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Pupils' Beliefs in Cultural Interpretations of 'Heat' associated with Anger: A Comparative Study of Ten Ethnic Communities in Kenya

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Emerging evidence indicates that culture influences pupils learning of science. However, the influence of culture on science learning is usually not considered when developing science curricular for both primary and secondary schools. This study investigated the extent to which primary and secondary school pupils believe in cultural interpretations of the physical phenomenon of 'heat' associated with anger and the influence of education level, ethnic communities and gender on cultural beliefs. Cross-sectional survey research design was used. The target population was Standard Seven, Form one and Form Three pupils in ten districts selected from Nyanza, Rift Valley, Central, Eastern and Coast Provinces in Kenya. The ten districts were selected purposively to represent 10 different ethnic communities from the five provinces. A total of 2837 secondary and 625 primary school pupils participated. The pupils were drawn from 15 primary and 31 secondary schools .A questionnaire was used to gather information from pupils. Both qualitative and quantitative techniques were used in analyzing data. Hypotheses were tested using the chi square (χ 2) statistic at α = 0.05 level of significance. Some of the results obtained give statistically significant relationship between pupils' beliefs in cultural interpretations of scientific phenomenon of heat associated with anger and the communities where they come from. This implies that such beliefs are confined to specific communities studied. There appears to be no significant association between pupils' beliefs in cultural interpretations of the scientific phenomenon of heat and level of education in some of the communities. The implication is that education reduces beliefs in cultural interpretations in such communities but does not eradicate such beliefs. There was also no statistically significant association between pupils' beliefs in cultural interpretations of the scientific phenomenon of heat and gender, implying that both boys and girls equally believe in cultural interpretations. The findings from this study inform curriculum developers of some of the cultural beliefs that are likely to influence the learning of science. It is recommended that teachers discuss cultural interpretations of scientific concepts before introducing them in their lessons.

Key words: science, culture, beliefs

Introduction

Science educators are now aware of the need to relate science more closely to the learners' cultural environment in order to minimize the possible conflicts that might arise from their view of the world and that of science (Biescheuvel,1972; Urevbu,1984; Odhiambo,1972; Scriber & Cole,1973; Champagne et.al., 1983; Black, 1984; Ogunniyi, 1979, 1984, 1985, 1986a). Ogawa (1986) suggested that, the individual in a traditional culture should be made to see the merits and demerits of science, the similarities and the differences between his worlds view vis-a-avis science such that he can use the knowledge gained to make wise decisions in his daily life. Ausubel, Novak and Hensian (1978) have argued that the construction of new knowledge in science is strongly influenced by prior knowledge, that is conceptions gained prior to the new learning. Knowledge construction takes place in a cultural context created by, for example, social and economic class, religion, geographical location, ethnicity and language.

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In addition to race and language, other significant factors influence the construction of meaning and therefore are part of cultural identity. These include economic and education levels, occupation, geographic location, gender religion and philosophy (Geertz, 1973). In cultural anthropology, teaching science is viewed as cultural transmission (Spindler, 1987) and learning science as culture acquisition (Wolcott, 1991), where culture means "an ordered system of meaning and symbols, in terms of which social interaction takes place "(Geertz, 1973 p.5). In past studies, different attributes of culture have been selected to focus on a particular interest in multicultural or cross-cultural science education (Baker&Taylor, 1995; Barba, 1993). For instance, Maddock(1981,p.20) listed "beliefs, attitudes, technologies, languages, leadership authority structures",Ogawa(1986) addressed culture's view of humans and nature and it's view of thinking;Aikenhead(1996) conceptualized culture according to the norms, values, beliefs, expectations and conventional actions of a group. In our study we conceptualized culture to subsume beliefs, expectations and conventional actions of a group. The phenomenon of heat is subsumed under beliefs. This definition is adopted because in Kenya there are various ethnic groups with different beliefs about 'heat', expected behaviour of a person who is angry and the causal relationship between anger and rise in temperature. Furnham (1992) identified several powerful subgroups that influence the learning of science including the family, peers, the school, the mass media and the physical, social and economic environment.

