Perceptions of the water cycle among primary school children in Botswana

A. A. Taiwo, H. Ray, M. J. Motswiri and R. Masene, Department of Mathematics and Science Education, University of Botswana, Botswana

The study was designed to elucidate the nature of the perception of the water cycle held by Botswana pupils in standards 4 to 7 of primary schools in three different areas (namely, remote area dwellers' settlement, peri-urban and urban areas) of Botswana. The research design employed a survey method involving the administration of a structured instrument and interview sessions for data collection. Analyses of research data were carried out by both qualitative and quantitative methods. Among other things, the outcome of the study showed that the perception of water cycle held by the study sample was positively influenced by schooling but negatively impacted upon, to some extent, by the 'untutored' ideas the children brought to school.

Introduction

The water cycle is a very important natural phenomenon because of the significance of water to mankind. Its significance becomes over-whelming in semi-arid countries such as Botswana where drought is a common occurence. Conservation of water is, therefore, vital to the economies of such countries. To appreciate the significance of water conservation as enunciated in the national water conservation policy, every Botswana citizen should have a clear understanding of water cycle as early as possible in life. Unfortunately, however, many everyday or common natural phenomena (such as evaporation, condensation and free fall inherent in the water cycle), which are experienced by people from childhood are more often than not misinterpreted by many an African as a result of his/her prevailing world views (Ramorogo *et al.* 1994, Taiwo 1976, 1978). Different age groups in such cultures tend to give different interpretations to common natural phenomena. It is, therefore, important to take congnizance of the prevailing world views in such societies in the education of the young.

Children's ideas should be the starting point of the teaching and learning of science in schools (Driver *et al.* 1989) as children do not come to science classes with *tabula rasa* minds about science concepts. They come to school already equipped with some understanding, pseudo-knowledge, or misconceptions, about science concepts. This understanding or lack of it, is more often than not, a product of their cultural beliefs. These 'untutored' ideas are known to play a significant role as children are initiated into the world of science (Hills 1989, Ogawa 1986, 1989).

The importance of the link between school science and children's ideas about science concepts is one of the driving forces behind the investigation into the perception of water cycle in nature among primary school children in Botswana reported here. Piaget's (1930) work on children's ideas about cloud and rain formation seem germane at this point. Piaget classified the explanations by children about cloud formation into three stages (of development) as follows:

Stage I: Clouds are made by gods
Stage II: Clouds are mainly made by smoke
Stage III: Clouds themselves are made of water

In like manner, he classified children's ideas about the source of rain according to their developmental stages as:

Stage I: Clouds and rain are independent
Stage II: Clouds foretell rain
Stage III: Rain comes from clouds

Piaget suggests that the stages are age-dependent with the older children operating at the third stage.

More recent work by Bar (1989) confirmed Piaget's early findings. In her study of the perception of water cycle among Israeli children aged between 5 and 15 years, she identified three levels (which are parallel to the three stages identified by Piaget) in the understanding of water cycle by her subjects. These levels are:

Level I (5–7 years)

Perception is dominated by primitive or cultural beliefs in that many of them are of the opinion that clouds contain bags of water which open up to form rain.

Level II (7+–9 years)

Perception of water cycle is pseudo-scientific in nature. They believe, for example, that rainfall is caused by the sun boiling up sea water to form clouds which are then shaken up by the wind to form rain.

Level III (9+–15 years)

The existing schema of the subjects becomes more structured and the children, by and large, tend to give scientifically correct explanations for cloud formation and the nature of clouds and free fall.

Many researchers in Africa have directed their efforts towards elucidating children's ideas about science. They have focussed attention on the effect of cultural beliefs on the ease with which the child learns school science and the implication of this for the teaching of school science (Cole 1975, Jegede and Okebukola 1991, Ogunniyi 1989, Ramorogo *et al*. 1994, Taiwo 1976, 1978, 1993). These researchers are of the opinion that the African child's thoughts about science-related natural phenomena are influenced, to a large extent, by

- his/her culture
- his/her perceptual thinking
- his/her tendency to focus on limited aspects of a given situation
- his/her tendency to focus on insignificant changes in a given situation.

