 0.93$ was also obtained. The mean priority scores and ranks of the test and retest performed with 11 science teachers-in-training is presented in Table 3.2 on page 33.

3.5 Hypotheses

The following null hypotheses are tested in this study.

Null Hypothesis 1 (*Home language rural-Northern Sotho versus home language urban-Xhosa*)

a) There will be no significant correlation between the mean rankings of sample 1 and sample 2 on the Le Grange Global Priorities Instrument (LGPI) as a whole.

b) There will be no significant differences between sample 1 and sample 2 with respect to their score distributions on each one of the fifteen major science and technology related global problems, taken individually.

Null Hypothesis 2 (*Home language rural-Northern Sotho versus home language urban-English*)

a) There will be no significant correlation between the mean rankings of sample 1 and sample 3, on the Le Grange Global Priorities Instrument (LGPI) as a whole.

b) There will be no significant differences between sample 1 and sample 3 with respect to the score distributions on each one of the fifteen major science and technology related global problems, taken individually.

Table 3.2
The mean priority scores, and ranks of relative importance, of global problems in science and technology: Test-retest summary data obtained over an interval of two weeks with science teachers-in-training in 1995.

	Test n = 11		Retest n = 11	
Global problem	**Mean priority score**	**Rank of relative importance**	**Mean priority score**	**Rank of relative importance**
Mass housing	8.6	9	8.2	8
Unsafe substances	7.4	8	9.1	10
Human health & disease	6.5	5	6.0	3
Mineral resources	10.5	12	9.4	11
Fresh water supplies	3.3	1	2.9	1
Population growth	4.7	2	6.1	4
Extinction of species	7.1	6	7.5	6
Energy shortages	9.5	11	8.5	9
War technology	10.8	13	9.7	12
Air pollution	5.5	3	6.6	5
World hunger	6.0	4	5.8	2
Bad land use	7.3	7	8.0	7
Nuclear power stations	9.1	10	9.8	13
High technology	12.2	15	10.4	14
Decision makers	11.5	14	11.9	15

Test/re-test reliability coefficient $r = 0.93$ ($n = 11$)

Null Hypothesis 3 (*Home language urban-Xhosa versus home language urban-English*)

a) There will be no significant correlation between the mean rankings of sample 2 and sample 3, on the Le Grange Priorities Instrument (LGPI) as a whole.

b) There will be no significant differences between sample 2 and sample 3 with respect to the score distributions on each one of the fifteen major science and technology related global problems, taken individually.

3.6 Selection of dependent and independent variables

The dependent variables in this study are **urban-rural** locality and **socio-economic context**. The independent variables are the 15 items (global problems) on the LGPI.

Urban and rural samples will be compared in terms of their responses to the 15 global problems on the LGPI. Two urban samples in different socio-economic contexts are also compared in relation to their responses to the 15 global problems on the LGPI.

3.7 Data collection

The data were collected by distributing the LGPI to groups of respondents as part of normal classroom science lessons. These were administered personally by the researcher with the help of enthusiastic and informed colleagues at the selected institutions. This natural method of data gathering was used in order to minimise any problems which may be caused by posting the questionnaires, failure to respond, or any delays in handling the questionnaires. Thus this procedure ensured a very high response rate. Convenient samples were used as favourable opportunities arose in well-run schools conveniently available to research data-gatherers.

The data collection was efficient, requiring a period of about ten minutes as part of the normal schedule of the pupils' classroom lessons in order to minimise the possibility of a Hawthorn effect.

All the Northern Sotho speaking pupils chose to respond to the LGPI in English. Of the

Xhosa speaking pupils, 48% chose to respond to the English version of the LGPI, while 52% answered the Xhosa version (attached in APPENDIX E).

3.8 Data capture and analysis

The data were entered and stored using the computer software programme, Lotus 123. The data files were imported from Lotus to the Statgraphics software programme which was used to compute Spearman rank correlation coefficients and Z-statistics for non-normally distributed data. Data capture and analysis was an accurate and efficient process, and random hand-calculator checks were made on the computer-generated statistics to verify calculations independently of the software programme.

3.9 Selection of statistical methods

As explained in chapter 2, non-parametric statistical methods must be used to analyse data produced by *rank-order scales*. The Spearman rank correlation is used to test null hypotheses 1a, 2a and 3a. The methods and procedures for computing Spearman rank correlation coefficients are the same as those described for the reliability coefficient for the LGPI on pages 29 and 30.

Mann-Whitney U-tests are used to test null hypotheses 1b, 2b and 3b in lieu of the Kolmogorov-Smirnov two sample test used by Gayford (1988). The Mann-Whitney U-test is one of the most powerful and popular non-parametric procedures and is regarded as the counterpart to the t-test (Kaplan, 1987:284; Siegel and Castellan, 1988:129; and Runyon and Haber, 1991:491). A Mann-Whitney U-test is used if the researcher wishes to avoid the t-test's assumptions or when the measurement in the research is weaker than an interval scale (Siegel and Castellan, 1988:128-129). Theoretically, the Mann-Whitney U-test is a test of the differences between two populations'/samples' score distributions, rather than a test of the differences between two means or medians (Kaplan, 1987:284). Mann-Whitney U-tests were used to indicate significant differences on individual items on the Le Grange Global Priorities Instrument (LGPI).

For details on the procedures and methods of the Mann-Whitney U-tests, the following works can be consulted: Siegel and Castellan (1988:126-136); Runyon and Haber (1988: 492-497); Kaplan (1987:286-290), Mann and Whitney (1947) and Whitney (1948).

The equation for the Mann-Whitney U-test is:-

$$Z = \frac{U - U_E}{\sigma_U}$$

Where: Z = Z-statistic
U = U-statistic
U_E = expected value of U
σ_U = standard deviation of U

3.10 Chapter summary

The research method, the setting for the survey, a description of the samples, the reliability of the measurement instrument, hypotheses to be tested, selection of dependent and independent variables, data collection, data capture and the selection of appropriate statistical methods have been described in this chapter. The results and findings of the research study follow on in **Chapter 4.**

CHAPTER 4

RESULTS AND FINDINGS

CHAPTER 4
RESULTS AND FINDINGS

In this chapter the results of the survey are presented and analysed. They are summarised by presenting the hypotheses one to six in order. An amplified explanation and discussion of the emerging significant differences occurs in the following Chapter 5.

4.1 Hypothesis testing

- Hypothesis 1(a) [Home language rural-Northern Sotho (sample 1) versus home language urban-Xhosa (sample 2)]

The first null hypothesis, *that there is no significant correlation between the 414 rural-Northern Sotho pupils and the 189 urban-Xhosa pupils with regard to their mean rankings of global problems on the LGPI as a whole*, is supported. Using the ranks in Table 4.1, on page 38, Spearman calculations yielded rho = 0.42 (n = 15), p = 0.12, which fails to reach statistical significance at the level p = 0.05.

However, the statistically non-significant correlation coefficient obtained is due to the inclusion of a single new item, *mass housing* in the LGPI in 1995. In the *other* respects (i.e. on items 2 to 15) the 414 Northern Sotho speaking pupils and 189 Xhosa speaking pupils correlate rho = 0.71 (n =14), p = 0.01, i.e. the two groups of pupils do agree with each other, highly significantly, although the samples are geographically located 1800km apart. It is only on the *mass housing* item that the two samples are highly polarised, lowering the correlation from 0.71 on 14 items (2-15) to 0.42 on all 15 items.

Table 4.1
The mean priority scores, and ranks of relative importance, of global problems in science and technology rated by rural-Northern Sotho speaking pupils and urban-Xhosa speaking pupils in 1995.

	Sample 1 (Northern Sotho) n = 414		Sample 2 (urban-Xhosa) n = 189	
Global problem	**Mean priority score**	**Rank of relative importance**	**Mean priority score**	**Rank of relative importance**
Mass housing	10.0	14	2.0	1
Unsafe substances	9.3	9	6.9	5
Human health & disease	4.0	2	4.3	2
Mineral resources	9.4	10	8.8	7
Fresh water supplies	1.8	1	4.7	3
Population growth	4.6	3	7.1	6
Extinction of species	10.1	15	9.2	9
Energy shortages	8.2	5	9.1	8
War technology	9.9	13	11.3	15
Air pollution	9.2	8	9.5	11
World hunger	6.0	4	5.9	4
Bad land use	8.7	6	9.3	10
Nuclear power stations	9.6	11	11.2	14
High technology	9.7	12	9.6	12
Decision makers	9.0	7	10.4	13

Among the urban-Xhosa speaking pupils, the *provision of mass housing* was ranked *first* (mean 2.0); but only *fourteenth* (mean 10.0) by the rural-Northern Sotho speaking pupils. Other differences were relatively minor. For example, whereas the urban-Xhosa speaking pupils ranked the concern for *unsafe substances* as their fifth (mean 6.9) priority, the rural-Northern Sotho speaking pupils ranked it ninth (mean 9.3). Among the urban-Xhosa speaking pupils, *mineral resources* was ranked seventh (mean 8.8) as a concern but tenth by rural-Northern Sotho speaking pupils with a similar mean rank of 9.4; and so on. A bar graph comparing the mean ranks for each of the 15 items on the LGPI between samples 1 and 2 is presented in Figure 4.1 on page 40.

The two samples agreed on the high prioritisation for *human health and disease*, *fresh water supplies* and *world hunger* as concerns, as well as the low prioritisation of *war technology*, *nuclear power* and *high technology*.

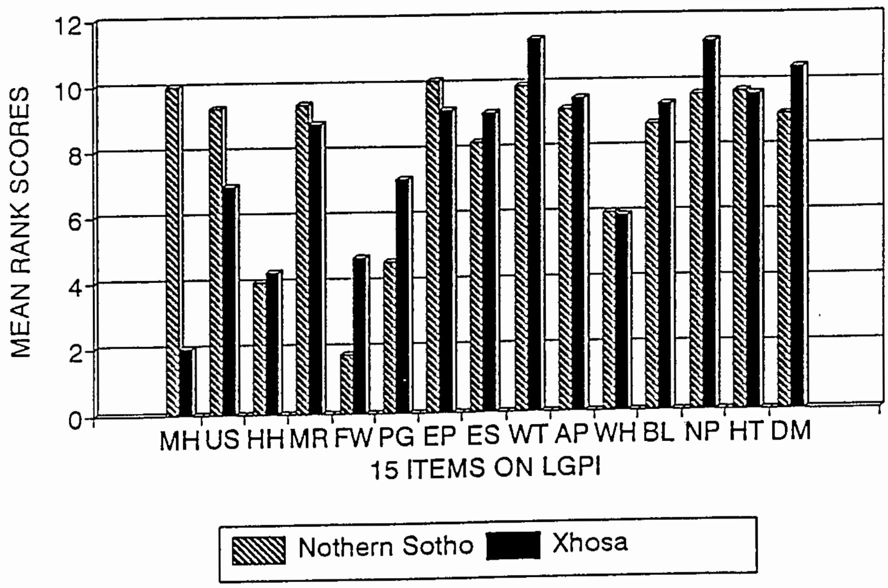
- Hypothesis 1(b) [Home language rural-Northern Sotho (sample 1) versus home language urban-Xhosa (sample 2)].

The null hypothesis that *there are no significant differences between sample 1 and sample 2 with respect to their score distributions on each of the fifteen major global problems* is rejected for the items *provision of mass housing*, *unsafe substances*, *fresh water supplies*, *population growth*, *extinction of plants and animals*, *energy shortages*, *war technology*, *nuclear power stations* and *ignorant decision makers*.

The Z-test statistics and levels of significance for each of the paired mean scores of the fifteen items on the LGPI are presented in Table 4.2 on page 41.

FIGURE 4.1

MEAN RANK SCORES OF NORTHERN SOTHO AND XHOSA SPEAKING PUPILS FOR THE 15 ITEMS OF THE LGPI



	LEGEND
MH	Mass housing
US	Unsafe substances
HH	Human health & disease
MR	Mineral resources
FW	Fresh water supplies
PG	Population growth
EPA	Extinction of species
ES	Energy shortages
WT	War technology
AP	Air pollution
WH	World hunger
BLU	Bad land use
NP	Nuclear power stations
HT	High technology
DM	Decision makers

Table 4.2
Z-test statistics and levels of significance between rural-Northern Sotho and urban-Xhosa samples.

GLOBAL PROBLEM	*Z-test statistic for sample 1 versus sample 2*	*Level of significance*
Mass housing	-18.0	* * *
Unsafe substances	-7.4	* * *
Human health & disease	1.3	
Mineral resources	-1.5	
Fresh water supplies	14.8	* * *
Population growth	7.6	* * *
Extinction of species	-3.2	* *
Energy shortages	3.6	* * *
War technology	4.7	* * *
Air pollution	0.8	
World hunger	-0.7	
Bad land use	1.7	
Nuclear power	4.5	* * *
High technology	-0.2	
Decision makers	4.1	* * *

* * $p < 0.01$

* * * $p < 0.001$

NB. Even though, for example, *fresh water supplies* was ranked first and third by sample 1 and sample 2 respectively, on the Mann-Whitney U-test there exists a highly significant difference between their skewed score distributions.