There is widespread acceptance in the international science education research community that students at all levels of schooling all over the world have a diversity of ideas prior to formal learning (Driver, 1989; Zietsman& Naidoo, 1979).According to Pfundt and Duit (1994) the conceptions about physical phenomena are formed early in life as children try to make sense of the physical world. The persistence of these conceptions have been observed even after the formal study of science (Champagne, Klopper &Anderson, 1980; Caramazza, McCloskey & Green,1981; Clement,1982;Osborne &Wittrock, 1983, 1985; Halloun & Hestenes, 1985).The highly robust nature of these preconceptions appears to indicate that they are deeply rooted in students' cognitive structures and makes plausible the idea that they are based upon "alternative frameworks"(Lynch,1995).

Cultural Knowledge Concerning Heat

The topic heat forms an important part of every science curriculum from primary school up to the University level. It is therefore important to understand the ideas about the concept of heat that students bring from the home environment to the school environment. That is when they are crossing cultural border between their community and the science community. The topic is also important from the point of view of the children's' cognitive development probably stemming from the fact that children come into contact with 'hot' and 'cold' an implicit sensation phenomenon at an early stage of life(Bar&Galili,1994). This establishes contact between the child and its environment thereby providing greater individual experience. Erickson(1979;1980) claims that the subject of 'heat' is one of the most misconceived in science education and that the source of this misconception centers on the semantic use of the words 'heat,' heat flow', and 'heat capacity. Bar and Travis(1991) found that while high school students know that the amount of 'heat' a body has relates to how much its components move and that 'heat' transfers from hot to cold substances, they are however not able to distinguish clearly between 'heat' and temperature and do not have appropriate ideas about mechanisms of heat transfer. In our study, we established the associations pupils have between the metaphor of a person 'being hot tempered' and temperature change in the body of the person. It is also well documented that there is a prevalent metaphor involving 'heat' amongst many African peoples (Shapera, 1979; Hammond-Tooke, 1981; Verryn, 1981).This metaphor as pointed out by Lakoff and Johnson(1981) is grounded in experience and is a dominant aspect of the social and physical environment of the people.

Gender and conceptualization of scientific phenomena

Although it has been observed that boys generally perform better than girls in science subjects there could be areas in science education where girls stand at a relative advantage over boys in conceptualizing scientific concepts (Okere, 1991). He conducted a study in Kenya to compare the ability of boys and girls on the planning aspect of scientific creativity. It was found that girls performed better than boys in a problem that required the comparison of the efficiency of two charcoal 'jikos'(stoves) in cooking fish.

Purpose and objectives of the study

The purpose of the study was to investigate the extent to which primary and secondary school pupils believe in cultural interpretations of the scientific phenomenon of heat associated with anger and the influence of education level, ethnic community and gender on such beliefs. The study was guided by the following objectives:

(i) To find out if primary and secondary school pupils believe in cultural interpretations of the scientific phenomenon of heat associated with anger.
(ii) To investigate the relationship between pupils' beliefs in cultural interpretations of the scientific phenomenon of heat associated with anger and level of education.
(iii) To compare pupils' beliefs in the cultural interpretations of the scientific phenomenon of heat associated anger from various ethnic communities.
(iv) To investigate the relationship between pupils' beliefs in cultural interpretations of the scientific phenomenon of heat associated with anger and gender.

Hypotheses

The following hypotheses were tested:

Ho1: There is no statistically significant relationship between pupils' beliefs in cultural interpretations of the scientific phenomenon of heat associated with anger and level of education.
Ho2: There is no statistically significant relationship between pupils' beliefs in cultural interpretations of the scientific phenomenon of heat associated with anger and different ethnic communities.
Ho3: There is no statistically significant relationship between pupils' beliefs in cultural interpretations of the scientific phenomenon of heat associated with anger and gender.

Methodology

The cross-sectional survey research design was used in this study to gather pupils' beliefs in cultural interpretations of heat associated with anger. The population in this study included standard seven primary schools pupils, Form One and Form Three pupils in the ten districts that participated in the study. The accessible population comprised pupils in the 15 primary and 31 secondary schools from which the sample was drawn.

Five provinces were selected randomly for investigation. These are, Nyanza, Rift Valley, Central, Eastern and Coast, in Kenya. The distribution of the sampled districts per province, the numbers of schools per district and school type are given in Table 1. The districts were selected purposively. This was to ensure that the majority of the pupils from each district represented a specific ethnic community. Purposive sampling was also used in selecting schools. The aim was to sample schools from rural set-

tings where beliefs in cultural interpretations of scientific phenomena are common. All the secondary schools sampled were provincial boarding, single sex. The aim was to have approximately equal numbers of boys and girls in the sample.