Research questions

The study was undertaken to examine the nature of the perception of Botswana pupils about the water cycle and related phenomena such as rainbow formation with a view to drawing important science curricular implications. The study objectives include investigating the following:

1. The views of Botswana primary school children in remote area dwellers' (RAD) settlements and in both urban and semi-urban areas of Botswana about the water cycle.
2. The difference(s), if any, in the perception of the water cycle among the different groups of children.

Research questions

To achieve the study objectives, the following four research questions were formulated to guide the investigation:

1. What perception of the water cycle in nature exists among standards 4, 5, 6 and 7 primary school pupils of remote area dwellers' (RAD) settlements and their counterparts in peri-urban and urban areas of Botswana?
2. Is there a significant difference with respect to grade level in the perception of the water cycle in nature among primary school pupils in standards 4, 5, 6 and 7 in RAD, peri-urban and urban areas of Botswana?
3. Is there a significant difference in the perception of the water cycle in nature among primary school pupils in RAD, peri-urban and urban areas of Botswana?
4. Is there a gender difference in the perception of the water cycle in nature among primary school pupils in RAD, peri-urban and urban areas of Botswana?

Methodology

Research design

The nature of the study dictated the use of a descriptive research approach. In particular, the survey technique was employed because the study sought to establish trends and/or patterns in the subjects' perception of the water cycle. A survey method using structured instrument administration and interviews was employed to gather data for the study.

Sample selection

The sample for the RAD pupils for the study was randomly selected from standards 4, 5, 6 and 7 classes in four schools in the Kgalagadi district and from corresponding classes in four schools in the Bobirwa sub-district in the central district of Botswana. A total of 255 RAD children whose ages ranged between 10 and 14 years were selected for the study.

Eight other schools were randomly selected from Gaborone city to provide the sample for urban setting with pupils also randomly selected from standards 4 to 7

Table 1. Sample sizes by location, gender and class.

Class/Gender		*Location*			*Totals*
		RAD	*Peri-urban*	*Urban*	*M F*
4	Male	40	40	38	118
	Female	37	40	40	117
	Sub-total	77	80	78	235
5	Male	38	40	38	116
	Female	30	40	42	112
	Sub-total	68	80	80	228
6	Male	28	40	35	103
	Female	22	40	40	102
	Sub-total	50	80	75	205
7	Male	30	40	40	110
	Female	30	40	40	110
	Sub-total	60	80	80	220
	Totals	255	320	313	888

in the chosen schools. Eight peri-urban schools located within 50 kilometres of Gaborone were randomly selected; a study sample representing the peri-urban settlement was also randomly chosen from standards 4 to 7 classes in the chosen schools. The peri-urban and urban samples consisted of a total of 633 pupils aged between 9 and 13 years. In all, a grand total of 888 subjects were sampled by the study. The breakdown of the study sample by location, gender and class is contained in table 1.

Instrumentation

The primary school science syllabus in Botswana covers the water cycle in the second term (May to August) of standard six. With a view to ensuring some measure on content validity, the construction of test items on the water cycle was directly informed by the syllabus. The first draft of the instrument consisted of twenty items of two types: ten scenario-type items and ten common multiple choice type items. Each item of both types had five multiple choice answers.

The draft instrument was vetted by a three-member panel of primary school teachers and trial-tested on twenty standard 6 pupils in Gaborone. The result of this exercise led to the refinement of the instrument in two significant respects: the reduction of the 20-item test to a 10-item test to avoid overlaps and duplication and to enhance clarity; the reduction of the five-choice answers to three-choice answers by eliminating the 'I don't know' option and by accommodating the option in each item dealing with the cultural element of 'gods' into a single culturally-based answer option. The three choices per item now covered aspects of a) scientific knowledge b) pseudo-knowledge and c) culturally-based knowledge of the natural phenomena (such as cloud formation, rainfall, etc.) explored by the study.

One item from the scenario-type questions and one from the common multiple choice question type are reproduced below.