- Hypothesis 2 (a) [Home language rural-Northern Sotho (sample 1) versus home language urban-English (sample 3)]

The second null hypothesis, that *there is no significant correlation between the 414 rural-Northern Sotho pupils and the 343 urban-English pupils with regard to their mean rankings of global problems on the LGPI as whole* is rejected. Using the ranks in Table 4.3, on page 43, Spearman calculations yielded rho = 0.54 (n = 15), p = 0.04, which is statistically significant at the level p = 0.05.

Among the urban-English speaking pupils, *the provision of mass housing* was ranked ninth but only fourteenth by the rural-Northern Sotho speaking pupils. However, even though the rank difference between the two samples is 5, similar mean priority scores exist of 9.4 and 10.0 respectively. Whereas the urban-English speaking pupils ranked a concern for the *extinction of plants and animals* as their seventh priority (mean 6.4), the rural-Northern Sotho speaking pupils ranked it only fifteenth (mean 10.1). Among the rural-Northern Sotho pupils, *ignorant decision makers* as a priority was ranked seventh and fourteenth by the urban-English speaking pupils with similar mean priority scores of 9.0 and 10.7 respectively. Other differences were relatively minor.

A bar graph showing a comparison between the mean rank scores of sample 1 and sample 3 is presented in Figure 4.2 on page 44.

- Hypothesis 2 (b) [Home language rural-Northern Sotho (sample 1) versus home language urban-English (sample 2)]

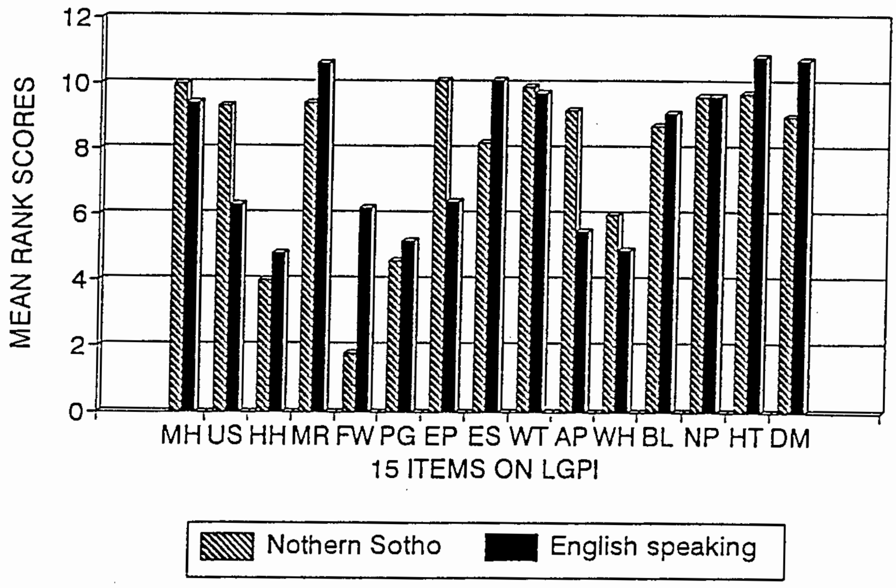
The null hypothesis *that there are no significant differences between sample 1 and sample 3 with respect to their score distributions on each of the fifteen major global problems* is rejected for the items *provision of mass housing*, *unsafe substances*, *human health*, *mineral resources*, *fresh water*, *extinction of plants and animals*, *energy shortages*, *air pollution*, *world hunger*, *high technology*, and *decision makers*.

Table 4.3
The mean priority scores, and ranks of relative importance, of global problems in science and technology rated by rural-Northern Sotho speaking pupils and urban-English speaking pupils in 1995.

	Sample 1 (Northern Sotho) n = 414		Sample 3 (urban-English) n = 343	
Global problem	**Mean priority score**	**Rank of relative importance**	**Mean priority score**	**Rank of relative importance**
Mass housing	10.0	14	9.4	9
Unsafe substances	9.3	9	6.3	6
Human health & disease	4.0	2	4.8	1
Mineral resources	9.4	10	10.6	13
Fresh water supplies	1.8	1	6.2	5
Population growth	4.6	3	5.2	3
Extinction of species	10.1	15	6.4	7
Energy shortages	8.2	5	10.1	12
War technology	9.9	13	9.7	11
Air pollution	9.2	8	5.5	4
World hunger	6.0	4	4.9	2
Bad land use	8.7	6	9.1	8
Nuclear power stations	9.6	11	9.6	10
High technology	9.7	12	10.8	15
Decision makers	9.0	7	10.7	14

FIGURE 4.2

MEAN RANK SCORES OF NORTHERN SOTHO AND ENGLISH SPEAKING PUPILS FOR THE 15 ITEMS OF THE LGPI



LEGEND: See Figure 4.1, page 40.

The Z-test statistics and levels of significance for each of the paired mean scores of the fifteen items on the LGPI are presented in Table 4.4 on page 45.

- Hypothesis 3 (a) [Home language urban-Xhosa (sample 2) versus home language urban-English (sample 3)

The third null hypothesis, that *there is no significant correlation between the 189 urban-Xhosa speaking pupils and the 343 urban-English speaking pupils with regard to their mean rankings of global problems on the LGPI as a whole* is rejected. Using the ranks in Table 4.5 on page 46, Spearman calculations yielded rho = 0.58 (n = 15), p = 0.03, which is statistically significant at the level p = 0.05.

Table 4.4
Z-test statistics and levels of significance between rural-Northern Sotho and urban-English samples

GLOBAL PROBLEM	*Z-test statistic for sample 1 versus sample 3*	*Level of significance*
Mass housing	-2.2	*
Unsafe substances	-10.6	* * *
Human health & disease	2.6	* *
Mineral resources	4.9	* * *
Fresh water supplies	19.4	* * *
Population growth	1.2	
Extinction of species	-12.3	* * *
Energy shortages	8.1	* * *
War technology	0.4	
Air pollution	-11.9	* * *
World hunger	-4.8	* * *
Bad land use	1.4	
Nuclear power	-0.2	
High technology	3.9	* * *
Decision makers	6.5	* * *

* $p < 0.05$

* * $p < 0.01$

* * * $p < 0.001$

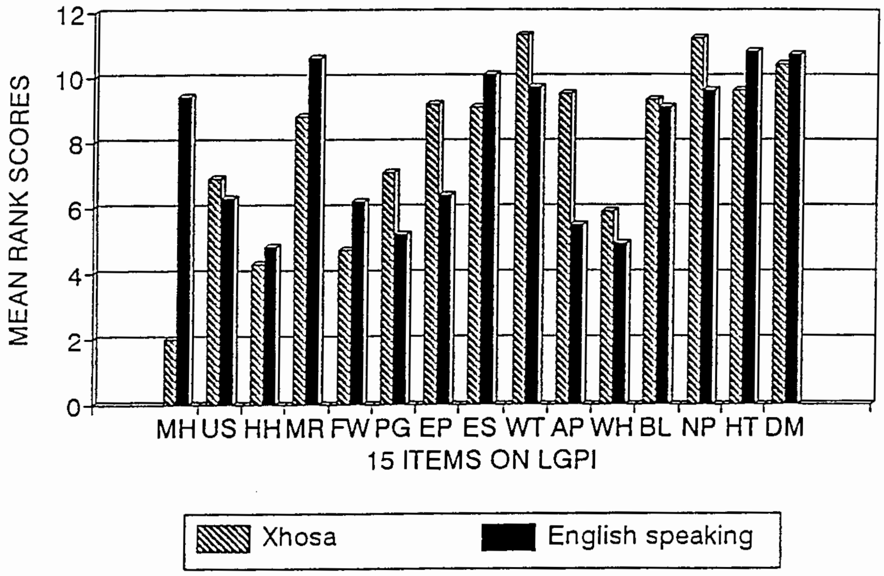
Table 4.5
The mean priority scores, and ranks of relative importance, of global problems in science and technology rated by urban-Xhosa speaking pupils and urban-English speaking pupils in 1995.

	Sample 2 urban-Xhosa n = 189		Sample 3 urban-English n = 343	
Global problem	**Mean priority score**	**Rank of relative importance**	**Mean priority score**	**Rank of relative importance**
Mass housing	2.0	1	9.4	9
Unsafe substances	6.9	5	6.3	6
Human health & disease	4.3	2	4.8	1
Mineral resources	8.8	7	10.6	13
Fresh water supplies	4.7	3	6.2	5
Population growth	7.1	6	5.2	3
Extinction of species	9.2	9	6.4	7
Energy shortages	9.1	8	10.1	12
War technology	11.3	15	9.7	11
Air pollution	9.5	11	5.5	4
World hunger	5.9	4	4.9	2
Bad land use	9.3	10	9.1	8
Nuclear power stations	11.2	14	9.6	10
High technology	9.6	12	10.8	15
Decision makers	10.4	13	10.7	14

Among the urban-Xhosa speaking pupils, the *provision of mass housing* was ranked first (mean 2.0) but only ninth (mean 9.4) by the urban-English speaking pupils. Whereas the urban-English speaking pupils ranked *air pollution* fourth (mean 5.5) as a priority, the urban-Xhosa speaking pupils ranked it only eleventh (9.5). Other differences were relatively minor. A bar graph showing a comparison of the mean priority scores between sample 2 and sample 3 is presented in Figure 4.3 below.

FIGURE 4.3

MEAN RANK SCORES OF XHOSA AND ENGLISH SPEAKING PUPILS FOR THE 15 ITEMS OF THE LGPI



LEGEND: See Figure 4.1, page 40

- Hypothesis 3 (b) [Home language urban-Xhosa (sample 2) versus home language urban-English (sample 3)]

The null hypothesis that there are *no significant differences between sample 2 and sample 3 with respect to their mean rankings of each of the fifteen major global problems* is rejected for the items *provision of mass housing*, *unsafe substances*, *mineral resources*, *fresh water supplies*, *population growth*, *extinction plants and animals*, *energy shortages*, *war technology*, *air pollution*, *world hunger*, *nuclear power* and *high technology.*

The Z-test statistics and levels of significance for each of the paired mean scores of the fifteen items on the LGPI are presented in Table 4.6 on page 49.

- Hypothesis 3 (b) [Home language urban-Xhosa (sample 2) versus home language urban-English (sample 3)]

The null hypothesis that there are *no significant differences between sample 2 and sample 3 with respect to their mean rankings of each of the fifteen major global problems* is rejected for the items *provision of mass housing*, *unsafe substances*, *mineral resources*, *fresh water supplies*, *population growth*, *extinction plants and animals*, *energy shortages*, *war technology*, *air pollution*, *world hunger*, *nuclear power* and *high technology*.

The Z-test statistics and levels of significance for each of the paired mean scores of the fifteen items on the LGPI are presented in Table 4.6 on page 49.

Table 4.6
Z-test statistics and levels of significance between urban-Xhosa and urban-English samples.

GLOBAL PROBLEM	Z-test statistic for sample 2 versus sample 3	Level of significance
Mass housing	-17.1	* * *
Unsafe substances	2.0	*
Human health & disease	-1.2	
Mineral resources	-5.9	* * *
Fresh water supplies	-5.6	* * *
Population growth	5.7	* * *
Extinction of species	7.7	* * *
Energy shortages	-3.5	* * *
War technology	3.4	* * *
Air pollution	11.2	* * *
World hunger	3.3	* * *
Bad land use	0.6	
Nuclear power	5.1	* * *
High technology	-3.7	* * *
Decision makers	-1.9	

* $p < 0.05$

* * * $p < 0.001$

4.2 Chapter summary

In this chapter the results of the survey have been presented and analysed. Six null hypotheses have been tested, and shown to be either supported or rejected. An explanation and discussion of the emerging significant differences now occurs in the following chapter 5.

CHAPTER 5

DISCUSSION OF RESULTS

CHAPTER 5

DISCUSSION OF RESULTS

5.1 Meeting basic human needs through the science curriculum

The rural-Northern Sotho, urban-Xhosa and urban-English speaking samples all placed *fresh water supplies*, *population growth*, *human health and disease* and *world hunger* as their top-ranked items. This is consistent with findings over a twelve year period by samples from disparate subject disciplines and in different countries. The urban-Xhosa sample ranked *mass housing* as their top priority. The top-ranked items relate to basic human needs for short and long term survival, and these ratings provide empirical evidence to support the importance of meeting basic human needs of the South African population as declared in the Government of National Unity's 1994 Reconstruction and Development Programme.

However, inclusion of the item *mass housing* produced diversified or polarised priority response lists from the three samples. Whereas the urban-Xhosa sample ranked the *provision of mass housing* first, the urban-English sample ranked it ninth, and the rural Northern Sotho sample ranked it only fourteenth. The differences in the mean rankings between the samples, and the highly significant differences in the score distributions for the item *mass housing* between samples 1 and 2, as well as between samples 2 and 3, on the Mann-Whitney U-test, tentatively suggest that the greatest perceived need for housing may be only among the urban black population living in townships and informal settlements, but generalisations cannot be made from the responses of only one sample in each geographical region. Follow-up studies will be needed to provide corroborative evidence in this regard. It is clear that - even when respondents are asked to focus on a human problem in its **global** context - there appears to be an introspective tendency instead to regress to perceiving the problem more in its **local** context, if it is regionally acute at that time.

