

# The correlates of the socio-cultural background of Botswana junior secondary school students with their attitudes towards and achievements in science

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*M. E. E. Kesamang, Examinations, Research and Testing Division Ministry of Education and A. A. Taiwo, Department of Mathematics and Science Education, University of Botswana*

The study was undertaken to find out whether there is a significant relationship between the socio-cultural beliefs held by beginning junior secondary school (JSS) students in Botswana and their attitudes towards school science on one hand and their achievement in school science on the other hand. Seven research questions were formulated. The nature of the study dictated the employment of descriptive research (survey) design. The sample for the study consisted of 395 JSS students randomly selected from eleven junior secondary schools within 120-kilometre radius of Gaborone, the state capital of Botswana. The collection of the data for the study was accomplished by the use of three constructed and validated research instruments. The findings of the study include the fact that Setswana<sup>1</sup> (Botswana) mythology has a telling effect, to a large extent, on the thought processes of the average Botswana JSS student. This resulted in significant negative relationships between the students' socio-cultural background and their attitudes towards school science on one hand and their achievement in school science on the other hand. But in spite of the negative effect of the elements of the students' culture on the ease with which they learn school science, Botswana JSS students are found to be positively disposed towards school science in general.

## Introduction

At this onset of a new millennium, the importance of science to national development cannot be over-emphasized. For it is science and its application that transformed the nations of the West and North America into prosperous nations today. It is science that has enabled them to take giant steps in the fields of agriculture, communication, medicine, transportation and the like. If the nations of Africa are to join in the foreseeable future the community of nations where science has become a dominant socio-cultural factor, concerted efforts must be made to critically study the contemporary socio-cultural milieu within which African school-going children are being raised. This would be with a view to synthesizing those factors within the African culture that impinge one way or the other on the ease with which the African child learns school science.

Evidence abounds in the literature to suggest that student background variables such as gender, race, ethnicity, home environment, attitudes and the like have a significant influence on their achievement in school science (Peterson and Carlson 1979, Schibeci and Riley 1986, Taiwo *et al.* 1999, Taiwo and Tyolo 2001). There is, however, no unanimity about the direction of the influence of some of the

variables. For example, while most researchers in the field opined that student attitude towards science impacts one way or another on his or her science achievement and not the other way, Peterson and Carlson (1979) concluded from their study that 'A much stronger argument can be made for saying that achievement creates positive attitudes and probably not the reverse as many of us have thought' (p. 184).

The view of Peterson and Carlson (1979) notwithstanding, there is compelling evidence (Averch *et al.* 1974, Bridge *et al.* 1979, Centra and Potter 1980, Glassman and Biniamonov 1981, Kremer and Walberg 1981, Burgess 1986, Schibeci and Riley 1986) in the literature to the contrary. For example, research findings by Schibeci and Riley (1986) have documented clearly causal relationship between perception and attitude towards science on the one hand and between attitude and achievement on the other. The researchers found that appropriate perception about science learning environment contributes significantly to the development of positive attitude towards science while positive attitude toward science in its own right enhances achievement in science. In effect, the three variables are somewhat related in a time-line continuum as follows:

Perception → Attitudes → Achievement

This stance is embraced by earlier researchers (Wiley and Harnschfenger 1974, Walberg and Rasher 1979) who found that thirteen to 46% of the variance in science achievement is attributed to students' perceptions of the science learning environment while about 30% of the variance is due to attitude towards science. It is the contention of several researchers (Urevbu 1984, Schibeci and Riley 1986, Taiwo *et al.* 1999) that one's perception of science is significantly influenced by one's socio-cultural background. According to Jegede (1987) and Jegede and Okebukola (1988), socio-cultural factors play a significant role in science learning in non-western cultures. They identified African worldview as one of such factors that impact negatively on the ease with which the African child learns science. They opined that such socio-cultural factors which are a composite part of the African child's environment control, to a large extent, what the child learns in such an environment. In the same vein, Ogunniyi (1988), (cited by Jegede and Okebkola 1991) states that since every human being:

... tends to resolve puzzles in terms of the meanings available in a particular socio-cultural environment, the baseline is that the meanings become firmly implanted in the cognitive structure and manifest themselves habitually and may act as templates, anchors, or inhibitors to new learning. (p. 276)

Many other African researchers (Odhiambo 1972, Ramorogo *et al.* 1994, Cole 1975, Taiwo, 1976, 1978, 1994, Abdullahi 1982) have also underscored the impact of socio-cultural factors on the African child's attitude towards science and his/her achievement in science. They all recognize the fact that the learner's socio-cultural background may serve as an impediment to fruitful learning of science.

In Botswana, as in many an African nation, such socio-cultural factors impinge significantly on the thought processes of the average Motswana child. A young person, for example, is not believed to die of natural causes as his/her death is, more often than not, linked to witchcraft. This view is so widely held in the country to the extent that when a young person dies of obvious AIDS-related

illness, he/she is believed to have been 'bewitched' by a relation, an enemy of his/her family, a witch doctor or a traditional medicine man or woman. Suicides and other sudden deaths such as those caused by car accidents are normally attributed to the evil machinations of the witches in the immediate environment of the deceased. And when a person is struck dead by lightning, his/her death is believed to be caused by a 'witch doctor' or an evil medicine man or woman in the village. The deaths of young people are, more often than not, interpreted as having been caused by some supernatural power in Setswana culture.