Scenario-type item:

If a few drops of water are poured on a flat stone on a hot day, the stone surface becomes dry within a few minutes. What has happened to the water?

a. It disappeared into the stone
b. It disappeared due to the wish of the elders/gods
c. It disappeared into air due to evaporation

Non-scenario-type item:

When a river dries up, what happens to its water?

a. Some of it disappears into the air due to evaporation
b. The water is drunk up by animals
c. The gods have taken the water away

The refined instrument was then translated into Setswana, the national language of Botswana. The Setswana version of the instrument was vetted by a Setswana language lecturer at the Department of African Languages and Literature of the University of Botswana for clarity of expression and contextual relevance as well as for regional vocabulary and spelling variations. The instrument was pilot-tested in four schools, one from each of the four areas covered by the study (Kgalagadi District, the Bobirwa sub-district in the Central District, Gaborone, and a peri-urban settlement, 40 kilometres north of Gaborone). During this exercise, it was discovered that some of the pupils (especially those in standard 4) had difficulty in using the separate answer sheets provided because of lack of experience with them. To overcome this unexpected difficulty, the following two steps were taken to modify the instrument:

1. The format of the instrument was slightly altered to allow pupils to mark their choices in the boxes provided beside the alternative answers.
2. The instruction on the instrument was followed by a worked example and a practice item. These are given in the appendix.

The choice of the subject for the practice item was deliberate. Traditionally, one's wealth is measured in Botswana by the size of one's herd of cattle. In addition, the customary *lobola* (bride's price) is still paid in cattle and practically every Botswana family owns cattle. Cattle is also an important foreign exchange earner (second only to diamond) for Botswana. The significance of this fact is that every Botswana child knows that a cow has four legs. His or her correct answer to the practice item reinforces the fact that the instruction is clear. The English version of the refined instrument is given here as an appendix.

Reliability of the instrument

The reliability of the instrument was determined by the split-half method. The modified 10-item instrument was administered to forty standard 5 pupils in two schools (one in Gaborone and the other in Ramotswa, about 20 kilometres from Gaborone). Analysis of their worked scripts using Pearson's product-moment method yielded a reliability coefficient of 0.75 for the two halves of the test. A reliability coefficient of 0.86 was obtained for the entire test on applying the

Spearman-Brown correction formula, showing a high internal consistency for the instrument.

Data collection

Data for the study were collected by the administration of the 10-item test to the subjects in their respective classes by the researchers assisted by four trained research assistants. The administration of the test in each class was followed by interviews. Two boys and two girls were individually interviewed from each of the classes covered by the study. A total of 384 subjects representing about 43% of the study sample were individually interviewed to elicit rationale or justifications and explanations for their choices on the test instrument.

In an interview session, each of the question items was read to the interviewee to obtain an answer and a rationale for his/her response. Where the reading of a question item to an interviewee did not elicit a response after the third attempt, the answer choices were read out to the interviewee to make his/her choice and to give reasons(s) and justification(s) for his/her choice. It should, however, be noted that cases of lack of response after the second reading, let alone after the third, were exceptions rather than the rule. A majority of the interviewees was very responsive and readily supplied answers and explanations for the queries on demand.

The researchers and their assistants tape-recorded all the interview sessions, noting in writing striking explanations and/or suggestions volunteered by the interviewees.

Data analysis

To answer Research Question 1, dealing with the perception of water cycle held by the three groups (RAD, Urban and Peri-urban pupils) studied, the following analyses were carried out:

1. Item analysis of the responses of the subjects to the 10-item test.
2. Analysis of the transcribed responses during the interview sessions.

Analysis of variance (ANOVA) was employed to test whether or not significant differences exist in the subjects' perception of the water cycle according to their grade level. The result of the ANOVA was followed by pair-wise comparison analyses to pinpoint where the significant differences lie in order to resolve Research Question 2. The question of significant differences according to location as stated in Research Question 3 was addressed by ANOVA in a similar manner.

Finally, research question 4 dealing with gender issue was addressed by the application of t-test. In all cases of the tests of significance for the study, the confidence level was set at 99% (that is, 0.01 level of significance).

Results and discusssion

Research Question 1

The responses of the children to the questions on the research instrument were item-analysed (see table 2).

Table 2. Response pattern.