The *provision of fresh water supplies* was ranked first, third and fifth by samples 1, 2 and 3 respectively. This indicates that secondary school pupils are aware of the importance of clean water as a natural resource. These findings underscore the importance of the RDP's goal to make fresh water available in a sustainable manner to all South Africans. The fact that water was ranked first by the rural-Northern Sotho sample indicates that water remains the most basic need in rural areas, particularly in drought-stricken areas such as the Northern Province. Evidence to support differences in the perceived need for water by rural and urban people, however, is the fact that - even though *the provision of fresh water supplies* was ranked first and third by samples 1 and 2 respectively, and first and fifth by samples 1 and 3 respectively - highly significant differences nevertheless occur in their score distributions on the Mann-Whitney U-test (see Table 4.2 on page 41 and Table 4.4 on page 45). The high ranking of water as a priority by pupils in the Northern Province provides independent empirical support for the Government's new RDP project of specifically upgrading the water supply system for 16 000 people in 34 villages in the Northern province's Mafefe (Chalmers, 1995). The findings also suggest that greater emphasis might be placed on **water** as a current theme in science curricula, particularly in rural areas. One implication of this is for the specification of regionally relevant science practical work on the topic "water". For example, pupils might use available water quality test kits with water bodies in their local environment; they might determine the health risks of such water bodies; and they might be given tasks such as designing water purification devices, etc.

Another basic human problem for short term survival concerns *world hunger and food supplies*. In 1992 Operation Hunger's executive director, Ina Perlman, estimated that over three million rural blacks in South Africa under the age of 15 suffered from clinically diagnosable malnutrition (Foundation for Research Development, 1992:19). The rapid population growth rate, coupled with increased unemployment in both urban and rural areas, compound the problem. These facts, together with the high ranking of *world hunger* by all three samples, provide evidence to support the recent government decision to introduce its school feeding scheme, as well as the urgent need for nutrition education to be emphasised at both the primary and secondary school level.

The global problem of human health and disease was ranked highly by all three samples. Samples 1 and 2 ranked it second and sample 3 ranked it first. This corroborates the earlier findings of Ndodana, Rochford and Fraser (1994), Le Grange, Rochford and Sass (1995) and Le Grange Rochford and Paulsen (1995). The high mean ranking given to *human health and disease* may be attributed to more widespread awareness of diseases such as AIDS. The deepening AIDS crisis in South Africa, with one million South Africans carrying HIV, is an area of great concern. It necessitates sustained educational programmes aimed at creating continuous awareness about AIDS so that the rapid increase in HIV positive cases might be stemmed (St Leger, 1995).

In the school curriculum, more relevant biology syllabuses should emphasise the study of pathogenic viruses and bacteria that cause disease such as AIDS and tuberculosis which affect the quality of the lives of South Africans. In an article entitled *The relevance of school biology and AIDS*, Munting (1988:41) says:

> The standard nine syllabus for biology prescribes only a very superficial study of viruses, for example, structure and biological importance are specifically mentioned. However, the nature of the pathogenic effects and present-day relevance of the AIDS virus, amply justify a brief study of it in a knowledgeable and sensitive way in the secondary school.

What Munting stated seven years ago largely holds true in 1995 for standard nine biology syllabuses in state schools. The inclusion of a study of the AIDS virus and its pathogenic effects in secondary school biology syllabuses is clearly urgent and obvious.

The international science educators surveyed by Bybee and Mau (1986) and the college students sampled by Bybee and Najafi (1986) predicted that all global problems would be worse by the year 2000 with the exception of *human health and disease*. Recent research findings, including the findings in this study to date, may indicate the contrary.

The other top-ranked item in the responses of all three samples is *population growth*. Population growth is a causal factor underlying virtually all global problems (Bybee and Mau, 1986:603), including some not ranked in the top half of the list. The relatively high ranking of *population growth* is an indication that secondary school pupils have some understanding of the fundamental nature of this problem. This is encouraging in the South African context, considering that the population growth rate is currently reported to be 2.7% at present (Ellis, 1995).

South Africa's burgeoning population presents a major threat to the success of the RDP, because every additional child requires an infrastructure of support: education, housing, water, employment and health care (*Ibid*). The importance of population growth as a factor determining the future quality of life of South Africans suggests a greater focus on human population dynamics in future biology curricula, compared to what is presently prescribed. For example, a survey of fifteen South African Matriculation examination papers of the last five years, by the writer, discloses that only **one percent** of all questions related to population dynamics asked of pupils in standard 10 (grade 12) focused on **human population dynamics**.

The relatively high ranking (fifth) of *energy shortages* by the rural-Northern Sotho pupils suggests that energy supply remains a basic perceived need of their rural communities, (even though they were asked to rank it as a global problem). It underscores the importance of the RDP's electrification programme to provide access to electricity for an additional 2.5 million households by the year 2000.

The ranking of *land use* as the sixth priority by the rural sample, compared to its more lowly eighth and tenth rankings by the two urban samples, indicates that the problems of land use are of basic concern for rural dwellers. The document entitled *Reconstruction and Development Programme* (RDP), published by the ANC in March, 1994, said that land reform would form part of a broader rural development programme. In lieu of dealing with only the bio-physical aspects of land - as is currently the case in school ecology curricula - a more holistic and integrated approach to land use, and issues related to it, is needed in school curricula, incorporating the economic, social, political and bio-physical aspects. This can be achieved by infusing Environmental Education into the formal curriculum, with the full support of classroom teachers who are both convinced and convicted.

The global problem *air pollution* produced almost polarised responses from the two urban samples, with the urban-English pupils ranking air pollution as a concern in fourth position while the urban-Xhosa sample ranked air pollution only eleventh. The high ranking given to air pollution by the urban-English pupils harmonises with the earlier findings of Bybee and Mau (1986), Bybee and Najafi (1986) and Ndodana, Rochford and Fraser (1994). The unexpectedly low ranking of air pollution by the urban-Xhosa sample is anomalous. This may be a sampling error. Alternatively, it may present an interesting area of concern for future research, since the number of respiratory illnesses are seven times higher among African children than among white children, and cause the second highest number of deaths among infants in South Africa (South African Institute of Race Relations, 1995 :45). However, the one sample of urban-Xhosa speaking pupils (n = 189) is at present too small to make generalisations in this regard, and it might be helpful to obtain further data from similar samples of urban-Xhosa speaking pupils.

The low ranking of the item *war technology* by all three samples corroborates fully the earlier findings of Ndodana, Rochford and Fraser (1994), Le Grange, Rochford and Paulsen (1995) and Le Grange, Rochford and Sass (1995). The consistently low ranking of war technology, by all South African samples surveyed to date, empirically supports the policy decision of the Reconstruction and Development Programme to redirect military/strategic production to civilian production (*RDP base document*, 1994:98).

The placing of *extinction of plants and animals* as the last ranked item by the rural-Northern Sotho sample may be due to the possible alienation of black Africans from conservation issues as a result of the former apartheid system. The lowest ranked position of extinction of plants and animals also matches one earlier finding with a sample of 27 Cape Town male business/marketing students (Le Grange, Rochford and Sass, 1995). According to Kahn (1989), one of the unforseen consequences of the apartheid system has been the increasing indifference and antagonism toward environmental issues expressed by communities alienated by that system. A second reason may be the fact that wood remains an important fuel and energy source which provides for the short-term needs of rural dwellers, rather than for long term community concerns about afforestation and deforestation.

It may therefore be useful to have extinction of plants **and** extinction of animals as *separate* items on the LGPI when sampling rural pupils in the future, in order to see whether the low ranking of extinction of plants and animals occurs as a result of wood being perceived as a basic need for rural dwellers, or as a result of a local attitude to wild animals, game, etc.

5.2 Comparison of findings with 76 science educators

The findings of this survey of 946 South African science pupils largely match the findings of the 1993 survey of 76 Western Cape science teachers on the original Bybee scale. The top-ranked items of the teachers were *human health and disease*, *population growth*, *world* *hunger* and *water resources* which fully corroborates the findings of this study. The three items that received low priority by the 76 teachers were *mineral resources*, *war technology* and *nuclear reactors*. The same three items also received low prioritisation by all three samples in this study.

The mean priority scores and ranks of relative importance of the 76 science educators surveyed in 1993 by Ndodana *et al* are reproduced in Table 5.1 on page 57.

5.3 Implications and Conclusions

The fifteen global problems on the LGPI, related to the basic human needs of the three samples, are both discrete yet interrelated. The provision of mass housing is sometimes linked to electrification, the supply of clean water and the availability of land. The supply of clean water, air quality, and nutrition have crucial implications for human health and disease. As mentioned earlier, an increase in population size has implications for all of the above problems. Therefore it is important for science pupils to understand the mutual interdependence of the components of natural and human systems. It is concluded that science education concerned with global problems related to basic human needs could offer an integrated approach in a holistic curriculum.

Table 5.1
The mean priority scores, and ranks of relative importance, of global problems in science and technology rated by science educators in 1993.

	Science educators n = 76	
Global problem	**Mean priority score**	**Rank of relative importance**
Unsafe substances	7.9	9
Human health & disease	3.4	1
Mineral resources	8.0	10
Fresh water supplies	4.6	4
Population growth	3.6	2
Extinction of species	7.8	8
Energy shortages	7.2	7
War technology	8.8	11
Air pollution	6.5	6
World hunger	4.0	3
Bad land use	6.0	5
Nuclear power stations	9.8	12

5.4 Chapter summary

In this chapter the results of the survey in relation to meeting basic needs in science curricula were discussed. A comparison was made of the findings of this survey with teachers surveyed in 1993. In **chapter six,** which follows, the research method and research instrument will be critiqued. Recommendations will also be made for the improvement of the research method and of the research instrument, as well as for further research investigations, not only as part of the emerging new South Africa but also in countries beyond our borders.

CHAPTER 6

RECOMMENDATIONS AND CONCLUSIONS

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6.1 Critique of the research method and research instrument

Due to the fact that non-probability survey sampling was used in this study, the results are generalisable to only the three samples concerned.

The LGPI is a *rank-order scale*. *Rank-order scales* are not equal interval scales, and data produced by them are not necessarily normally distributed. As a result the data cannot be analysed by parametric statistical methods which are more powerful than non-parametric statistics.

The only way in which the reliability of a *rank-order scale* can be measured is by using the test/retest method. The split-half method of determining reliability and methods of determining internal consistency cannot be applied to *rank-order scales*. Statistical item analyses also cannot be performed with this type of scale.

The following recommendations concerning the future use of the research method and instrument are suggested.

Recommendation 1

For larger studies, it is recommended that probability sampling methods be used, such as random sampling or stratified sampling, to produce results that are more generalisable and which will replicate current findings.

Recommendation 2

When using *rank-order scales* it is recommended that two or more statistical methods be used to analyse data which will ensure that results and conclusions drawn are reliable and valid. In this study Spearman rank correlation coefficients were used successfully in combination with Mann-Whitney U-tests. Gayford (1988) used Kendall's rank coefficient in combination with Kolmogorov-Smirnov two-sample tests. Spot accuracy checks on the computer-generated statistical results were also made using hand calculators, which agreed to within three decimal places.

However, statistical analyses of data produced by *rank-order scales* have shortcomings. The computation of Spearman rank correlation coefficients in this study was based on difference in ranks of items on the LGPI. However, in certain cases, for example, the item *mass housing* as a priority was ranked ninth by the urban-English speaking sample and fourteenth by the rural-Northern Sotho speaking sample even though they had close mean priority scores of 9.4 and 10.0. The Mann-Whitney U-test produced several statistically significant differences in the score distributions among the three samples in this study even when similar mean rank scores existed on most of the items (See Figures 4.1, 4.2, 4.3 on pages 40, 44 and 47). The statistically significant differences on so many items among the three samples may be due to the fact that the LGPI has fifteen items and the fact that relatively large samples were used in the study.

Recommendation 3

It is therefore recommended that, in the interpretation of results, not only should ranks of relative importance and score distributions be used, but also mean rank scores and Z-statistics should be employed to determine which findings are **practically (educationally)** significant.

The 15 items of the LGPI exceeded the number of items for rank-order scales recommended by Oppenheim (1992), namely that placing ten items in rank order is probably as much as can be asked of respondents. During the administration of the survey, junior secondary pupils did report difficulty in ranking the items, and more than half the responses from 13 -14 year old Xhosa speaking pupils were unusable. Because the instrument is still in the process of being updated for use in the mid-to-late-1990s, and being refined, the following is recommended for shortening and improving the scale:

Recommendation 4

> The items *war technology*, *nuclear power stations* and *high technology*, *mineral resources* and *ignorant decision makers*, might be excluded from the instrument in future studies, as these items were ranked least by all three samples in this study as well as by other samples of other studies in 1995 (Le Grange, Rochford and Sass, 1995; and Le Grange, Rochford and Paulsen, 1995) and the 1994 study by Ndodana *et al*. However, some of these items might be retained if it is intended to use the LGPI with samples of lecturers or students at specialised technikons (e.g. leaders in mineral processing). The item *forestry* may be *included* in the LGPI if it is used in certain countries such as New Zealand or Brazil.

Based on the findings of this study it is further recommended that the LGPI is not adopted blindly for use in different contexts. Three specific recommendations are made in this regard:-

Recommendation 5

> It is recommended that the item *provision of mass housing* be considered for *exclusion* from the instrument when *rural* sampling is done but *included* with *urban* sampling, especially in crowded townships areas and peri-urban informal settlements.

Recommendation 6

> It is recommended that the item *decision makers* be considered for *exclusion* from the instrument with *urban* samples but be considered for *inclusion with and adapted for rural* samples where a system of traditional authority or tribal or clan leadership exists.