Many a Motswana child like his/her counterparts in other parts of Africa is acculturated in a traditional *cum* authoritarian atmosphere. He/she thereby internalises beliefs and viewpoints of the world around him/her (including beliefs about natural phenomena) which are, more often than not, at variance with those that he/she is likely to encounter in school science. The socio-cultural background of the average Motswana child could be encapsulated as follows in the words of Jegede and Okebukola (1988):

- (a) Authoritarianism – which relates to the general environment in which the learner spends most of his/her time.
- (b) African worldview – the reasoning pattern dictated by the traditional society.
- (c) Sacredness of science – the knowledge within a traditional society which regards science as magical ... (p. 276).

Documentary evidence abounds in the literature (Ramorogo *et al.* 1994, Taiwo *et al.* 1999) to support the view that the Motswana child's thought processes like those of his/her other African counterparts are shaped by the goings-on in his/her traditional society. These thought processes are generally dominated by aspects of witchcraft, magic, 'attributes of lesser gods' (Fafunwa 1967) and the like. Knowledge system within such a traditional society normally 'regards science as magical, weird ... '(Jegede and Okebukola 1988). Such a traditional society could aptly be depicted as follows in the words of Fafunwa (1967):

Any child is fascinated with the world around him, the world above him and even the world below. To the African child and his parents these are mysterious worlds and both parents and child explain away the echoes, the rain, the stars, thunder and lightning either as the attributes of lesser gods or the work of a bigger god who controls their activities. The rain falls, the thunder blasts, the lightning strikes a man or a woman when [the witch doctor] wishes it. (p. 22)

In addition, the products of science and technology such as aeroplanes, electricity and the like are seen as the magic of the white man by the average African child. And like his/her counterpart in any other part of sub-Saharan Africa, this is the type of socio-cultural milieu within which the average Motswana child is raised. There is no gainsaying that the socio-cultural environment depicted above, and in which the average Motswana child is raised, is likely to militate against the development of positive attitudes towards science and the achievement of excellence in science learning.

It is the above connectivity between socio-cultural background and attitude toward *cum* achievement in science that informed the goal of this study.

### *Purpose of the study*

Based on the above exposition, the study was designed to find out whether there is a significant relationship between the socio-cultural beliefs held by beginning Botswana junior secondary school students and their attitudes towards and achievement in school science. In order to achieve the goal of the study, the following research questions were formulated to guide the study:

- (1) What impact does the socio-cultural background of Botswana junior secondary school students have on their worldview?
- (2) What is the nature of Botswana junior secondary school students' attitudes towards science?
- (3) Is there a significant relationship between Botswana junior secondary school students' socio-cultural background and their attitudes towards science?
- (4) Is there a significant relationship between Botswana junior secondary school students' socio-cultural background and their achievement in science?
- (5) Is there a significant relationship between Botswana junior secondary school students' attitudes towards science and their achievement in science?
- (6) Is there a significant difference between the attitude mean scores of the students with low socio-cultural background (LCB) scores and their counterparts with high socio-cultural background (HCB) scores?
- (7) Is there a significant difference between the science achievement mean scores of students with low socio-cultural background (LCB) scores and their counterparts with high socio-cultural background (HCB) scores?

### **Methodology**

#### *Sample selection*

Eleven Botswana junior secondary schools within 120 kilometres of the country's capital (Gaborone) were randomly selected for the study. To ensure that the selected schools represented both the urban and non-urban areas (including peri-urban centres), a stratified random sampling technique was employed. And from form one classes in the eleven selected schools, a total, of 395 students (made up of 179 boys and 216 girls) were randomly selected for the study. The average age of the study sample was 14 years.

#### *Instrumentation*

Three instruments, namely (i) a socio-cultural scale, (ii) an attitudinal scale and (iii) a science achievement test, were used for data collection for the study. The details of the instruments' construction, validation and reliability determination are as follows:

*The socio-cultural scale.* The construction of this instrument was informed by Setswana (Botswana) beliefs, taboos, customs and way of life. Specifically, the instrument covered Setswana customs and beliefs as they relate to identifiable

practices at home, at the lands and at the cattle posts as well as beliefs about death, rainfall, drought, etc. A total of 30 socio-cultural items which were to be rated on a 5-point agree-disagree Likert-type scale were constructed by the researchers and subjected to both face validation and pilot testing. For face validation purposes, a five-member panel of experts in Setswana customs vetted the instrument. On their advice, the 30-item draft instrument was reduced to a 20-item instrument after expunging 10 items that were considered inadequate or irrelevant in the light of the goal of the study. A pilot study involving 60 standard seven students from a primary school in Gaborone provided data for further validation and reliability determination of the instrument. The results of the pilot study revealed that the instrument is readable; and it yielded a reliability coefficient of 0.86 through the split-half method after the application of Spearman-Brown correction formula. A further statistical analysis employing factor analysis revealed that the 20 items of the scale measure related aspects of Setswana culture. All in all, six factors were identified. Below is a list of the factors and the underlying themes the scale items may be measuring.

FACTORS	STATEMENTS	THEMES
Factor 1	6, 7, 16, and 19	} Taboos
Factor 2	9, 11, 12, 13 and 20	
Factor 3	1, 8, 10 and 18	} Omens
Factor 4	14, 15 and 17	
Factor 5	4 and 5	} Witchcraft
Factor 6	2 and 3	

For ease of reference, one statement from each theme is reproduced below.

*Taboos*

Item 6: A young girl should not wash (take a bath) at night as she might start menstruating that night.

*Omens*

Item 10: If a cock stands on one leg, it is a sign that there will be a visitor to the yard later that day.

*Witchcraft*

Item 4: When someone commits suicide, it is because he/she has been bewitched. The details of the instrument are contained in Appendix 1.