Instrument items	*Response pattern* S*	P**	C***	Totals+
1	487 (56%)	323 (37%)	59 (7%)	869
2	434 (49%)	313 (36%)	133 (15%)	880
3	524 (59%)	225 (26%)	136 (15%)	885
4	365 (42%)	95 (11%)	416 (47%)	876
5	345 (39%)	358 (41%)	175 (20%)	878
6	599 (69%)	171 (20%)	99 (11%)	869
7	640 (75%)	134 (16%)	85 (9%)	859
8	504 (57%)	296 (34%)	80 (9%)	880
9	464 (53%)	313 (36%)	98 (11%)	875
10	241 (27%)	433 (49%)	213 (24%)	887
Totals	4603 (53%)	2661 (30%)	1494 (17%)	8758

* S Scientifically correct response
** P Pseudo-scientific response
*** C Culturally-based response
+ The total in each of the cases should be 888. Missing cases (i.e. unanswered items) account for the differences

As can be seen from table 2, the overall performance of the subjects in supplying the correct scientific response was 53%. This shows that a substantial number of responses (47%) was in the domains of pseudo-scientific and culturally-based 'knowledge' about the water cycle. The pupils in primary schools in Botswana, therefore, bring a significant amount of 'untutored' ideas about science-related natural phenomena to school.

The relative performances of the subjects in the two sections of the research instrument vary. Contrary to expectations, the children seemed to have more difficulties with scenario-type questions (questions 1 to 5 in section A) than with the common multiple choice type items (questions 6 to 10 in section B). A success rate of 75% was achieved with one of the items of the multiple choice type whereas the highest success rate with the scenario-type items was only 59%. The item dealing with the rainbow in both question-types presented the most difficulty to the pupils, with only a 39% pass rate for scenario-type and as low as a 27% pass rate for the multiple choice item.

Overall, a pattern which shows that the perception about the water cycle held by primary school children in Botswana, irrespective of formal tuition is dominated by pseudo-scientific knowledge (from 11% to 49%) seems to emerge from table 2. The sample's perception of clouds (item 4) is coloured, to some extent, by their cultural beliefs in that as many as 47% of their answers to the query on clouds are culturally based.

The rationale provided by the subjects during the interview sessions confirmed that their perception of the water cycle was clouded, to some extent, by their cultural beliefs and, to a large extent, by their pseudo-scientific knowledge about the subject-matter. Some of the statements that point to cultural elements provided by the subjects during the interview sessions are paraphrased below in three categories according to the major elements of the water cycle: of cloud formation, rainfall and rainbow formation:

a) Cloud formation

1. Clouds come from heaven
2. Clouds are made by gods
3. Clouds are formed by smoke
4. Clouds come from the smoke formed from burning tree branches
5. When the smoke from a fire rises, it cools and comes together to form clouds.
6. Clouds come from smoke from burning trees cut to clear the land for planting.
7. The smoke from burning tree branches after farm clearing causes clouds to form.
8. Clouds are formed after fires have been made and their smoke has drifted upwards.
9. Clouds are formed from smoke that rises from burning vegetation and cooking fires.
10. The black smoke that rises into the air forms the clouds.

b) Rainfall

1. The clouds collide when commanded by the gods to cause rain.
2. Rain falls because someone has whistled five times
3. Rain falls because water-carrying clouds develop holes and leak out water as rain.
4. Clouds fetch water from rivers to produce rain.
5. Clouds normally go to the sea to draw water and when they are full they come back to cause rain.
6. Clouds move across the sky and open up to form rain.
7. When clouds collide, cracks are formed and these let water come down as rain.
8. When clouds collide, the impact of the collision causes rainfall.
9. Rain is caused by the collision of the clouds.
10. When black clouds collide, it rains.

c) Rainbow formation

1. Rainbow is caused by the gods
2. Rainbow shows that it has rained and the gods are pleased.
3. The gods make the rainbow and it indicates that there will be no more rain that day.
4. Rainbow is a sign that the gods are happy.

5. When the sun comes out during rain, the clouds open up as rainbow to show that it will not rain again that day.
6. Rainbow develops when it has stopped raining.
7. Rainbow is a sign that it will not rain again.
8. Rainbow is caused by the heat of the sun.
9. Rainbow is formed when the heat of the sun mixes with the coldness of the clouds.
10. Rainbow is a sign that the gods are happy after the rain.