Recommendation 7

> It is recommended that in future studies in rural or inland areas it may be useful to split the item *extinction of plants and animals* into two separate items to establish whether or not there is a difference in the perceived relative importance of plants and animals by respondents living in deserts, on farms, on islands, in polar regions, in jungles, etc.

6.2 Recommendations with regard to data collection

Recommendation 8

> It is recommended that data be collected unobtrusively as a natural part of pupils'/students' formal classroom instruction by the researcher and reliable colleagues in relevant institutions.

For example, the LGPI could be administered without the Hawthorne effect occurring when any topic related to any one of the fifteen items is being discussed or studied by a group.

6.3 Recommendations with regard to science education policy

Although the study shows consistency in the mean rankings of items on the LGPI as a whole by disparate samples from two different regions of the country, highly significant differences in the score distributions on individual items of the LGPI exist between the different samples. For example, on the item *fresh water supplies* the Z-test statistic is 19.4 between samples 1 and 3, and between samples 1 and 2 it is 14.8. It is therefore recommended that:

Recommendation 9

> Some aspects of future school science curricula might be designed regionally or locally on a core-plus-options model.

The syllabus core might cater for interests that are nationally important, and options could be more relevant to regional or cultural values. For example, it is important for all pupils to learn about water as a natural resource; but it may be necessary for greater local emphasis to be placed on issues related to water in drought-stricken areas such as those in the Northern Province.

In this study the importance of meeting the basic needs of people is emphasised. It is recommended that:

Recommendation 10

> Some aspects of regional science and technology programmes, curricula and examinations may be designed to meet the diverse needs of the different societies of the South African nation.

Ten years ago Ogunniyi (1986) wrote:-

> topics that relate to mechanised farming, control of malaria and many tropical diseases, ecological balance, provision of good drinkable water, production of food, development of good roads, drought, small agro-based industries etc. are more relevant to the African setting than topics such as computers in the school, computer assisted learning, laser beams, radio-activity and many other topics that have featured in science curricula of industrial societies.

What Ogunniyi said a decade ago may still be applicable to certain regions in the South African context.

The global problems which form part of this study are interrelated and it is therefore recommended that:

Recommendation 11

> Global STS problems might be introduced into school curricula through environmental education involving an inter-disciplinary, integrated and active approach.

In the Department of Environmental Affairs and Tourism's discussion document on the

Integration of Environmental Education into formal Education it is stated that:

> The Science, Technology and Society (STS) approach to curriculum and syllabus development, which is internationally widely recognised by various countries (e.g. Australia, Great Britain, United States, Canada and various others), might be a suitable way to infuse environmental issues into the curriculum (Joubert and Steenkamp, 1995:122).

6.4 Recommendations for further research

Recommendation 12

In the light of the reliable and consistent results produced by the LGPI in different contexts, it is recommended that science education studies consider utilising *rank-order scales*, as a research technique, more widely. Once their component items have been validated individually they are relatively simple to administer, and the data is relatively easily analysed.

Recommendation 13

The LGPI has proved to be a convenient instrument which produced mostly consistent results across different cultures. It is suggested that similar surveys might be considered in other multicultural countries with a third/world interface to see whether similar results are obtained globally.

Recommendation 14

To date the instrument has been translated from English into Xhosa. It is suggested that the instrument be translated into more of the official South African languages to see whether similar findings will be obtained.

Recommendation 15

Samples of respondents from secondary school to post-graduate level might be sampled with the aim of determining their subject matter priorities for changes in syllabi or areas of specialisation in South Africa and beyond.

Recommendation 16

In a larger study it may be useful to establish whether the order in which items are arranged on the LGPI significantly affect the way the respondents rank the items.

6.5 Conclusion

In this study in 1995, and in other similar surveys conducted by the writer's team earlier in 1995, the LGPI has proved to be a convenient instrument which has produced generally consistent results across disciplines, gender and culture. It might be useful to establish whether the preferences of respondents in other multicultural countries yield similar findings.

The LGPI is an up-to-date, simple, valid, adaptable and reliable instrument. It might be used to gather further response data efficiently from samples in South Africa and in other countries around the Indian Ocean and Pacific Rim with a first world/third world interface. For example, sets of priorities could be derived from *nurses* in the Ciskei and in Zimbabwe; *farmers* with agriculture diplomas in Natal and the Karoo; *technology* students in technikons in different regions of sub-Saharan Africa; *employees* in large international oil refineries etc.

The results of this survey have corroborated findings over a 12 year period that the top-ranked items remain those related to the basic needs for short-term and long-term survival of human beings. The survey provides some empirical justification for the inclusion of one of the Key programmes - *Meeting Basic Needs* - in the South African Government's Reconstruction and Development Programme (RDP).

The survey also supports a perceived need for more modern and relevant science curricula adapted to preparing a citizenry to be more critically conscious of global problems, and able to make informed decisions in a democratic society.

The fact that significant local differences were found on some items between the samples indicate that people's perceptions of global problems may be modified or shaped by their own context i.e. by their immediate environment and personal needs for survival.

According to the Foundation of Research Development,

> South Africa's reconstruction and Development Programme (RDP) is on the lips of all South Africans. But to turn words into workable solutions the classroom is where reconstruction must start for true development to follow (Foundation for Research Development, 1995:2).

Education does have an important role to play in South Africa's Reconstruction and Development Programme, and in solving global problems related to science and technology. David Orr (1990:46) however, cautions that education *per se* is not a panacea for global environmental ills. He says,

> If today is a typical day on plant Earth, we will lose 116 square miles of rainforest, or about an acre a second. We will lose another 72 miles square miles to encroaching deserts, as a result of human mismanagement and overpopulation. We will lose 40 to 100 species, and no one knows whether the number is 40 or 100. Today the human population will increase by 250 000. And today we will add 2700 tons of chlorofluorocarbons to the atmosphere and 15 millions tons of carbon. Tonight the Earth will be a little hotter, its waters more acidic, and the fabric of life more threadbare.
> The truth is that many things on which your and my future depend are in dire jeopardy: climate stability, the resilence and productivity of natural systems, the beauty of the natural world, biological diversity. It is, rather, largely the result of the work by people with BAs, BSs, LLBs, MBAs, and PhDs. It is not education that will save us, but education of a certain kind.

In educating about global problems, it is not only important that these problems are taught and learned, but also important in the *way* they are taught and learned. The effectiveness of teaching methods will also require research, but they are beyond the scope of this dissertation. In problem-solving process is as important, if not more important, than content. It is not only knowledge, but also values, skills and attitudes that should be an integral part of learning so that local communities and thus of the globe of life will benefit.

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APPENDICES

	LEGEND
MH	Mass housing
US	Unsafe substances
HH	Human health & disease
MR	Mineral resources
FW	Fresh water supplies
PG	Population growth
EPA	Extinction of species
ES	Energy shortages
WT	War technology
AP	Air pollution
WH	World hunger
BLU	Bad land use
NP	Nuclear power stations
HT	High technology
DM	Decision makers

APPENDIX A

THE DATA

SAMPLE 1: 1995 RURAL-NORTHERN SOTHO PUPILS' RANKINGS ON THE LE GRANGE GLOBAL PRIORITIES INSTRUMENT: RAW SCORES

SEX	STD	MH	US	HH	MR	FW	PG	EPA	ES	WT	AP	WH	BLU	NP	HT	DM
F	E	11	7	4	13	1	9	6	8	12	15	3	2	5	10	14
F	E	13	7	6	9	1	2	12	5	15	14	10	11	4	3	8
F	E	8	13	3	2	1	7	5	12	15	14	10	11	4	6	9
F	E	13	7	6	9	1	14	12	8	15	10	4	11	5	2	3
F	E	9	14	6	7	1	13	15	5	3	12	4	2	10	8	11
F	N	10	11	5	7	1	2	13	6	14	15	3	4	9	8	12
F	N	8	5	2	14	1	13	10	9	7	12	4	15	6	3	11
F	N	8	13	12	2	1	7	5	9	15	14	4	10	11	6	3
F	N	13	7	11	9	2	1	12	8	15	14	10	3	5	4	6
F	N	11	7	4	13	3	14	12	8	15	6	10	9	5	1	2
F	N	10	6	4	9	1	7	12	5	8	11	3	15	2	14	13
F	N	13	5	6	9	1	14	7	12	8	10	4	3	2	11	15
F	N	11	7	3	8	2	9	6	5	12	10	15	4	1	13	14
F	T	11	7	12	9	1	3	10	5	13	14	8	15	6	2	4
F	T	10	14	6	2	1	4	7	11	8	9	3	15	13	5	12
F	T	9	13	6	12	1	14	10	5	7	15	11	8	4	2	3
F	T	8	13	4	7	1	3	6	10	15	14	12	11	9	2	5
F	T	10	11	6	1	2	4	15	3	14	12	13	9	5	7	8
F	N	14	11	3	13	2	1	10	12	9	8	4	5	7	6	15
F	N	9	11	2	13	8	1	3	12	4	5	15	7	14	10	6
F	N	11	13	3	7	2	1	10	4	9	5	6	15	8	12	14
F	N	9	2	5	6	8	3	13	14	7	4	1	15	10	11	12
F	N	9	13	2	6	1	3	10	8	4	5	7	15	12	14	11
F	N	15	8	5	7	1	2	13	12	4	14	3	9	6	11	10
F	N	6	13	2	15	5	8	11	12	9	14	4	10	7	1	3
F	N	6	12	2	8	1	3	9	7	14	5	15	4	10	11	13
F	N	15	12	1	8	3	2	11	10	13	7	4	5	14	6	9
F	N	15	9	7	12	1	8	2	10	14	6	5	11	13	3	4
F	T	14	8	11	15	3	1	13	7	4	6	2	5	10	12	9
F	T	15	13	11	12	2	1	10	4	9	8	5	6	14	7	3
F	T	11	10	3	12	1	8	2	13	15	14	4	5	6	9	7
F	T	9	8	3	14	1	7	12	10	15	13	6	2	5	4	11
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F	T	6	8	2	12	1	7	3	10	14	13	5	15	4	9	11
F	E	3	7	8	2	1	6	11	13	14	9	4	10	5	15	12
F	E	10	11	2	13	1	3	14	6	12	7	4	5	15	8	9
F	E	12	13	2	14	1	3	8	9	10	15	4	5	11	6	7
F	E	12	14	1	13	2	3	11	7	8	10	4	5	15	9	6
F	E	8	9	4	7	1	3	12	10	11	15	6	5	13	14	2
F	E	9	12	3	13	1	2	15	4	10	11	5	6	8	14	7
F	E	8	9	4	7	1	3	12	10	11	15	2	5	13	14	6
F	E	9	12	3	13	1	2	15	4	10	11	5	6	8	14	7
F	E	8	9	4	7	1	3	12	10	11	15	6	5	13	14	2
F	E	10	14	11	9	1	3	12	7	6	15	13	2	4	5	8
F	E	11	4	7	6	3	15	13	1	10	9	2	14	5	8	12
F	E	3	8	6	10	1	5	11	12	15	13	7	2	14	4	9
F	E	14	6	5	13	1	11	3	4	7	15	2	9	10	8	12
F	E	6	13	5	11	1	4	15	12	14	10	2	9	7	3	8
F	E	15	13	6	7	5	1	14	9	10	12	2	11	4	8	3
F	E	15	10	12	9	1	5	14	7	13	8	2	4	3	6	11
F	E	6	5	4	11	1	8	14	12	9	10	2	3	7	13	15

F	E	13	11	10	6	5	1	15	9	7	8	14	4	2	12	3
F	E	13	2	4	8	5	1	12	7	15	10	6	11	3	9	14
F	E	11	1	10	9	6	4	7	12	13	8	14	15	5	2	3
F	E	1	8	9	10	6	5	7	12	13	11	2	4	15	3	14
F	E	8	5	6	11	2	4	15	10	7	14	1	3	9	12	13
F	E	12	8	5	6	1	4	15	7	10	11	13	9	2	14	3
F	E	3	8	2	7	4	5	15	6	13	12	1	14	9	11	10
F	E	3	12	4	15	1	5	13	9	11	14	2	6	8	10	7
F	E	5	6	4	8	1	2	9	7	15	14	3	10	13	11	12
F	E	9	3	2	1	8	7	10	12	4	5	13	15	14	11	6
F	E	6	11	2	5	1	10	12	9	13	15	3	7	14	4	8
F	E	13	8	4	5	1	2	3	10	14	11	9	12	15	6	7
F	E	13	12	1	5	2	7	11	8	9	4	6	10	3	14	15
F	E	3	5	4	11	6	1	7	12	13	8	2	10	15	14	9
F	E	13	9	1	14	4	5	10	6	11	12	2	3	15	8	7
F	N	5	6	2	13	1	3	12	14	11	15	4	9	7	8	10
F	N	15	11	2	12	1	3	13	6	9	5	4	8	14	10	7
F	N	4	9	3	8	1	2	12	7	10	11	5	6	15	14	13
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M	N	6	3	1	9	2	14	15	13	4	5	8	10	12	11	7
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F	N	13	4	5	9	1	2	6	8	11	7	10	12	14	15	3
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F	N	3	10	5	4	1	9	13	8	15	12	2	11	14	6	7
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F	N	7	12	6	11	2	5	13	4	9	1	3	15	8	14	10
F	N	14	2	3	1	6	7	9	10	13	15	12	5	11	8	4
F	N	10	3	2	12	1	11	14	4	9	5	6	15	8	7	13
F	N	4	6	3	8	5	1	7	13	15	11	9	2	10	12	14
F	N	7	8	6	2	1	3	11	14	9	10	13	4	15	5	12
AVE.		10.0	9.3	4.1	9.4	1.9	4.6	10.2	8.2	10.0	9.2	6.1	8.7	9.6	9.7	9.0