*The attitudinal scale.* Giving special consideration to statements dealing with people's likes and dislikes of science as a discipline, a 26-item Likert-type scale was developed by the researchers to gauge the nature of the subjects' attitudes towards science. The 26 statements which covered a wide range of attitudinal areas dealing with likes and dislikes of science and the importance of science to mankind were subjected to face validation by a three-member panel of experts in attitudinal studies. This exercise resulted in the reduction of the 26 items to 20 on the

recommendation of the panellists on the basis of the relevance and appropriateness of the 20 items. The 20-item attitudinal scale was then pilot-tested for reliability determination with the group of 60 standard seven pupils used for the refinement of the socio-cultural scale. The split-half method used for the reliability determination of the instrument yielded a reliability coefficient of 0.60 for the two halves of the instrument. The reliability coefficient for the entire 20-item scale was found to be 0.75 on the application of Spearman-Brown formula. A further statistical treatment of the data employing factor analysis identified two core factors of likes and dislikes. The factor loadings dealing with the 'likes of science' cover items 1, 2, 3, 4, 5, 7, 8, 10, 14, 16, 17, and 19 while items 6, 9, 11, 12, 13, 15, 18 and 20 were identified as items dealing with the 'dislikes of science' (see Appendix 2 for details).

*The science achievement test.* The content of this test was based on Botswana primary school integrated science syllabus as the study sample had just completed their primary school education. To enhance the content validity of the test right from the construction stage, the syllabus was content-analysed and past science papers in Botswana primary school leaving examination (PSLE) were critically reviewed. The result of the content analysis of the syllabus revealed that it was made up of about 25% content in the realm of biological sciences and about 75% content in the area of physical sciences. The reviewed PSLE science examination papers also revealed the one-to-three ratio coverage between the biological sciences and the physical sciences respectively.

At the end of this exercise, a 30-item multiple choice test patterned against PSLE format for science papers was constructed by the researchers. Attempts were deliberately made during the construction of the test to proportionately cover both the biological and the physical aspects of the syllabus as revealed by the content analysis of the syllabus. The adequacy of the difficulty levels and the discriminating indices of each of the test items as well as the overall difficulty level of the entire test were ascertained through pilot-testing the constructed science test. A further vetting of the instrument was carried out by a three-member panel of science officers in the department of the Ministry of Education which is responsible for PSLE in the country.

The above exercise led to the reduction of the 30-item test to a 20-item science test by expunging ten unsatisfactory items in terms of (i) either inappropriate difficulty level or low discriminating power or (ii) both and (iii) advice from the PSLE science examiners. The 20-item science achievement test is made up of five items (items 1, 2, 5, 6 and 7) in the area of biological sciences and fifteen items (items 3, 4, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19 and 20) in the realm of physical sciences in line with the content-analysed syllabus.

The split-half method was used to determine the reliability of the 20-item science achievement test. Using the same sample of 60 standard seven pupils from a Gaborone primary school, the reliability coefficient of the instrument was found to be 0.76 after the application of the Spearman-Brown formula.

#### *Data collection*

Data for the study were collected within the first month of the school year to minimize the effect of tuition on the subjects. The three research instruments

which were made into a booklet form for easy administration were administered one after the other in each of the 11 form one classes.

### *Data analysis*

Both qualitative and quantitative methods were used to analyse data for the study. Item analysis technique was used to document the patterns of the responses of the subjects to both the socio-cultural and attitudinal scales. Both descriptive and inferential statistical analyses were employed for the resolution of the research questions. In particular, research questions 1 and 2 were resolved qualitatively while research questions 3 to 7 were dealt with quantitatively. For research questions 1 and 2, item analysis of the responses of the subjects to both the socio-cultural scale and attitudinal scale provided critical information for their resolution. The following quantitative analyses were carried out to resolve research questions 3 to 7: (a) To resolve research questions 3 to 5 dealing with whether a significant relationship exists between each pair of the study variables, product-moment correlational analysis and *t*-test analysis were used, and (b) to test the mean differences between the two groups of students identified in research questions 6 and 7, *t*-test analysis was employed.

In addition to the analysis above, attempts were made to find out whether the subjects' mean score on the science achievement test was better than what they would have scored by guesswork alone due to the multiple-choice nature of the test. This was achieved by subjecting the subjects' mean score of 8.80 (SD = 2.61) on the test and their 'chance mean score' (Taiwo 1976) of 5.00 from the four-multiple-choice, 20-item science test to a *t*-test analysis. Using a 'chance binomial model' (Taiwo 1976), the standard deviation for the chance mean score of 5.00 was found to be 1.94. The *t*-test analysis resulted in a calculated *t*-value of 23.75 which was found to be significant at 0.05 level of significance (*df* = 393) which thus indicated that the mean score of the subjects on the test was statistically better than their expected chance mean score.

### **Results and discussion**

Item-by-item analysis of the responses of the respondents to the items of the socio-cultural instrument yielded the results given table 1, below.

For ease of reference, the results contained in the table are discussed below under three broad themes in which the items of the socio-cultural scale were factorially grouped into under instrumentation.

#### *Taboos*

From the total of nine items (*viz*: items 6, 7, 9, 11, 12, 13, 16, 19 and 20) dealing with Setswana taboos, more than 50% of the 395 study subjects believe in the efficacy of four (items 7, 11, 12 and 16) of those aspects of Setswana culture. The details of these are:

Item 7: 51.4% of the subjects are of the opinion that a widow should not be anywhere close to cattle as she could make the pregnant ones among them to abort.