Examples of the explanations that border on pseudo-scientific knowledge on the same concepts include the following:

a) Cloud formation

1. Clouds are formed by water in the air.
2. Clouds are packets of water swept into the sky by wind.
3. Water vapour turns into ice to form clouds.
4. The sun boils the water in the dam and causes it to form clouds.
5. The wind takes water from the river to form clouds.
6. Clouds are formed from water vapour which has turned into ice.
7. Clouds are formed from water swept into the atmosphere by wind.
8. Clouds are formed from droplets of water produced by the sun.
9. When water rises into the atmosphere it turns into iced clouds.
10. The heat of the sun produces clouds.

b) Rainfall

1. The movement of clouds causes rain.
2. When clouds become heavy and black, they develop into rain.
3. When iced clouds melt, they come down as rain.
4. When clouds become many and heavy, they result in rain.
5. The heat of the sun causes iced clouds to melt and fall as rain.
6. It rains when the clouds melt.
7. The heat of the sun causes iced clouds to melt resulting in rain.
8. When clouds become cold they turn into ice and when the ice becomes heavy it rains.
9. It rains when the clouds are warmed by the heat of the sun.
10. It rains because clouds turn black.

c) Rainbow formation

1. The rainbow is caused by wind after rain.
2. Rainbow is a sign indicating that it is raining.
3. Rainbow is formed when the heat of the sun comes in contact with rain water during rainfall.
4. Rainbow is an indication that there is water in the atmosphere.
5. Rainbow develops when it has just stopped raining.
6. When the sun's rays pass through a rain droplet, a single colour of the rainbow appears. A complete rainbow appears when sun rays pass through many rain droplets.
7. Rainbow indicates that there is no water in the atmosphere.

8. Rainbow is formed when the sun lights up the clouds.
9. Rainbow is produced by a mixture of sun and water vapour in the atmosphere.
10. When the sun appears after a rainfall, it makes different colours that form the rainbow.

It is, however, pertinent to note that the overall mean score (5.34) of the sample on the research instrument is in excess of the 50 % mark level; and that this score produces a significant mean difference result when compared with the chance mean of 3.33 obtainable on the 10-item three-choice multiple answer instrument used to gather data for the study. The test of significance between the two means carried out by using the chance binomial model (Taiwo 1976) to obtain the standard deviation for the chance mean score of 3.33 resulted in a significant t-value of 19.3 (t_t = 2.576, $p > 0.01$ and df = 1774). The import of this is that whatever the difficulty experienced by the study subjects, they do possess a better than chance knowledge of the aspects of the water cycle covered in the study.

Research Question 2

The results shown in table 3 indicate that school grade level plays an important part on the relative performance of the subjects. Standards 5 to 7 pupils obtained a success rate level of 50% and above whereas the standard 4 pupils gained only a 38% success rate. A pattern seems to emerge from table 3: the higher the grade level, the better the performance. The corollary to this is that the lower the grade level, the greater is the influence of 'untutored' ideas on the perception of the pupils. For the grade levels covered by the study, the water cycle as a unit is covered in the second term of standard six of primary school science syllabus and, to some extent, in standard five social studies syllabus in Botswana. It is, therefore, logical to suggest that schooling plays a positive part in moderating the effect of 'untutored' ideas the pupils could have brought from home to school.

A summary of the performances of the subjects according to grade level is presented in table 4.

Table 3. Analysis of research data by school grade level and response pattern.

	Response pattern			
School grade	*S*	*P*	*C*	*Totals*
4	902 (38%)	819 (35%)	623 (27%)	2344
5	1076 (50%)	694 (32%)	386 (18%)	2156
6	1224 (59%)	595 (28%)	273 (13%)	2092
7	1381 (64%)	573 (26%)	212 (10%)	2166
Totals	4603 (53%)	2661 (30%)	1494 (17%)	8758

Table 4. Descriptive statistical data of study sample by grade level.

Grade level (stds)	Mean $\bar{X}$	Std dev SD	N
4	4.23	2.10	235
5	5.03	2.20	228
6	5.89	2.08	205
7	6.49	2.02	220

Table 5. ANOVA result for performance by grade level.