SAMPLE 2: 1995 URBAN-XHOSA PUPILS' RANKINGS ON THE LE GRANGE GLOBAL PRIORITIES INSTRUMENT: RAW SCORES

SEX	STAND	LANG	MH	US	HH	MR	FW	PG	EPA	ES	WT	AP	WH	BLU	NP	HT	DM
M	9	X	1	6	2	4	5	7	11	10	9	15	13	3	8	12	14
M	9	X	1	15	14	10	13	2	5	7	4	9	12	3	11	8	6
M	9	X	3	4	2	5	1	11	15	14	13	6	7	8	9	10	12
F	9	X	2	7	3	5	1	4	10	11	8	9	6	12	13	15	14
F	9	X	1	9	3	11	2	10	13	15	7	8	5	12	14	4	6
F	9	X	1	6	2	12	3	5	15	7	13	14	4	8	9	10	11
F	9	X	1	7	2	6	3	8	4	12	14	9	11	15	10	13	5
F	9	X	1	5	3	15	2	7	6	4	13	12	10	11	14	8	9
F	9	X	2	4	1	10	5	6	14	11	15	12	3	9	13	7	8
F	9	X	2	8	3	11	4	1	6	12	9	14	5	7	10	13	15
F	9	X	3	8	4	15	7	2	9	11	12	14	13	5	10	1	6
F	9	X	3	7	2	15	4	13	6	9	14	10	8	5	12	1	11
M	9	X	1	5	4	10	2	12	7	13	15	11	3	8	14	6	9
F	9	X	13	9	4	3	8	14	6	5	15	11	12	10	1	2	7
F	9	X	1	4	5	15	3	2	8	12	14	7	6	10	9	13	11
F	9	X	2	8	4	12	5	1	3	11	15	10	6	7	14	13	9
F	9	E	9	3	1	10	5	2	6	8	12	11	4	7	13	15	14
F	9	E	5	3	2	8	4	9	15	7	6	10	1	13	11	12	14
F	9	E	2	11	3	13	8	1	10	9	15	4	5	12	6	7	14
F	9	E	1	2	5	3	4	12	14	11	10	6	9	7	8	13	15
F	9	E	1	9	3	14	5	11	8	12	15	10	2	7	13	6	4
M	9	E	1	2	3	10	4	6	7	14	8	5	13	9	11	12	15
F	10	X	1	8	2	10	3	6	15	11	7	5	4	12	14	13	9
F	10	X	1	6	2	8	3	7	15	10	13	4	9	12	5	11	14
F	10	X	1	6	3	7	2	4	10	9	12	11	5	8	13	14	15
M	10	E	15	10	14	8	7	13	12	5	1	9	11	4	2	6	3
F	10	E	1	4	5	6	2	15	7	8	9	10	3	12	13	11	14
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F	10	X	1	10	7	15	2	5	9	6	12	13	8	4	14	11	3
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		AVE.	2.08	6.90	4.32	8.87	4.77	7.20	9.21	9.19	11.30	9.54	5.92	9.34	11.24	9.68	10.44

SAMPLE 3: 1995 URBAN-ENGLISH PUPILS' RANKINGS ON THE LE GRANGE GLOBAL PRIORITIES INSTRUMENT: RAW SCORES

SEX	MH	US	HH	MR	FW	PG	EPA	ES	WT	AP	WH	BLU	NP	HT	DM
M	12	3	9	15	4	5	14	13	6	1	2	8	10	11	7
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AVE.	9.45	6.31	4.88	10.74	6.27	5.22	6.44	10.16	9.77	5.55	4.89	9.15	9.64	10.79	10.76

PILOT SAMPLE: 1995 16 YEAR OLD HIGH SCHOOL SCIENCE PUPILS (n = 58)

TEST

CODE	MH	US	HH	MR	FW	PG	EPA	ES	WT	AP	WH	BLU	NP	HT	DM
A	13	2	15	14	5	10	7	12	3	1	8	6	4	9	11
B	13	2	5	11	7	4	3	6	15	1	10	9	8	12	14
C	14	6	2	9	7	10	3	13	8	4	1	12	11	5	15
D	13	4	6	8	12	1	5	9	11	7	2	3	10	14	15
E	15	12	4	13	10	1	2	9	14	6	3	5	8	11	7
F	6	4	13	15	12	1	2	11	10	3	14	5	9	7	8
G	15	2	5	11	6	12	3	10	1	7	9	8	4	13	14
H	11	9	3	8	5	1	2	6	13	7	4	10	12	14	15
I	3	13	8	14	9	7	12	2	5	15	6	11	4	1	10
J	8	10	7	11	6	4	1	13	14	3	2	12	5	9	15
K	7	5	6	9	2	14	3	8	15	1	4	12	11	10	13
L	9	8	5	11	2	7	3	12	14	1	4	6	10	13	15
M	13	1	7	12	6	2	5	14	8	3	4	9	15	10	11
N	12	8	1	13	2	6	5	10	9	7	3	4	11	14	15
O	6	2	12	11	9	5	4	14	13	7	8	3	10	15	1
P	8	7	2	14	3	5	9	12	6	4	1	11	13	10	15
Q	9	6	5	13	11	2	4	14	8	1	3	10	12	15	7
R	8	4	5	11	10	1	6	9	13	2	3	7	12	14	15
S	13	12	1	11	4	10	2	14	15	6	3	5	7	8	9
T	8	10	2	6	15	1	11	14	5	13	3	7	12	4	9
U	8	2	6	12	3	7	1	14	15	5	9	4	13	10	11
V	3	12	2	13	6	7	8	15	9	4	1	14	10	11	5
W	7	9	4	10	8	5	2	3	15	6	1	11	12	14	13
X	4	10	3	15	2	1	8	9	12	7	5	6	11	13	14
Y	15	11	4	13	9	10	1	3	12	8	2	7	14	5	6
Z	14	11	12	9	4	3	2	8	10	1	5	7	6	13	15
AA	6	7	3	11	8	2	4	14	9	13	5	10	12	15	1
AB	9	14	7	15	10	8	11	13	6	12	5	4	3	2	1
AC	13	1	14	15	7	6	3	11	10	2	5	4	8	12	9
AD	15	11	4	12	5	2	3	8	9	7	6	13	10	14	1
AE	14	3	1	8	7	9	4	11	10	5	2	6	12	15	13
AF	6	3	4	11	7	12	8	10	15	2	1	5	13	9	14
AG	3	7	10	13	6	5	1	12	11	8	2	4	9	15	14
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AK	6	5	4	11	10	1	2	13	14	9	3	15	12	8	7
AL	9	7	5	8	1	13	4	15	10	6	2	3	14	12	11
AM	13	3	2	14	11	9	6	10	12	7	1	5	4	8	15
AN	3	8	4	14	5	1	12	9	13	6	2	7	10	11	15
AO	5	6	3	7	9	4	8	12	10	13	2	15	11	14	1
AP	10	8	2	9	3	1	5	11	13	6	4	12	7	15	14
AQ	13	1	5	7	4	11	3	8	10	2	14	9	12	15	6
AR	11	9	3	13	10	5	1	2	15	6	4	8	14	12	7
AS	10	8	4	11	6	7	1	15	3	2	5	9	13	12	14
AT	15	3	1	12	4	5	6	11	8	7	2	13	9	10	14
AU	14	4	10	7	11	15	6	8	3	9	12	13	5	1	2
AV	8	7	2	15	9	10	4	11	6	3	1	12	13	5	14
AW	12	10	1	13	6	3	7	5	14	2	4	9	11	8	15
AX	10	2	7	14	3	8	4	15	6	1	5	12	11	9	13
AY	10	8	12	7	2	3	5	6	13	1	4	9	14	11	15
AZ	14	12	2	10	1	8	9	7	6	3	11	4	5	15	13
BA	3	7	8	11	9	10	12	13	6	5	4	14	2	1	15
BB	9	4	3	13	5	6	1	12	15	7	2	8	14	10	11
BC	12	8	3	7	6	2	1	14	11	9	4	5	10	15	13
BD	8	1	3	13	6	15	7	12	9	2	5	4	11	10	14
BE	11	13	2	6	3	5	4	10	15	12	1	7	8	9	14
BF	13	7	4	11	5	1	8	9	15	2	3	12	6	10	14
AVE	9.83	6.53	4.91	11.00	6.47	5.79	5.10	10.43	10.47	5.45	4.33	8.43	9.81	10.59	10.86

APPENDIX B

SUMMARY STATISTICS

SUMMARY STATISTICS FOR THE RURAL-NORTHERN SOTHO SAMPLE

Variable:	MH	US	HH
Sample size	414	414	414
Average	10.0169	9.29952	4.07729
Median	10	9	3
Mode	13	13	2
Geometric mean	9.16827	8.4132	3.25561
Variance	12.2588	12.7866	8.30878
Standard deviation	3.50126	3.57583	2.8825
Standard error	0.172077	0.175743	0.141667
Minimum	1	1	1
Maximum	15	15	15
Range	14	14	14
Lower quartile	8	7	2
Upper quartile	13	12	5
Interquartile range	5	5	3
Skewness	-0.509717	-0.237558	1.39442
Standardized skewness	-4.23402	-1.9733	11.5829
Kurtosis	-0.549931	-0.924544	1.5112
Standardized kurtosis	-2.28404	-3.83992	6.27648
Coeff. of variation	34.9535	38.4518	70.6963

Variable:	MR	FW	PG
Sample size	414	414	414
Average	9.38406	1.87681	4.63768
Median	9	1	3
Mode	7	1	3
Geometric mean	8.42635	1.47806	3.62285
Variance	13.7335	2.77656	11.0645
Standard deviation	3.70587	1.6663	3.32634
Standard error	0.182134	0.0818942	0.163481
Minimum	1	1	1
Maximum	15	11	15
Range	14	10	14
Lower quartile	7	1	2
Upper quartile	13	2	6
Interquartile range	6	1	4
Skewness	-0.212426	2.3547	1.26099
Standardized skewness	-1.76454	19.5596	10.4746
Kurtosis	-0.954983	5.55642	1.01683
Standardized kurtosis	-3.96634	23.0775	4.22321
Coeff. of variation	39.4912	88.7835	71.7242

Variable:	EPA	ES	WT
Sample size	414	414	414
Average	10.1812	8.20773	9.95169
Median	11	8	10
Mode	15	5	9
Geometric mean	9.38317	7.46345	9.17128
Variance	12.2504	10.504	11.7943
Standard deviation	3.50006	3.24098	3.43428
Standard error	0.172018	0.159286	0.168786
Minimum	1	1	1
Maximum	15	15	15
Range	14	14	14
Lower quartile	7	6	8
Upper quartile	13	11	13
Interquartile range	6	5	5
Skewness	-0.420205	0.140711	-0.353804
Standardized skewness	-3.49049	1.16883	-2.93891
Kurtosis	-0.698198	-0.796681	-0.590734
Standardized kurtosis	-2.89983	-3.30887	-2.4535
Coeff. of variation	34.3778	39.4869	34.5095

Variable:	AP	WH	BLU
Sample size	414	414	414
Average	9.20048	6.0942	8.74396
Median	10	5	9
Mode	15	4	5
Geometric mean	8.10097	4.92017	7.68296
Variance	15.5505	15.1364	15.6922
Standard deviation	3.94341	3.89055	3.96133
Standard error	0.193808	0.19121	0.194689
Minimum	1	1	1
Maximum	15	15	15
Range	14	14	14
Lower quartile	6	3	5
Upper quartile	12	9	12
Interquartile range	6	6	7
Skewness	-0.173191	0.825	0.0308038
Standardized skewness	-1.43864	6.85296	0.255876
Kurtosis	-1.05299	-0.494919	-1.231
Standardized kurtosis	-4.37341	-2.05555	-5.11272
Coeff. of variation	42.8609	63.8402	45.3036

Variable:	NP	HT	DM
Sample size	414	414	414
Average	9.62077	9.66667	9.04106
Median	10	10	9
Mode	13	14	7
Geometric mean	8.56108	8.58109	7.98735
Variance	15.3062	15.3898	15.3179
Standard deviation	3.91231	3.92299	3.91381
Standard error	0.19228	0.192804	0.192353
Minimum	1	1	1
Maximum	15	15	15
Range	14	14	14
Lower quartile	6	7	6
Upper quartile	13	13	12
Interquartile range	7	6	6
Skewness	-0.335145	-0.349909	-0.0964417
Standardized skewness	-2.78392	-2.90656	-0.801105
Kurtosis	-1.06456	-0.971455	-1.11522
Standardized kurtosis	-4.42145	-4.03475	-4.63184
Coeff. of variation	40.6653	40.5826	43.2893