**Table 1. Responses of the study sample to the socio-cultural statements on percentage basis by theme**

<i>Themes</i>	<i>Statement No.</i>	<i>% Agreement</i>	<i>% Neutrality</i>	<i>% Disagreement</i>	<i>% Missing cases</i>
Taboos	6	38.5	22.3	38.2	0.5
	7	51.4	32.2	16.0	0.4
	9	24.8	41.0	33.7	0.5
	11	57.7	20.8	21.3	0.2
	12	62.3	17.7	19.7	0.3
	13	44.8	29.4	24.6	1.2
	16	58.3	24.1	17.5	0.1
	19	18.5	37.2	43.4	0.9
Omens	20	42.1	35.2	22.2	0.5
	1	80.0	8.1	11.1	0.8
	8	15.2	22.5	61.7	0.7
	10	41.0	32.4	25.3	1.3
	14	15.2	38.7	44.5	1.6
	15	23.1	40.5	35.2	1.2
Witchcraft	17	13.7	42.8	43.3	1.2
	18	40.5	41.8	17.3	0.4
	2	44.3	28.6	25.9	1.2
	3	55.5	22.5	21.0	1.0
	4	24.0	24.0	51.7	0.3
	5	36.7	20.8	42.0	0.5

Item 11: 57.7% of the study sample believes that handing over a child to someone over the fence is unacceptable; as such an act may lead such a child to become a thief in the future.

Item 12: 62.30% of the students believe that ‘putting on one shoe brings bad luck to one’s mother’.

Item 16: 58.3% of them are of the opinion that ‘water or fire should not be brought into [one’s] compound at night’.

Based on the above results, it is obvious that the identified Setswana taboos hold sway, to a large extent, with the population of the study. In addition to the four items above, three of the five remaining items (namely, item 2 [38.5%], item 13 [44.8%] and item 20 [42.1%]) dealing with Setswana taboos were each agreed to by more than a third of the study sample.

It is significant to note that the violation of any of the taboos is believed to attract severe consequence(s), and oral evidence to support this is never in short supply. Hence, the taboos are well entrenched in Setswana culture. There is always somebody in the village with at least second hand knowledge of a family or a person who has suffered the consequences of a particular taboo in a nearby village or in their own village, some time ago. And even though, such claims are normally not supported by any concrete or provable evidence, they are strong enough for many a Motswana child to believe in them and obey their injunctions even when these are at variance with what they have learnt in school science.



### *Omens*

Of the seven statements (items 1, 8, 10, 14, 15, 17 and 18) dealing with omens, only one (item 1) attracted significant agreement with its claims. For this omen item, 80% of the study sample agreed with the statement that 'rainbow signals the end of rain'. Incidentally, there is strong scientific evidence in support of this stance. This goes to show that some of the traditional Setswana beliefs about natural phenomena may not be totally out of tune with scientific propositions. This view corroborates an earlier observation on a related study by Ogunniyi (1988) who opines that 'traditional view and science are not necessarily mutually exclusive of each other'.

It is logical to postulate here that as a result of careful observation over the years, the traditional Setswana culture may have been able to discover the causal relationship between the appearance of a rainbow and the cessation of rain.

Apart from items 10 and 18 where the study sample also showed substantial concurrence (41% and 40.5% respectively) with cultural omens, the remaining four omen items of the scale (item 8 [15.2%], item 14 [15.2%], item 15 [23.1%] and item 17 [13.7%]) did not attract significant attention of the subjects of the study. A cursory look at these four omen items shows that they have little or no serious consequence on the life of the average school-going Motswana child. For example, the link between fighting cocks and the arrival of visitors to their compounds later that day has little or no bearing on the subjects' lives; and as such a preponderance of them care less about the omen. Another plausible explanation for the low agreement rates with the four omens is the fact that they seem to be at variance with common sense. Or how else could one explain a view like this (item 14 omen): 'When cocks fight, it is a sign that there will be a visitor to one's compound' later on that day.

### *Witchcraft*

More than a third of the subjects believe in some aspects of witchcraft as depicted in items 2, 3, 4 and 5 of the scale. For example, 44.3% of the study sample believes that an owl is a witch's bird. This belief is probably predicated on the fact that owls are nocturnal birds and witches are believed to perpetuate their evil machinations at night by turning themselves in bird-like creatures, and hence the link between owls and witchcraft. In a similar vein, 55.5% of the subjects believe that lightning is normally sent by the witch doctor or traditional doctor to strike his/her enemy. The belief in witchcraft in Setswana culture is so pervasive that when a person dies of AIDS-related ailments, he/she is generally said to have been 'bewitched' during burial rites in Botswana. In Botswana, as it is the case in many other African countries, the death of a young person by illness, accident or even by suicide is promptly linked to witchcraft. No wonder then the thought processes of many of the subjects relating to nocturnal birds, suicide, death by lightning and the like are dominated by witchcraft.

Deriving from the above analysis of the responses of the respondents to the statements on the socio-cultural scale, six items (items 1, 3, 7, 11, 12 and 16) on Setswana socio-cultural beliefs are upheld by more than half of the study sample while another seven socio-cultural items (items 2, 5, 6, 10, 13, 18 and 20) were believed in by more than a third of them. The commonality between these statements is that they are all at the core of Setswana customs, myths, taboos and

folklores. The converse is probably true of the seven remaining beliefs (see items 4, 8, 9, 14, 15, 17 and 19) that were upheld by less than a third of the subjects of the study. A cursory look at some of these beliefs indicates that they are at variance with 'common sense'. Or how else could one explain a view like: 'If an old person hits/knocks his/her toe against a tree stump or a stone, it is a bad omen?'.