	Sources of variance		
	Between groups	*Within groups*	*Total*
DF	3	884	887
SS	658.73	3897.64	4556.37
MS	219.58	4.41	223.99
F-value	49.80	49.80	
P-value	<.0001	.0001	

ANOVA was used to test whether the above observed performance differentials were due to chance or to the inherent differences among the four grade levels. The ANOVA result is presented in table 5.

Judging from the relative magnitudes of the computed F-value and the corresponding tabled F-value, significant differences do exist among standards 4, 5, 6 and 7 pupils in their performances on the the water cycle task. To locate the area(s) of the difference(s), Scheffe' pair-wise comparison analyses were carried out. This resulted in the establishment of significant differences between each of the pairs (i.e. standards 4 and 5, 4 and 6, 4 and 7, 5 and 6, 5 and 7, 6 and 7) tested. In short, standard 7 pupils fared best on the task followed by standard 6 pupils and so on. This result confirms an early postulation that school grade level seems to play an important role in the performances of the study subjects.

Research Question 3

Analysis of research data by school location yielded the following results according to response pattern.

The result shown in table 6 is weighted in favour of the urban pupil followed by the peri-urban child. The RAD pupils turned out to be the least favoured. The apparent differences among the three groups of the study sample are most likely to be due to non-school (i.e. socio-cultural) influences rather than any other reason as all public primary schools in Botswana use the same (national) science syllabus and human and material resource allocation to the schools is centrally and evenly distributed by the Ministry of Education. It can, therefore, be assumed that the

Table 6. Analysis of research data by school location and response pattern.

Location	*Response pattern*			*Totals*
	S	*P*	*C*	
RAD	1197 (49%)	787 (32%)	461 (19%)	2445
Peri-urban	1692 (53%)	953 (30%)	535 (17%)	3180
Urban	1717 (55%)	983 (30%)	478 (15%)	3133
Total	4606 (53%)	2678 (30%)	1474 (17%)	8758

Table 7. Descriptive statistical data of study sample by school location.

School location	*Mean* $\bar{X}$	*Std. deviation S.D.*	*N*
Rad	4.89	2.29	255
Peri-urban	5.29	2.29	320
Urban	5.54	2.18	313

Table 8. ANOVA result for performance by location.

Sources of variance	*DF*	*SS*	*MS*	*F-value*	*P-value*
Between groups	2	80.96	40.48		
Within groups	885	4475.41	5.06	8.01	< 0.0004
Total	887	4556.37	45.54		

cultural as well as the social environment of the urban child is much more supportive of school ideals than that of the RAD child.

To test whether the observed differences according to school location are statistically significant, ANOVA was applied. Table 7 presents a summary of the performances of the subjects according to school location.

Analysis of variance carried out on the pertinent data according to school location resulted in a significant outcome with the calculated F-value being 8.01 as against the tabled F-value of 4.60 (at 0.01 level and df = 2, 885). The details of the ANOVA result are shown in table 8.

Scheffe' test for pair-wise comparison pinpointed the differences to lie between the RAD pupils and the peri-urban pupils and between the RAD pupils and the urban pupils. No significant difference was found between the peri-urban child and the urban child on the task. This serves to underscore the point that the RAD child is at a relative disadvantage.

Table 9. Analysis of research data by gender and response pattern.

	Response pattern			
Gender	*S*	*P*	*C*	*Totals*
Male	2340 (53%)	1320 (30%)	730 (17%)	4390
Female	2263 (52%)	1341 (31%)	764 (17%)	4368
Total	5603 (53%)	2661 (30%)	1494 (17%)	8578

Table 10. Test of mean difference on study task according to gender.

Gender	*Mean* $\underline{X}$	*Std. deviation* *S.D.*	*No.* *N*	*t-value*
Male	5.33	2.12	447	
Female	5.18	2.34	441	1.01

Research Question 4

Analysis of research data by gender yielded the results shown in table 9.

The results of the t-test analysis used to test whether a significant difference exists in the performances of the study sample on the study task according to gender are shown in table 10.