SUMMARY STATISTICS FOR THE URBAN-XHOSA SAMPLE

Variable:	MH	US	HH
Sample size	189	189	189
Average	2.07937	6.90476	4.32275
Median	1	6	3
Mode	1	5	2
Geometric mean	1.48696	5.97228	3.51611
Variance	6.40324	11.959	8.9857
Standard deviation	2.53046	3.45817	2.99762
Standard error	0.184064	0.251545	0.218044
Minimum	1	1	1
Maximum	15	15	15
Range	14	14	14
Lower quartile	1	4	2
Upper quartile	2	9	5
Interquartile range	1	5	3
Skewness	3.3578	0.59596	1.5945
Standardized skewness	18.8456	3.34481	8.94911
Kurtosis	11.8843	-0.253894	2.45885
Standardized kurtosis	33.3504	-0.712487	6.90014
Coeff. of variation	121.694	50.0839	69.3451

Variable:	MR	FW	PG
Sample size	189	189	189
Average	8.86772	4.77249	7.19577
Median	9	4	6
Mode	8	2	5
Geometric mean	7.95746	3.88704	5.8465
Variance	13.3282	11.1767	17.2221
Standard deviation	3.65077	3.34316	4.14995
Standard error	0.265555	0.243179	0.301865
Minimum	2	1	1
Maximum	15	14	15
Range	13	13	14
Lower quartile	6	2	4
Upper quartile	11	6	10
Interquartile range	5	4	6
Skewness	8.37043E-3	1.4384	0.482464
Standardized skewness	0.0469789	8.073	2.70782
Kurtosis	-0.820586	1.23923	-0.812909
Standardized kurtosis	-2.30276	3.47757	-2.28122
Coeff. of variation	41.1692	70.0506	57.6721

Variable:	EPA	ES	WT
Sample size	189	189	189
Average	9.20635	9.19048	11.2963
Median	9	9	12
Mode	10	7	15
Geometric mean	8.34255	8.50788	10.5261
Variance	12.8349	9.70821	11.7096
Standard deviation	3.58258	3.1158	3.42193
Standard error	0.260594	0.226641	0.248909
Minimum	1	1	1
Maximum	15	15	15
Range	14	14	14
Lower quartile	7	7	9
Upper quartile	12	12	14
Interquartile range	5	5	5
Skewness	-0.098022	-0.211183	-0.835292
Standardized skewness	-0.550147	-1.18526	-4.68806
Kurtosis	-0.826249	-0.448133	-0.0662615
Standardized kurtosis	-2.31866	-1.25757	-0.185946
Coeff. of variation	38.9142	33.9025	30.2925

Variable:	AP	WH	BLU
Sample size	189	189	189
Average	9.54497	5.91534	9.34392
Median	10	5	10
Mode	11	3	12
Geometric mean	8.82103	4.71744	8.49711
Variance	11.3238	14.3226	11.9822
Standard deviation	3.36508	3.78452	3.46153
Standard error	0.244774	0.275283	0.251789
Minimum	2	1	1
Maximum	15	15	15
Range	13	14	14
Lower quartile	7	3	7
Upper quartile	12	9	12
Interquartile range	5	6	5
Skewness	-0.219261	0.702399	-0.303153
Standardized skewness	-1.2306	3.9422	-1.70144
Kurtosis	-0.796501	-0.713092	-0.764359
Standardized kurtosis	-2.23518	-2.00111	-2.14498
Coeff. of variation	35.255	63.978	37.0458

Variable:	NP	HT	DM
Sample size	189	189	189
Average	11.2434	9.67725	10.4392
Median	12	10	11
Mode	13	13	15
Geometric mean	10.6572	8.60608	9.55821
Variance	8.96172	13.7729	14.0987
Standard deviation	2.99361	3.71119	3.75482
Standard error	0.217753	0.269949	0.273123
Minimum	1	1	1
Maximum	15	15	15
Range	14	14	14
Lower quartile	10	7	7
Upper quartile	13	13	14
Interquartile range	3	6	7
Skewness	-1.02177	-0.552974	-0.448359
Standardized skewness	-5.73465	-3.10356	-2.51641
Kurtosis	0.671082	-0.600075	-0.971403
Standardized kurtosis	1.88322	-1.68396	-2.72599
Coeff. of variation	26.6256	38.3496	35.9686

SUMMARY STATISTICS FOR THE URBAN-ENGLISH SAMPLE

Variable:	MH	US	HH
Sample size	343	343	343
Average	9.44606	6.30904	4.88047
Median	10	6	4
Mode	13	4	1
Geometric mean	8.50871	5.17099	3.65319
Variance	12.8502	13.0914	12.1757
Standard deviation	3.58471	3.6182	3.48937
Standard error	0.193556	0.195364	0.188408
Minimum	1	1	1
Maximum	15	15	15
Range	14	14	14
Lower quartile	7	3	2
Upper quartile	12	9	7
Interquartile range	5	6	5
Skewness	-0.375332	0.586086	0.85611
Standardized skewness	-2.83783	4.43132	6.47293
Kurtosis	-0.763296	-0.403622	-0.0629613
Standardized kurtosis	-2.88559	-1.52587	-0.238021
Coeff. of variation	37.9493	57.3494	71.4967

Variable:	MR	FW	PG
Sample size	343	343	343
Average	10.7376	6.27114	5.21866
Median	11	6	4
Mode	13	6	1
Geometric mean	10.2189	5.22924	3.81467
Variance	8.66779	11.7888	15.4813
Standard deviation	2.94411	3.43349	3.93463
Standard error	0.158967	0.185391	0.21245
Minimum	2	1	1
Maximum	15	15	15
Range	13	14	14
Lower quartile	9	4	2
Upper quartile	13	8	7
Interquartile range	4	4	5
Skewness	-0.609263	0.551843	0.947924
Standardized skewness	-4.60655	4.17241	7.16713
Kurtosis	-0.144129	-0.331879	-0.0374345
Standardized kurtosis	-0.54487	-1.25465	-0.141519
Coeff. of variation	27.4187	54.7507	75.3954

Variable:	EPA	ES	WT
Sample size	343	343	343
Average	6.44315	10.1574	9.76676
Median	6	10	11
Mode	4	10	15
Geometric mean	5.05782	9.49212	8.2409
Variance	15.3294	10.2617	19.6297
Standard deviation	3.91527	3.20339	4.43054
Standard error	0.211405	0.172967	0.239226
Minimum	1	2	1
Maximum	15	15	15
Range	14	13	14
Lower quartile	3	8	6
Upper quartile	9	13	14
Interquartile range	6	5	8
Skewness	0.45918	-0.509709	-0.444307
Standardized skewness	3.4718	-3.85384	-3.35934
Kurtosis	-0.731389	-0.417877	-1.09439
Standardized kurtosis	-2.76497	-1.57976	-4.13725
Coeff. of variation	60.7665	31.5374	45.3634

Variable:	AP	WH	BLU
Sample size	343	343	343
Average	5.5481	4.8863	9.14577
Median	5	4	9
Mode	1	2	11
Geometric mean	4.3539	3.70583	8.28453
Variance	12.1548	12.3701	12.043
Standard deviation	3.48638	3.51711	3.4703
Standard error	0.188247	0.189906	0.187379
Minimum	1	1	1
Maximum	15	15	15
Range	14	14	14
Lower quartile	3	2	7
Upper quartile	8	7	12
Interquartile range	5	5	5
Skewness	0.684066	0.982422	-0.273631
Standardized skewness	5.17213	7.42796	-2.06888
Kurtosis	-0.170269	0.120239	-0.786243
Standardized kurtosis	-0.643692	0.454554	-2.97234
Coeff. of variation	62.8391	71.9791	37.9444

Variable:	NP	HT	DM
Sample size	343	343	343
Average	9.6414	10.7872	10.7609
Median	10	12	13
Mode	10	14	15
Geometric mean	8.62988	9.7558	8.96376
Variance	12.9675	13.3201	20.2526
Standard deviation	3.60104	3.64967	4.50029
Standard error	0.194438	0.197063	0.242993
Minimum	1	1	1
Maximum	15	15	15
Range	14	14	14
Lower quartile	7	9	8
Upper quartile	12	14	15
Interquartile range	5	5	7
Skewness	-0.565979	-0.922326	-0.924317
Standardized skewness	-4.27929	-6.97358	-6.98863
Kurtosis	-0.445868	0.0600872	-0.390777
Standardized kurtosis	-1.68557	0.227155	-1.4773
Coeff. of variation	37.3498	33.8334	41.8206

APPENDIX C

RANK CORRELATION COEFFICIENTS

SPEARMAN RANK RESULTS OF TEST/RETEST RELIABILITY (n = 58)

Spearman Rank Correlations

	TEST	RETEST
TEST	1.0000	.9286
	(15)	(15)
	1.0000	.0005
RETEST	.9286	1.0000
	(15)	(15)
	.0005	1.0000

Coefficient (sample size) significance level

SPEARMAN RANK RESULTS OF TEST/RETEST RELIABILITY (n = 11)

Spearman Rank Correlations

	TEST	RETEST
TEST	1.0000	.9321
	(15)	(15)
	1.0000	.0005
RETEST	.9321	1.0000
	(15)	(15)
	.0005	1.0000

Coefficient (sample size) significance level

SPEARMAN RANK RESULTS FOR THE THREE MAIN SAMPLES OF THIS STUDY

Spearman Rank Correlations

	N_Sotho	Xhosa	English
N_Sotho	1.0000	.4179	.5357
	(15)	(15)	(15)
	1.0000	.1179	.0450
Xhosa	.4179	1.0000	.5821
	(15)	(15)	(15)
	.1179	1.0000	.0294
English	.5357	.5821	1.0000
	(15)	(15)	(15)
	.0450	.0294	1.0000

Coefficient (sample size) significance level

APPENDIX D

Z - STATISTICS

MANN-WHITNEY U-TEST RESULTS FOR NORTHERN SOTHO VERSUS URBAN-XHOSA SPEAKING PUPILS

```
                         Comparison of Two Samples
--------------------------------------------------------------------------
Sample 1: NSOTHO.MH

Sample 2: XHOSA.MH

Test: Unpaired

Average rank of first group = 387.755 based on 414 values.
Average rank of second group = 114.156 based on 189 values.
Large sample test statistic Z = -18.0164
Two-tailed probability of equaling or exceeding Z = 0

NOTE:  603 total observations.


                         Comparison of Two Samples
--------------------------------------------------------------------------
Sample 1: NSOTHO.US

Sample 2: XHOSA.US

Test: Unpaired

Average rank of first group = 337.528 based on 414 values.
Average rank of second group = 224.177 based on 189 values.
Large sample test statistic Z = -7.43356
Two-tailed probability of equaling or exceeding Z = 1.06581E-13

NOTE:  603 total observations.


                         Comparison of Two Samples
--------------------------------------------------------------------------
Sample 1: NSOTHO.HH

Sample 2: XHOSA.HH

Test: Unpaired

Average rank of first group = 296.008 based on 414 values.
Average rank of second group = 315.124 based on 189 values.
Large sample test statistic Z = 1.26852
Two-tailed probability of equaling or exceeding Z = 0.204613

NOTE:  603 total observations.
```

```
                    Comparison of Two Samples
------------------------------------------------------------------
Sample 1: NSOTHO.MR

Sample 2: XHOSA.MR

Test: Unpaired

Average rank of first group = 309.377 based on 414 values.
Average rank of second group = 285.841 based on 189 values.
Large sample test statistic Z = -1.54386
Two-tailed probability of equaling or exceeding Z = 0.122622

NOTE:  603 total observations.
```

```
                    Comparison of Two Samples
------------------------------------------------------------------
Sample 1: NSOTHO.FW

Sample 2: XHOSA.FW

Test: Unpaired

Average rank of first group = 234.813 based on 414 values.
Average rank of second group = 449.172 based on 189 values.
Large sample test statistic Z = 14.8216
Two-tailed probability of equaling or exceeding Z = 0

NOTE:  603 total observations.
```

```
                    Comparison of Two Samples
------------------------------------------------------------------
Sample 1: NSOTHO.EPA

Sample 2: XHOSA.EPA

Test: Unpaired

Average rank of first group = 317.15 based on 414 values.
Average rank of second group = 268.815 based on 189 values.
Large sample test statistic Z = -3.17229
Two-tailed probability of equaling or exceeding Z = 1.51254E-3

NOTE:  603 total observations.
```

Comparison of Two Samples

Sample 1: NSOTHO.PG

Sample 2: XHOSA.PG

Test: Unpaired

Average rank of first group = 265.5 based on 414 values.
Average rank of second group = 381.952 based on 189 values.
Large sample test statistic Z = 7.66093
Two-tailed probability of equaling or exceeding Z = 1.86517E-14

NOTE: 603 total observations.

Comparison of Two Samples

Sample 1: NSOTHO.ES

Sample 2: XHOSA.ES

Test: Unpaired

Average rank of first group = 284.722 based on 414 values.
Average rank of second group = 339.847 based on 189 values.
Large sample test statistic Z = 3.61831
Two-tailed probability of equaling or exceeding Z = 2.96601E-4

NOTE: 603 total observations.