From the foregoing results, it is evident that the socio-cultural background of Botswana junior secondary school students impacts substantially on their worldview as more than a third of them believe in:

- (1) Rainbow as a sign for the end of rain.
- (2) Owls as witches' birds.
- (3) Lightning as wreaking havoc due to evil machination of the witch doctor.
- (4) Thunder being caused by a particular bird.
- (5) Young girls (not yet at puberty stage) not taking their bath at night to prevent induced early menstruation.
- (6) A widow not passing through a herd of cattle to prevent induced abortion for the pregnant ones among them.
- (7) A cock standing on one of its legs as a sign that there would be (a) visitor(s) to the household later that day.
- (8) Making a thief of a child at a later date in her/his life if handed over a fence when young.
- (9) Bad luck to one's mother if one puts on just one of his/her pair of shoes.
- (10) Bad luck to one's family or even death in one's family if one sweeps at night.
- (11) The taboo that water or fire should not be brought into one's compound at night.
- (12) Good harvest if there is a large circle around the moon during a particular period of the year.
- (13) Poor harvest as a result of cutting down some particular trees during the ploughing season.

Looking back at research question 1 which raises the issue of the impact of the socio-cultural background of Botswana junior secondary school students on their worldview, the fact cannot be denied that Setswana beliefs, customs, folklores and like have a substantial impact on the thought processes of the subjects of the study. Hence, it would not be inappropriate to suggest, on the basis of above outcomes, that the socio-cultural background of the study subjects has a telling effect on their worldview.

For the resolution of research question 2, an item-by-item analysis of the responses of the subjects of the study to the items of the attitudinal scale was carried out. This was with a view to finding out the nature of Botswana junior secondary school students' attitudes towards science. For ease of reference, the results of the item analysis are provided in table 2 under two broad categories of the 'likes of science' and the 'dislikes of science' as isolated by factor loadings.

As could be seen from the table below, with the exception of items 18 and 20, over 50% of the subjects of the study demonstrated positive attitude towards science. The responses of the subjects to the 12 'likes-of-science' items were significantly instructive. There is overwhelming evidence from the above to indicate that the study subjects have positive attitude towards science. This position is reinforced by the results of the analysis of the respondents' responses according

**Table 2. Responses of the study sample to the attitudinal scale statements**

<i>Themes</i>	<i>Statement No.</i>	<i>% Agreement</i>	<i>% Neutrality</i>	<i>% Disagreement</i>	<i>% Missing cases</i>
	<b>1</b>	<b>95.0</b>	0.5	4.5	0.0
	<b>2</b>	<b>94.0</b>	2.5	3.5	0.0
	<b>3</b>	<b>79.5</b>	6.8	13.4	0.3
Likes (12 items)	<b>4</b>	<b>77.7</b>	8.9	13.1	0.3
	<b>5</b>	<b>68.9</b>	4.8	26.0	0.3
	<b>7</b>	<b>63.3</b>	13.4	22.5	0.8
	<b>8</b>	<b>73.3</b>	8.1	17.3	1.3
	<b>10</b>	<b>69.1</b>	4.3	25.3	0.8
	<b>14</b>	<b>62.8</b>	12.7	24.0	0.5
	<b>16</b>	<b>59.0</b>	16.2	22.8	2.0
	<b>17</b>	<b>83.0</b>	5.1	11.1	0.5
	<b>19</b>	<b>61.7</b>	10.4	26.9	1.0
	<b>6</b>	<b>29.6</b>	13.4	<b>56.2</b>	0.8
	<b>9</b>	<b>25.1</b>	21.8	<b>51.6</b>	1.5
	<b>11</b>	<b>13.9</b>	7.8	<b>77.5</b>	0.5
Dislikes (8 items)	<b>12</b>	<b>26.1</b>	15.7	<b>57.4</b>	0.8
	<b>13</b>	<b>19.2</b>	6.3	<b>73.2</b>	1.3
	<b>15</b>	<b>16.0</b>	9.4	<b>72.9</b>	1.7
	<b>18</b>	<b>41.0</b>	30.6	28.4	0.0
	<b>20</b>	<b>66.1</b>	12.1	20.5	0.5

to a Likert-type format. Using the Likert-type five-point scale analysis technique, the respondents had a mean score of 74.5% on the attitudinal scale. This goes to confirm the positivism of the nature of the study subjects' attitude towards science. This result underscores the fact that Botswana junior secondary school students have a positive disposition towards science; and hence the resolution of research question 2.

In order to resolve research question 3, Pearson's correlational analysis was carried out on the subjects' socio-cultural background scores and their science attitude scores. The analysis yielded a correlation coefficient of  $-0.144$ . The sign of the coefficient underscores the fact that an inverse relationship exists between the two study variables (namely socio-cultural background and science attitude). This means that a subject's 'high' score on the socio-cultural background scale is accompanied with a 'low' score on the attitudinal scale and vice versa. This result is in line with expectation as belief in Setswana myth is likely to impact negatively on one's disposition towards science. This finding corroborates the findings by earlier researchers (Horton 1971, Odhiambo 1972, Ogunniyi 1988, Jegede and Okebukola 1991) in the area. Subjecting the obtained correlation coefficient to *t*-test analysis to test its significance yielded a *t*-value of 8.62 which was found to be significant at 0.05 level ( $df = 393$ ). This further confirms the significance albeit the significant inverse relationship between the two variables of the study. It, therefore, follows that there is a significant (negative) relationship between Botswana junior secondary school students' socio-cultural background and their attitude towards science.