Since the computed t-value of 1.01 is less than the corresponding tabled t-value of 2.576 (at 0.01 level of significance and df of 886), the apparent difference between the two groups is due to chance. It follows, therefore, that neither the school environment nor the socio-cultural environment of the child puts him/her at a disadvantage on account of his/her gender.

Conclusions and implications

The following conclusions can be reached from the results of this study:

1. The perception of the water cycle held by standards 4, 5, 6 and 7 primary school pupils in Botswana is positively and significantly influenced by schooling but negatively impacted upon, to some extent, by the 'untutored' ideas the children bring to school.
2. A preponderance of standard 4 pupils in Botswana operates at the pseudo-scientific level, in contrast to standards 5 to 7 pupils whose ideas are more structured and thus give more scientifically correct explanations.
3. The RAD pupils exhibited significantly greater coloration of their perception of the water cycle by socio-cultural elements than their counterparts in the peri-urban and urban areas of Botswana.

4. Gender does not significantly influence the perception of the water cycle held by Botswana children.

The curricular implications of above conclusions are significant. There is a need to create cognitive harmony in the pupils in their attempt to learn school science. Necessary steps should be taken by primary school science curriculum developers in Botswana to ameliorate the impact of children's 'untutored' ideas on science learning. The impact of 'untutored' ideas on the ease with which the child learns science concepts should be underscored in Botswana primary school science curriculum. Botswana primary school teachers should be schooled at both pre-service and in-service levels about ways and means of dealing with such a curriculum for the maximum benefit of the Botswana child.

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Appendix A

DEPARTMENT OF MATHEMATICS AND SCIENCE EDUCATION
UNIVERSITY OF BOTSWANA

WATER CYCLE TEST (STD 4 - 7)

Please supply the following information

Name:

Name of School:

Age: **Sex:** **Class**

You are requested to read the test items carefully and put a cross (X) on the letter corresponding to your choice for each item below.

The following is an example to assist you.

Example

What is the capital of Botswana?

[a] Francistown

[X b] Gaborone

[c] Lobatse

Practice Items

How many legs does a cow have?

[a] 2

[b] 3

[c] 4

Section A

1. If a few drops of water are poured on a concrete floor or a flat stone on a hot day, the floor or stone surface becomes dry within a few minutes. What has happened to the water?

[a] It disappeared into the stone or the concrete floor

[b] It disappeared due to the wish of elders/gods

[c] It disappeared into air due to evaporation

2. Water droplets are found on grasses or on the leaves of plants in the early mornings sometimes even though it has not rained over-night. Where does the water come from?

a The god of rain makes the water droplets for the grass and plants "to drink"

b The water droplets came from within the grass and plants because they contain too much water.

c The water droplets are due to the condensation of water vapour in the air.

3. On a clear day when you look up into the sky, you may see a clear blue sky; whereas on some other days, particularly in the rainy season, you may find black patches of clouds moving across the sky. Where do these black patches of clouds come from?

a They are sent by the gods.

b They rise to the sky from burning bushes

c They are water vapours coming from seas and rivers.

4. One windy morning Mpho observed that clouds were moving fast across the sky towards the west. In the afternoon it started to rain. What caused the rainfall?

a Clouds moved west to draw water from the sea.

b Clouds developed holes and rain started falling.

c Clouds became colder; water drops became heavier and started falling as rain.

5. Sometimes, immediately after it stops raining, the sun comes out and you can see rain-bow in the sky. What do you think is responsible for this?

a The gods caused the rainbow.

b The sun and water droplets caused the rainbow.

c Temperature rise due to the sun caused the rainbow.

Section B

6. When a river dries up, what happens to its water?

a Some of it disappears into the air due to evaporation.

b The water is drunk up by animals.

c The gods have taken the water away.

7. Water droplets are formed outside a glass tumbler containing an ice-cold drink. Where does the water come from?

a The water comes out through the glass tumbler.

b Water vapour in the air forms the water droplets.

c The water droplets are formed by the gods

8. How are clouds formed?

a From smoke from burning bushes

b From condensation of water vapour in the air

c By the rain makers

9. The rain falls when:

a The clouds become too heavy

b The clouds collide and open up

c A traditional doctor commands it to fall

10. A rainbow is a sign that

a The gods are happy with us

b There is no water in the sky

c There are water droplets in the sky