Comparison of Two Samples

Sample 1: NSOTHO.WT

Sample 2: XHOSA.WT

Test: Unpaired

Average rank of first group = 279.807 based on 414 values.
Average rank of second group = 350.614 based on 189 values.
Large sample test statistic Z = 4.65075
Two-tailed probability of equaling or exceeding Z = 3.31089E-6

NOTE: 603 total observations.

```
                    Comparison of Two Samples
---------------------------------------------------------------
Sample 1: NSOTHO.AP

Sample 2: XHOSA.AP

Test: Unpaired

Average rank of first group = 298.075 based on 414 values.
Average rank of second group = 310.598 based on 189 values.
Large sample test statistic Z = 0.821202
Two-tailed probability of equaling or exceeding Z = 0.411529

NOTE:  603 total observations.



                    Comparison of Two Samples
---------------------------------------------------------------
Sample 1: NSOTHO.WH

Sample 2: XHOSA.WH

Test: Unpaired

Average rank of first group = 305.248 based on 414 values.
Average rank of second group = 294.886 based on 189 values.
Large sample test statistic Z = -0.681362
Two-tailed probability of equaling or exceeding Z = 0.49564

NOTE:  603 total observations.



                    Comparison of Two Samples
---------------------------------------------------------------
Sample 1: NSOTHO.BLU

Sample 2: XHOSA.BLU

Test: Unpaired

Average rank of first group = 293.446 based on 414 values.
Average rank of second group = 320.738 based on 189 values.
Large sample test statistic Z = 1.78939
Two-tailed probability of equaling or exceeding Z = 0.0735522

NOTE:  603 total observations.
```

```
                    Comparison of Two Samples
-----------------------------------------------------------------
Sample 1: NSOTHO.NP

Sample 2: XHOSA.NP

Test: Unpaired

Average rank of first group = 280.516 based on 414 values.
Average rank of second group = 349.061 based on 189 values.
Large sample test statistic Z = 4.50031
Two-tailed probability of equaling or exceeding Z = 6.79154E-6

NOTE:  603 total observations.
```

```
                    Comparison of Two Samples
-----------------------------------------------------------------
Sample 1: NSOTHO.HT

Sample 2: XHOSA.HT

Test: Unpaired

Average rank of first group = 302.755 based on 414 values.
Average rank of second group = 300.347 based on 189 values.
Large sample test statistic Z = -0.157734
Two-tailed probability of equaling or exceeding Z = 0.874661

NOTE:  603 total observations.
```

```
                    Comparison of Two Samples
-----------------------------------------------------------------
Sample 1: NSOTHO.DM

Sample 2: XHOSA.DM

Test: Unpaired

Average rank of first group = 282.504 based on 414 values.
Average rank of second group = 344.706 based on 189 values.
Large sample test statistic Z = 4.08012
Two-tailed probability of equaling or exceeding Z = 4.50357E-5

NOTE:  603 total observations.
```

MANN-WHITNEY U-TEST RESULTS FOR NORTHERN SOTHO VERSUS URBAN-ENGLISH SPEAKING PUPILS

```
                    Comparison of Two Samples
---------------------------------------------------------------
Sample 1: NSOTHO.MH

Sample 2: ENGLISH.MH

Test: Unpaired

Average rank of first group = 394.748 based on 414 values.
Average rank of second group = 359.993 based on 343 values.
Large sample test statistic Z = -2.18467
Two-tailed probability of equaling or exceeding Z = 0.0289131

NOTE:  757 total observations.


                    Comparison of Two Samples
---------------------------------------------------------------
Sample 1: NSOTHO.US

Sample 2: ENGLISH.US

Test: Unpaired

Average rank of first group = 455.351 based on 414 values.
Average rank of second group = 286.844 based on 343 values.
Large sample test statistic Z = -10.5823
Two-tailed probability of equaling or exceeding Z = 0

NOTE:  757 total observations.


                    Comparison of Two Samples
---------------------------------------------------------------
Sample 1: NSOTHO.HH

Sample 2: ENGLISH.HH

Test: Unpaired

Average rank of first group = 360.498 based on 414 values.
Average rank of second group = 401.332 based on 343 values.
Large sample test statistic Z = 2.5827
Two-tailed probability of equaling or exceeding Z = 9.80295E-3

NOTE:  757 total observations.
```

```
                    Comparison of Two Samples
----------------------------------------------------------------
Sample 1: NSOTHO.MR

Sample 2: ENGLISH.MR

Test: Unpaired

Average rank of first group = 343.793 based on 414 values.
Average rank of second group = 421.494 based on 343 values.
Large sample test statistic Z = 4.88636
Two-tailed probability of equaling or exceeding Z = 1.02862E-6

NOTE:  757 total observations.
```

```
                    Comparison of Two Samples
----------------------------------------------------------------
Sample 1: NSOTHO.FW

Sample 2: ENGLISH.FW

Test: Unpaired

Average rank of first group = 243.099 based on 414 values.
Average rank of second group = 543.032 based on 343 values.
Large sample test statistic Z = 19.38
Two-tailed probability of equaling or exceeding Z = 0

NOTE:  757 total observations.
```

```
                    Comparison of Two Samples
----------------------------------------------------------------
Sample 1: NSOTHO.PG

Sample 2: ENGLISH.PG

Test: Unpaired

Average rank of first group = 370.035 based on 414 values.
Average rank of second group = 389.821 based on 343 values.
Large sample test statistic Z = 1.24851
Two-tailed probability of equaling or exceeding Z = 0.211844

NOTE:  757 total observations.
```

```
                    Comparison of Two Samples
-----------------------------------------------------------------
Sample 1: NSOTHO.EPA

Sample 2: ENGLISH.EPA

Test: Unpaired

Average rank of first group = 467.74 based on 414 values.
Average rank of second group = 271.891 based on 343 values.
Large sample test statistic Z = -12.2972
Two-tailed probability of equaling or exceeding Z = 0

NOTE:  757 total observations.



                    Comparison of Two Samples
-----------------------------------------------------------------
Sample 1: NSOTHO.ES

Sample 2: ENGLISH.ES

Test: Unpaired

Average rank of first group = 320.79 based on 414 values.
Average rank of second group = 449.259 based on 343 values.
Large sample test statistic Z = 8.07543
Two-tailed probability of equaling or exceeding Z = 6.66134E-16

NOTE:  757 total observations.



                    Comparison of Two Samples
-----------------------------------------------------------------
Sample 1: NSOTHO.WT

Sample 2: ENGLISH.WT

Test: Unpaired

Average rank of first group = 376.245 based on 414 values.
Average rank of second group = 382.325 based on 343 values.
Large sample test statistic Z = 0.382117
Two-tailed probability of equaling or exceeding Z = 0.702371

NOTE:  757 total observations.
```

```
                          Comparison of Two Samples
------------------------------------------------------------
Sample 1: NSOTHO.AP

Sample 2: ENGLISH.AP

Test: Unpaired

Average rank of first group = 465.537 based on 414 values.
Average rank of second group = 274.55 based on 343 values.
Large sample test statistic Z = -11.9929
Two-tailed probability of equaling or exceeding Z = 0

NOTE:  757 total observations.
```

```
                          Comparison of Two Samples
------------------------------------------------------------
Sample 1: NSOTHO.BLU

Sample 2: ENGLISH.BLU

Test: Unpaired

Average rank of first group = 368.627 based on 414 values.
Average rank of second group = 391.52 based on 343 values.
Large sample test statistic Z = 1.43788
Two-tailed probability of equaling or exceeding Z = 0.150468

NOTE:  757 total observations.
```

```
                          Comparison of Two Samples
------------------------------------------------------------
Sample 1: NSOTHO.WH

Sample 2: ENGLISH.WH

Test: Unpaired

Average rank of first group = 413.226 based on 414 values.
Average rank of second group = 337.69 based on 343 values.
Large sample test statistic Z = -4.76002
Two-tailed probability of equaling or exceeding Z = 1.93816E-6

NOTE:  757 total observations.
```

```
                         Comparison of Two Samples
-----------------------------------------------------------------
Sample 1: NSOTHO.DM

Sample 2: ENGLISH.DM

Test: Unpaired

Average rank of first group = 332.045 based on 414 values.
Average rank of second group = 435.675 based on 343 values.
Large sample test statistic Z = 6.5201
Two-tailed probability of equaling or exceeding Z = 7.06124E-11

NOTE:  757 total observations.
```

```
                         Comparison of Two Samples
-----------------------------------------------------------------
Sample 1: NSOTHO.HT

Sample 2: ENGLISH.HT

Test: Unpaired

Average rank of first group = 350.435 based on 414 values.
Average rank of second group = 413.478 based on 343 values.
Large sample test statistic Z = 3.96552
Two-tailed probability of equaling or exceeding Z = 7.32669E-5

NOTE:  757 total observations.
```

```
                         Comparison of Two Samples
-----------------------------------------------------------------
Sample 1: NSOTHO.NP

Sample 2: ENGLISH.NP

Test: Unpaired

Average rank of first group = 380.559 based on 414 values.
Average rank of second group = 377.118 based on 343 values.
Large sample test statistic Z = -0.216084
Two-tailed probability of equaling or exceeding Z = 0.828918

NOTE:  757 total observations.
```

MANN-WHITNEY U-TEST RESULTS FOR URBAN-XHOSA VERSUS URBAN-ENGLISH SPEAKING PUPILS

```
                    Comparison of Two Samples
----------------------------------------------------------------
Sample 1: XHOSA.MH

Sample 2: ENGLISH.MH

Test: Unpaired

Average rank of first group = 113.807 based on 189 values.
Average rank of second group = 350.637 based on 343 values.
Large sample test statistic Z = 17.172
Two-tailed probability of equaling or exceeding Z = 0

NOTE:  532 total observations.
```

```
                    Comparison of Two Samples
----------------------------------------------------------------
Sample 1: XHOSA.US

Sample 2: ENGLISH.US

Test: Unpaired

Average rank of first group = 284.833 based on 189 values.
Average rank of second group = 256.398 based on 343 values.
Large sample test statistic Z = -2.04972
Two-tailed probability of equaling or exceeding Z = 0.0403918

NOTE:  532 total observations.
```

```
                    Comparison of Two Samples
----------------------------------------------------------------
Sample 1: XHOSA.HH

Sample 2: ENGLISH.HH

Test: Unpaired

Average rank of first group = 256.22 based on 189 values.
Average rank of second group = 272.165 based on 343 values.
Large sample test statistic Z = 1.15381
Two-tailed probability of equaling or exceeding Z = 0.248576

NOTE:  532 total observations.
```

```
                    Comparison of Two Samples
----------------------------------------------------------------
Sample 1: XHOSA.MR

Sample 2: ENGLISH.MR

Test: Unpaired

Average rank of first group = 213.709 based on 189 values.
Average rank of second group = 295.589 based on 343 values.
Large sample test statistic Z = 5.90395
Two-tailed probability of equaling or exceeding Z = 3.56081E-9

NOTE:  532 total observations.
```

```
                    Comparison of Two Samples
----------------------------------------------------------------
Sample 1: XHOSA.FW

Sample 2: ENGLISH.FW

Test: Unpaired

Average rank of first group = 216.119 based on 189 values.
Average rank of second group = 294.261 based on 343 values.
Large sample test statistic Z = 5.64271
Two-tailed probability of equaling or exceeding Z = 1.67861E-8

NOTE:  532 total observations.
```

```
                    Comparison of Two Samples
----------------------------------------------------------------
Sample 1: XHOSA.PG

Sample 2: ENGLISH.PG

Test: Unpaired

Average rank of first group = 317.611 based on 189 values.
Average rank of second group = 238.337 based on 343 values.
Large sample test statistic Z = -5.71657
Two-tailed probability of equaling or exceeding Z = 1.09015E-8

NOTE:  532 total observations.
```

```
                    Comparison of Two Samples
--------------------------------------------------------------------
Sample 1: XHOSA.EPA

Sample 2: ENGLISH.EPA

Test: Unpaired

Average rank of first group = 335.307 based on 189 values.
Average rank of second group = 228.586 based on 343 values.
Large sample test statistic Z = -7.68308
Two-tailed probability of equaling or exceeding Z = 1.55431E-14

NOTE:  532 total observations.
```

```
                    Comparison of Two Samples
--------------------------------------------------------------------
Sample 1: XHOSA.ES

Sample 2: ENGLISH.ES

Test: Unpaired

Average rank of first group = 234.812 based on 189 values.
Average rank of second group = 283.961 based on 343 values.
Large sample test statistic Z = 3.5444
Two-tailed probability of equaling or exceeding Z = 3.93587E-4

NOTE:  532 total observations.
```

```
                    Comparison of Two Samples
--------------------------------------------------------------------
Sample 1: XHOSA.WT

Sample 2: ENGLISH.WT

Test: Unpaired

Average rank of first group = 297.296 based on 189 values.
Average rank of second group = 249.531 based on 343 values.
Large sample test statistic Z = -3.44976
Two-tailed probability of equaling or exceeding Z = 5.61189E-4

NOTE:  532 total observations.
```

```
                    Comparison of Two Samples
--------------------------------------------------------------
Sample 1: XHOSA.AP

Sample 2: ENGLISH.AP

Test: Unpaired

Average rank of first group = 366.931 based on 189 values.
Average rank of second group = 211.16 based on 343 values.
Large sample test statistic Z = -11.218
Two-tailed probability of equaling or exceeding Z = 0

NOTE:  532 total observations.
```

```
                    Comparison of Two Samples
--------------------------------------------------------------
Sample 1: XHOSA.WH

Sample 2: ENGLISH.WH

Test: Unpaired

Average rank of first group = 295.656 based on 189 values.
Average rank of second group = 250.434 based on 343 values.
Large sample test statistic Z = -3.26674
Two-tailed probability of equaling or exceeding Z = 1.08805E-3

NOTE:  532 total observations.
```

```
                    Comparison of Two Samples
--------------------------------------------------------------
Sample 1: XHOSA.BLU

Sample 2: ENGLISH.BLU

Test: Unpaired

Average rank of first group = 272.127 based on 189 values.
Average rank of second group = 263.399 based on 343 values.
Large sample test statistic Z = -0.628678
Two-tailed probability of equaling or exceeding Z = 0.529557

NOTE:  532 total observations.
```

```
                  Comparison of Two Samples
--------------------------------------------------------------------
Sample 1: XHOSA.NP

Sample 2: ENGLISH.NP

Test: Unpaired

Average rank of first group = 312.46 based on 189 values.
Average rank of second group = 241.175 based on 343 values.
Large sample test statistic Z = -5.14224
Two-tailed probability of equaling or exceeding Z = 2.71971E-7

NOTE:  532 total observations.
```

```
                  Comparison of Two Samples
--------------------------------------------------------------------
Sample 1: XHOSA.HT

Sample 2: ENGLISH.HT

Test: Unpaired

Average rank of first group = 233.728 based on 189 values.
Average rank of second group = 284.558 based on 343 values.
Large sample test statistic Z = 3.66736
Two-tailed probability of equaling or exceeding Z = 2.45132E-4

NOTE:  532 total observations.
```

```
                  Comparison of Two Samples
--------------------------------------------------------------------
Sample 1: XHOSA.DM

Sample 2: ENGLISH.DM

Test: Unpaired

Average rank of first group = 249.86 based on 189 values.
Average rank of second group = 275.669 based on 343 values.
Large sample test statistic Z = 1.86901
Two-tailed probability of equaling or exceeding Z = 0.0616218

NOTE:  532 total observations.
```