A similar procedure as above was followed in resolving research question 4, which sought to find out whether a significant relationship exists between the

subjects' socio-cultural background and their achievement in science. The correlation analysis exercise carried out between the two variables yielded a correlation coefficient of  $-0.117$ . This shows that the variable of socio-cultural background is indirectly correlated with the variable of science achievement. The import of this is that a 'high' score in one of the variable attracts a 'low' score on the other variable. The *t*-test analysis carried out on the obtained correlation coefficient yielded a *t*-value of  $-6.96$  which was found to be significant at 0.05 level ( $df = 393$ ). This result confirms that cultural beliefs held by the subjects impact negatively on their science achievement. This finding is in conformity with many a finding (Okebukola 1986, Nwana 1987, Jegede and Okebukola 1991) in the area of study. For example, Jegede and Okebukola (1991) found that traditional African beliefs and taboos tend to hinder science learning. They found that students who hold strong beliefs in traditional African cosmology made fewer correct observations on the test of observational skills than those who do not. An earlier writer (Ogunniyi 1984) on the subject, however cautioned that traditional African views and the tenets of science are not necessarily mutually exclusive of each other in that it is possible for an African child to hold a correct scientific view as well as a traditional African view about many a science-related concept. This probably accounts for the low and negative correlation coefficient found between the two study variables.

For research question 5, a moderate positive relationship ( $r = 0.363$ ) was established between science attitude scores and science achievement scores. This implies that a 'high' score on the attitudinal scale is complimented with a 'high' score on the science test and vice versa. The obtained correlation coefficient of 0.363 was found to be significant at 0.05 level ( $df = 393$ ) on subjecting it to a *t*-test analysis ( $t = 23.12$ ). This finding shows that there is a significant positive relationship between Botswana junior secondary school students' attitudes towards science and their achievement in science. It should be added though that, generally speaking, a weak relationship is expected between the variable of attitude and the variable of achievement because of the nature of attitudinal variable. In this case only 13.2% of the variance in science achievement is explained by the attitudinal disposition of the subjects. This is, however, in conformity with the expected trend (Walberg and Rasher 1979).

To resolve research question 6 which seeks to establish whether a significant relationship exists between the attitude mean scores of the subjects with low socio-cultural background (LCB) scores and their counterparts with high socio-cultural background (HCB) scores, attitude mean score of the subjects in the 20% upper echelon of the socio-cultural background score distribution was contrasted with the corresponding 20% lower echelon. The *t*-test analysis carried out on the data yielded a *t*-value of 2.26 which was found to be significant at 0.05 (tabled *t*-value = 1.96,  $df = 156$ ). This result shows that the two attitude mean scores (of 76.37 for LCB and 72.51 for HCB) are significantly different from each other and in favour of the LCB group. The import of this is that the subject with a lower socio-cultural background score is better disposed to science and hence his/her higher attitudinal score. This finding in itself further underscores the fact that the traditional African worldview impacts negatively on the African child's attitude towards science.

Using a similar procedure to establish the nature of the difference between the science achievement mean scores of the students with low socio-cultural background (LCB) scores and their counterparts with high socio-cultural background

(HCB) scores (research question 7), it was found that a significant difference exists between the two groups. This difference was in favour of the LCB group with a higher science achievement score of 9.44 (in contrast to that of 8.44 for the HCB group). The resulting *t*-value of 2.42 is found to be significant at 0.05 level (*df* = 156). This finding conclusively demonstrates the negative impact of the traditional African worldview on science learning.

### Conclusions, implications and recommendations

Deriving from the findings of the study, it could be concluded that:

- (1) Setswana mythology has, to some extent, a discernible effect on the thought processes of Botswana junior secondary school students.
- (2) In spite of the negative impact of the elements of their culture on science learning, Botswana junior secondary school students seem to be positively disposed to science.
- (3) A significant negative relationship exists between Botswana junior secondary school students' socio-cultural background and their attitude towards science.
- (4) There is a significant negative relationship between Botswana junior secondary school students' socio-cultural background and their achievement in science.
- (5) There exists a significant positive relationship between Botswana junior secondary school students' attitudes towards science and their achievement in science.
- (6) Botswana junior secondary school students with low socio-cultural background (LCB) scores appear to be more positively disposed to science than their counterparts with high socio-cultural background (HCB) scores.
- (7) Botswana junior secondary school students with low socio-cultural background (LCB) scores seem to significantly achieve higher in science than their counterparts with high socio-cultural background (HCB) scores.

The findings of this study have implications for the science curriculum developer, the junior secondary school science teacher and the science textbook writer for that level of education. The trio should be aware of the fact that the learner's socio-cultural background may impede the ease with which he/she learns school science. Concerted efforts should, therefore, be made to identify those elements of the student's culture that are at variance with the scientific culture and which could impact negatively on the ease with which he/she comes to grips with school science. No effort should be spared in ensuring that the everyday experiences of the child are used as a springboard for science learning by treating the elements of the child's culture with the appropriate care they deserve.

The point must be stressed that students do not come into the science class with *tabula rasa* minds. But in the African context, the student sometimes comes to the science class with a worldview that may be diametrically opposed to what is known to be scientifically correct as a result of his/her cultural background. How else could one explain the prevailing view (among the subjects of this study) that lightning is normally caused by the witch doctor to incapacitate or even kill his/her enemies? There is, therefore, a need to replace any unscientific 'knowledge' that

the child may possess as a result of his/her local myths, witchcraft and divination with a scientifically correct one. It is the contention of the investigators that with good understanding and knowledge of the rampant science misconceptions among the Botswana secondary school students, the science teacher, the curriculum developer and the textbook writer will be able to ameliorate the situation and assist students to learn science without tears. It is indeed essential for the trio to treat prevailing science misconceptions with the understanding that such a situation deserves instead of dismissing them off-hand as 'superstitions'. This could be done by exploring the origins of such misconceptions with the students and then demonstrating as succinctly as possible why explanations such as the cause of thunder, lightning and so forth are no longer tenable in this day and age.

In the light of the findings of this study, it is recommended that both the primary and junior secondary school science syllabi in Botswana should be revamped to underscore in the most ameliorative manner how the linkages between traditional Setswana culture and scientific culture could be made. Pre-service science teacher education programmes should contain elements of Setswana culture that impinge one way or the other on the ease with which the child learns school science; and science teachers already in service should be 'in-serviced' as appropriate.

#### Note

1. Setswana is the national language of Botswana. Her culture is referred to as Setswana culture while her citizens are called Batswana (with an individual member known as a Motswana).

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## Appendix 1

### *Socio-cultural background scale*

This is not a test. The information you give will be treated as confidential and would not be disclosed to any one without your permission. Respond by a tick (✓) where appropriate. Please complete the WHOLE questionnaire.

Below is a list of statements. Tick in the appropriate boxes depending on how much you agree or disagree with each statement.

Key scale: SA = Strongly agree A = Agree DK = Do not know  
D = Disagree SD = Strongly disagree

<i>Statements</i>	SA	A	DK	D	SD
1. When a rainbow appears, it shows that rain has stopped for the day.					
2. An owl ( <i>morubisi</i> ) is a witch's bird.					
3. Lightning can be sent by a witch doctor to strike other people.					
4. When somebody commits suicide, (e.g. by hanging herself/himself), it is because he/she has been bewitched ( <i>o loitwe</i> ).					
5. Thunder is caused by a bird ( <i>Tladi-Mothwana</i> ).					
6. A young girl should not wash (take her bath) at night as she might start menstruating that night.					
7. A widow ( <i>Mothholagadi</i> ) should not go through cattle ( <i>ga a tshwanela go valala dikgomo</i> ) as pregnant ones among them may abort ( <i>Di tla holotsa</i> ).					
8. If an old person hits/knocks a tree stump or stone with his/her toe ( <i>A kgopitwa</i> ), it is a bad omen ( <i>ke Botlhodi</i> ).					
9. A girl who is menstruating should not go through a field of crops as the harvest will be poor ( <i>O tla a diokama</i> ).					
10. If a cock stands on one leg, it is a sign that there will be a visitor to the yard later that day.					
11. A young child should not be handed over a fence ( <i>ga tlodisitwe legora</i> ), as he/she will become a thief in the future.					
12. Putting on one shoe brings bad luck to one's mother ( <i>o a mohutsa</i> ).					
13. Sweeping at night may bring bad luck or death in the family.					
14. When cocks fight, it is a sign that there will be a visitor to the compound.					
15. An abundance of moretwa fruit is a sign of an impending drought.					
16. Water or fire should not be brought into the compound at night, as it is a taboo to do ( <i>ke moila</i> ).					
17. If a small child puts an object on his/her head, it is a sign that there will be a visitor to the compound.					
18. A large circle around the moon ( <i>Pitso</i> ) predicts good harvest.					
19. One is not supposed to carry water on his/her head in the field as it may not rain in that field.					
20. During ploughing season ( <i>Letsema</i> ), some trees e.g., Moseitha, are not supposed to be cut as this may lead to a poor harvest or a hailstorm ( <i>Sefako</i> ) may destroy the crops.					



## Appendix 2

### *Attitude scale*

This is not a test. The information you give will be treated as confidential and would not be disclosed to any one without your permission. Respond by a tick (✓) where appropriate. Please complete the WHOLE questionnaire. The same key scale applies here.

SA = Strongly agree    A = Agree    DK = Do not know  
D = Disagree        SD = Strongly disagree

<i>Statements</i>	SA	A	DK	D	SD
1. I like science.					
2. I think science is important.					
3. I would like to be a scientist.					
4. Science is an interesting subject.					
5. I would like to spend most of my time doing science.					
6. Science is a difficult subject.					
7. I feel at ease doing science.					
8. I would like science more if I scored higher marks in it.					
9. Science should not be a compulsory school subject.					
10. I like science assignments/homework.					
11. Science lessons are boring to me.					
12. I am scared of science.					
13. I do not like science.					
14. Science is very useful in many careers.					
15. I think science is not important.					
16. The number of science lessons should be increased.					
17. Science is a subject I enjoy.					
18. Science requires too much of one's thinking (mental ability).					
19. Science is an easy subject.					
20. Science is sometimes too abstract (talks about things one can not see or touch, e.g., electricity).					

## Appendix 3

### *Science achievement test*

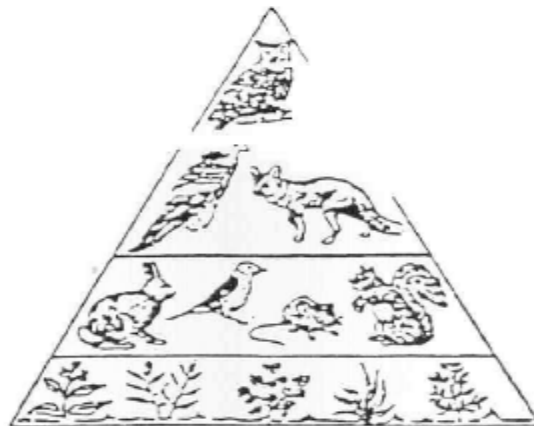
Answer ALL questions by circling the letter for the answer you think is the best like this:

A    **(B)**    C    D

1. Which of the following animals require some parental care?  
A Tadpoles  
B Mosquito larvae  
C Lambs  
D Snakes

2. The organ which filters out urinary waste from the blood is called the:  
A rectum  
B liver  
C kidney  
D heart
3. Which of the following substances is a common waste product of the skin, lungs and kidneys?  
A Carbon dioxide  
B Water  
C Mineral salts  
D Urea
4. The diet of a pregnant woman must be rich in proteins because it:  
A gives the woman energy to carry the baby  
B is needed for the growth of the baby  
C protects the woman from becoming ill  
D keeps the woman and the baby warm

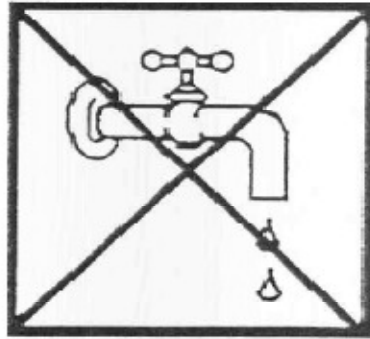
Study the food pyramid shown below and answer question 5.



5. Why is the base of the pyramid made up of green plants?  
A They are producers  
B They are consumers  
C They are herbivores  
D They are omnivores
6. If one drinks too much salty water, the excess water and salts are removed from the body by the kidney. This is an example of:  
A respiration  
B excretion  
C urinating  
D elimination

7. Which one of the following substances provides fibre for healthy intestinal movement?
- A Glucose
  - B Cellulose
  - C Vitamin C
  - D Fats
8. By what process does water move from the surface of the earth into the atmosphere?
- A Condensation
  - B Evaporation
  - C Boiling
  - D Freezing
9. Which one of the following methods of storing water is man-made?
- A Dam
  - B River
  - C Lake
  - D Pan
10. Rust takes place when iron reacts with:
- A oxygen to form iron oxide
  - B water to form salt
  - C an acid to form a reddish substance
  - D an alkali to form a brownish substance
11. Which of the following units is used in the measurement of length?
- A Square centimetre
  - B Cubic metre
  - C Millimetre
  - D Millilitre
12. In which of the following method(s) of heat transfer are moving particles used to pass on heat?
- A Conduction and convection
  - B Radiation and convection
  - C Convection only
  - D Conduction only
13. A student found that sea water boiled at  $103^{\circ}\text{C}$ . What caused the sea water to have a higher boiling point than  $100^{\circ}\text{C}$ ?
- A The different amounts of heat used to boil the seawater
  - B A faulty thermometer used by the student
  - C Uneven stirring of the water
  - D Dissolved impurities in the water

Study the diagram below to answer question 14.



14. Which of the following statements corresponds to the message given by the drawing?
- A Do not use the resource
  - B Use more of the resource
  - C Recycle the resource
  - D Avoid wasting the resource

The diagram shows a strip made of iron and brass fixed together. Brass expands faster than iron when heated. Use this information to answer question 15.

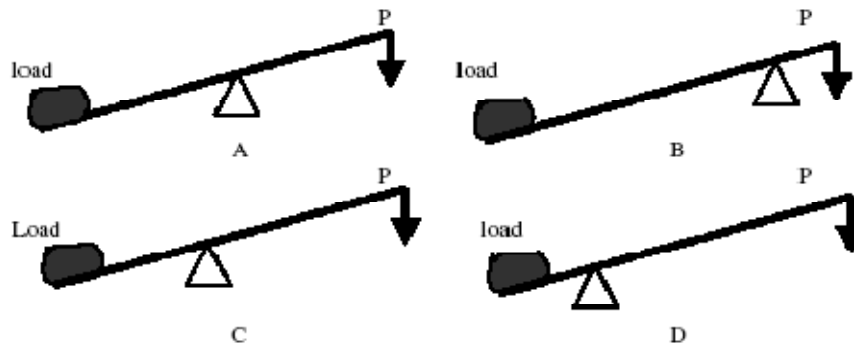


15. What will the strip appear like when it is heated?

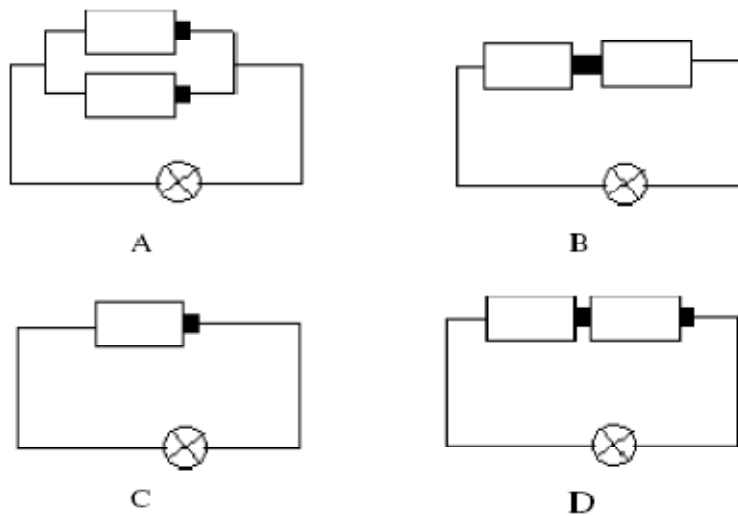


16. Which of the following materials is the best conductor of electricity?
- A A sheet of paper
  - B A plastic ruler
  - C A nylon thread
  - D A pair of steel scissors

17. In which of the four diagrams below would it be easiest to lift the load by pushing down at P?



18. In which of the following circuits will the bulb light brightest?



19. Which of the following type of spoon is suitable for stirring food which is being cooked?

- A Steel
- B Wooden
- C Silver
- D Copper

Goitse is testing materials to see how well they can conduct electricity by connecting them between points X and Y.

20. Which one of the following circuits should she use?