APPENDIX E

The Xhosa-version of the **LGPI** (The Le Grange Global Priorities Instrument)

UKUBEKWA EZINGENI KWEZENZULULWAZI KWANEZOBUNGCALI-IINGXAKI ZELIZWE EZICHAPHAZELEKAYO

Ziziphi ezona ngxaki uzibona njengezona zibalulekileyo ehlabathini ngokuphathelele ekusetyenzisweni kwezengcali nezenzululwazi entlalweni yabantu? Linganisela ezi zilandelayo ukususela ku 1 - 15 (ubonise okuthatha njengokona kubalulekileyo kuwe). Fakela amanani akho kwizivalelo (brackets) ezifanelekileyo.

IINGXAKI ZELIZWE

[ ] **UKWAKHIWA KWEZINDLU EZININZI ZOKUHLALISA ABANTU** (amakhaya alungele wonke umntu, kwanokuthuthwa kwenkunkuma nococeko lwangasese, iindawo zokufihla intloko, ukhuseleko, izibane ezitalatweni, iinkonzo zentlalontle ezinjengomkhosi wamapolisa noonoposi).

[ ] **IZINTO EZINOBUNGOZI** (iindawo zokulahla inkunkuma, iikhemikhali ezinobungozi, iilead paints, ielectro-magnetic wave radiation umz: iultraviolet radiation evela elangeni ne microwave oven radiation).

[ ] **IMPILO NEZIFO** (izifo ezibulalayo nezingabulaliyo ezifana ne gawulayo, umthambo, izigulo zengqondo, ukudinwa, ingxolo ukutya nesondlo).

[ ] **IZIMBIWA EZIVUTHAYO NEZINGAVUTHIYO** (ezisisinyithi nezi ngesiso sinyithi, ezemigodi, ezengcali, ezikwinqanaba eli phantsi, irecycling, imigqomo).

[ ] **AMANZI ACOCEKILEYO** (inkunkuma, umlambo, ukusetyenziswa kwamanzi, ukungcoliseka kwamanzi asemhlabeni, ukungcolisa kwezichumisi, ukuphathwa kwamanzi angasese, uqaphelo nolawulo lwezantyala tyala zemvula kwanembalela).

[ ] **UKWANDA KOLUNTU** (Ehlabathini, uthutho/imfuduko, indawo yokuhlala, ucwangwiso lwedolophu).

[ ] **UKUTSHITSHA KWEZITYALO NEZILWANYANA** (ukusala kwentlobo zezilwanyana ezimbalwa, ukuloba okubaxwayo, ukungcoliseka nokucutheka kwezilwanyana nezityalo zaselwandle, ukukhuseleka kobomi basendle izityalo nezilwanyana).

[ ] **UKUNQONGOPHALA KWAMANDLA** (amandla enziwe ngabantu, amandla elanga, amandla embiwayo/amalahle, ukunqongophala kwemithombo ugcino lwamahlathi, imveliso ye-oli).

[ ] **UBUNGCALI BEZEMFAZWE** (i-nerve gas, ukwakhiwa kweze-nuclear, ilifu lezixhobo ze-nuclear elothusayo).

[ ] **UNGCOLISEKO LOMOYA** (imvula ye-acid, CO_2, ukucutheka kwe-Ozone, umsi ongcolisayo, i-global warming).

[ ] **INDLALA NOKUFUMANEKA KOKUTYA** (imveliso yokutya, izityalo nendlela zolimo).

[ ] **UKUSETYENZISWA OKUNGEKUKO KOMHLABA** (ukhukuliseko lomhaba, ukuncipha komhlaba, ukwanda nokukhula kwedolophu, ukuswela kwendle indawo zokuhlala, ukususwa kwamahlathi, ukukhula kwentlambo, ukwanda kwetyuwa emhlabeni).

[ ] **IZITISHI ZE-NUCLEAR** (ulawulo lolahlo lwenkunkuma ye-nuclear, uxabiso lokwakhiwa, ukhuseleko,izenzo zobhukuqo).

[ ] **UKUSETYENZISWA OKULUNGILEYO NOKUNGALUNGANGA KWEZOBUNGCALI OBUKWINQANABA ELIPHEZULU** (i-electronic information explosion, imfundo nokusasazwa kolwazi, i-genetic engineering, unxibelelwano lomhlaba, ngokubanzi ukwakhiwa kwemisebenzi, imfundiso zomabonakude, ukwahlulelana okukhawulezileyo ngenkcukacha ezingaginyisi mathe/ezixhalabisayo nge-satelite).

[ ] **ABAQULUNQI MTHETHO ABANGACHUBEKANGA** (inkokheli zasekuhlaleni ezingenalwazi ngenzululwazi nezengcali, inzululwazi nezoluntu njengezithethe ezahlukeneyo).

Qaphela: Zinike elinye igama (codename) xa ungafuni ukusebenzisa elakho.

UKUBEKWA EZINGENI KWEZENZULULWAZI KWANEZOBUNGCALI-IINGXAKI ZELIZW EZICHAPHAZELEKAYO

Ziziphi ezona ngxaki uzibona njengezona zibalulekileyo ehlabathini ngokuphathelele ekusetyenzisweni kwezengcali nezenzululwazi entlalweni yabantu? Linganisela ezi zilandelayo ukususela ku 1-15 (ubonise okuthatha njengokona kubalulekileyo kuwe). Fakela amanani akho kwizivalelo (brackets) ezifanelekileyo.

IINGXAKI ZELIZWE

( ) UKWAKHIWA KWEZINDLU EZININZI ZOKUHLALISA ABANTU (amakhaya alungele wonke umntu, kwanokuthuthwa kwenkunkuma nococeko lwangasese, iindawo zokufihla intloko, ukhuseleko, izibane ezitalatweni, iinkonzo zentlalontle ezinjengomkhosi wamapolisa noonoposi).

( ) IZINTO EZINOBUNGOZI (iindawo zokulahla inkunkuma, iikhemikhali ezinobungozi, iilead paints, ielectro-magnetic wave radiation umz: iultraviolet radiation evela elangeni ne microwave oven radiation).

( ) IMPILO NEZIFO (izifo ezibulalayo nezingabulaliyo ezifana ne gawulayo; umthambo; izigulo zengqondo; ukudinwa, ingxolo ukutya nesondlo).

( ) IZIMBIWA (EZIVUTHAYO NEZINGAVUTHIYO,ezisisinyithi nezi ngesiso sinyithi, ezemigodi, ezengcali, ezikwinqanaba eli phantsi, irecycling, imigqomo).

( ) AMANZI ACOCEKILEYO (inkunkuma, umlambo, ukusetyenziswa kwamanzi, ukungcoliseka kwamanzi asemhlabeni, ukungcolisa kwezichumisi, ukuphathwa kwamanzi angasese, uqaphelo nolawulo lwezantyala tyala zemvula kwanembalela)

( ) UKWANDA KOLUNTU (Ehlabathini, uthutho/imfuduko, indawo yokuhlala, ucwangwiso lwedolophu).

( ) UKUTSHITSHA KWEZITYALO NEZILWANYANA (ukusala kwentlobo zezilwanyana ezimbalwa, ukuloba okubaxwayo, ukungcoliseka nokucutheka kwezilwanyana nezityalo zaselwandle, ukukhuseleka kobomi basendle (izityalo nezilwanyana).

( ) UKUNQONGOPHALA KWAMANDLA (amandla enziwe ngabantu, amandla elanga, amandla embiwayo/amalahle, ukunqongophala kwemithombo ugcino lwamahlathi, imveliso ye-oli.)

( ) UBUNGCALI BEZEMFAZWE (i-nerve gas, ukwakhiwa kweze-nuclear, ilifu lezixhobo ze-nuclear elothusayo).

( ) UNGCOLISEKO LOMOYA (imvula ye-acid, CO_2, ukucutheka kwe-Ozone, umsi ongcolisayo, i-global warming).

( ) INDLALA NOKUFUMANEKA KOKUTYA (imveliso yokutya, izityalo nendlela zolimo).

( ) UKUSETYENZISWA OKUNGEKUKO KOMHLABA (ukhukuliseko lomhaba, ukuncipha komhlaba, ukwanda nokukhula kwedolophu, ukuswela kwendle indawo zokuhlala, ukususwa kwamahlathi, ukukhula kwentlambo, ukwanda kwetyuwa emhlabeni).

( ) IZITISHI ZE-NUCLEAR (ulawulo lolahlo lwenkunkuma ye-nuclear, uxabiso lokwakhiwa, ukhuseleko, izenzo zobhukuqo).

( ) UKUSETYENZISWA OKULUNGILEYO NOKUNGALUNGANGA KWEZOBUNGCALI OBUKWINQANABA ELIPHEZULU (i-electronic information explosion imfundo nokusasazwa kolwazi, i-genetic engineering, unxibelelwano lomhlaba ngokubanzi, ukwakhiwa kwemisebenzi, imfundiso zomabonakude, ukwahlulelana okukhawulezileyo ngenkcukacha ezingaginyisi mathe/ezixhalabisayo nge-satelite

( ) ABAQULUNQI MTHETHO ABANGACHUBEKANGA (inkokheli zasekuhlaleni ezingenalwazi ngenzululwazi nezengcali; inzululwazi nezoluntu njengezithethe ezahlukeneyo).

Valela ibe nye kwezi zilandelayo ngesangqa:-

Indoda	Ibhinqa

	Std. 6	Std. 7	Std. 8	Std. 9	Std.10

APPENDIX F

The 1984 Bybee Scale

RANKING OF SCIENCE AND TECHNOLOGY - RELATED GLOBAL PROBLEMS

What do you see as the most important global problems related to science and technology for the human race? Rank the following from 1 to 12 (with 1 indicating your top priority). Insert your numbers in the appropriate brackets.

GLOBAL PROBLEM

[ ] **HAZARDOUS SUBSTANCES** (waste dumps, toxic chemicals, lead paints).

[ ] **HUMAN HEALTH AND DISEASE** (infectious and non-infectious diease, stress, noise, diet and nutrition, exercise, mental health).

[ ] **MINERAL RESOURCES** (non-fuel minerals, metallic and non-metallic minerals, mining, technology, low grade deposits, recycling, refuse).

[ ] **WATER RESOURCES** (waste disposal, estuaries, supply, distribution, ground water contamination, fertilizer contamination).

[ ] **POPULATION GROWTH** (world population, immigration, carrying capacity, foresight capability).

[ ] **EXTINCTION OF PLANTS AND ANIMALS** (reducing genetic diversity, wildlife protection).

[ ] **ENERGY SHORTAGES** (synthetic fuels, solar power, fossil fuels, conservation, oil production).

[ ] **WAR TECHNOLOGY** (nerve gas, nuclear developments, nuclear arms threat).

[ ] **AIR QUALITY AND ATMOSPHERE** (acid rain, CO_2, depletion of ozone, global warming).

[ ] **WORLD HUNGER AND FOOD RESOURCES** (food production, agriculture, cropland conservation).

[ ] **LAND USE** (soil erosion, reclamation, urban development, wildlife habitat loss, deforestation, desertification, salinization).

[ ] **NUCLEAR REACTORS** (nuclear waste management, breeder reactors, cost of construction, safety, terrorism).

The mean priority scores, and ranks of relative importance, of global problems in science and technology rated by international science educators in 1984.

	1984 international science educators n = 262	
Global problem	**Mean priority score**	**Rank of relative importance**
World hunger and food resources	3.92	1
Population growth	4.35	2
Air quality and atmosphere	5.43	3
Water resources	5.53	4
War technology	5.80	5
Human health and disease	5.82	6
Energy shortages	6.30	7
Land use	6.52	8
Hazardous substances	7.49	9
Extinction of plants and animals	8.37	10
Nuclear reactors	8.38	11
Mineral resources	9.40	12