Table 1. Distribution of districts per province, number of schools and pupils per province

Province	Districts	No and school type			No and gender of pupils						**Total**
		Boys Sec	Girls Sec	Primary	Primary		Form 1		Form 3		
					Boys	Girls	Boys	Girls	Boys	Girls	
Nyanza	Rachuonyo	2	2	2							
	Kisii	2	2	2	88	84	199	280	188	268	1107
	Kuria	-	1	-							
Eastern	Meru South	2	2	2							
					46	113	203	166	182	171	881
	Embu East	2	2	2							
Coast	Kilifi	1	1	1	27	75	72	87	58	81	400
	Kwale	1	1	1							
Central	Nyeri	1	1	1	-	16	43	40	46	38	189
Rift Valley	Nandi	2	2	2							
	Bomet	2	2	2	80	96	168	180	177	180	885
	TOTAL										3462

The primary schools were mixed day, apart from two girls' boarding. Only one form one and one from three streams were used in each secondary school. The streams were selected using simple random sampling technique. All the primary schools had only one standard seven class and all the pupils in those classes participated. A total of 2837 secondary and 625 primary school pupils participated in the study.

The questionnaire used contained 6 items which gave suggestions concerning cultural interpretations of the physical phenomenon of heat, lightning, rainbow and evaporation. The pupils were asked to indicate whether or not they agreed with the cultural interpretations by ticking YES or NO in the two boxes which were provided. They were further asked to explain why they agreed or disagreed with suggestions given. Responses to only one of the items are reported in this paper. These are beliefs in cultural interpretations associated with ANGER. The questionnaire was administered to the pupils over a period of 30 minutes. The period was found adequate for the pupils to answer the items. The administration of the questionnaire was conducted by the researchers with the assistance of the class teachers.

Results

The results are presented in frequencies and percentages of pupil's responses, which were either YES or NO indicating agreeing or disagreeing with the suggested cultural interpretation of the scientific phenomenon 'heat'. Sample responses for this particular item are also provided. These were categorized as follows: scientific (SC), partially scientific (PSC), cultural (CUL) and non scientific (NSC). Analysis of the types of responses was done for each district and for all the districts combined, in terms of educa-

tion level, ethnic community and gender. Hypotheses are tested using chi-square (χ^2) statistic at 0.05 level of significance.

Pupils' beliefs in cultural interpretations of heat associated with anger

Pupils' beliefs in cultural interpretations of 'heat' associated with anger were investigated using the following question.

Question: Hot Blood
Otieno found Njoroge's cows eating his crops. He started shouting and gesturing at Njoroge angrily. Can we describe Otieno as hot? Indicate whether you agree or disagree with the suggestion by putting a tick (√) in one of the two boxes provided.
YES ☐ NO ☐
Explain your answer_____
_____

Sample responses
(a) Scientific responses

(i)His temper was high but the blood did not change in temperature.

(ii) Hot means ones temperature is high but body temperature remained the same.

(b) Partially Scientific Responses

(i) Someone is hot when temperature is high.

(ii) To be hot action of heat is required.

(c) Non Scientific Responses

(i) Blood temperature rose making him angry.

(ii) Because his temperature rose as he shouted and gestures at Njoroge making him to become hot.

Cultural Responses

(i) Otieno could not control his temper.

(ii) Because he was burning with anger.

Objective (i) of the study was to find out if primary and secondary school pupils believe in cultural interpretations of the scientific phenomenon of 'heat' associated with anger. The sample responses given above and the percentages of those who agreed and disagreed with the

cultural interpretations in table 2 confirm that a high percentage of the school pupils from the ten ethnic communities believe in the cultural interpretations of 'heat' associated with anger.

Table 2 presents a summary of the responses from all the districts and chi square tests for the significance of the relationship between level of education and pupils' beliefs in cultural interpretations of the scientific phenomenon of 'heat' associated with anger.

Table 2. Chi-square Tests, Outputs Generated by Districts

District	Education Level	Type of Response				Total	χ^2	Df	Asymp. Sig (2-sided)
		YES	%	NO	%				
Embu	Std 7	88	98.90	1	1.10	89	40.263	2	0.000
	F1	140	69.31	62	3.69	202			
	F3	122	63.21	71	36.79	193			
Meru South	Std 7	58	82.86	12	17.14	70	10.581	2	0.005
	F1	112	62.22	68	37.77	180			
	F3	105	63.25	61	36.75	166			
Kisii	Std 7	69	75.82	22	24.18	91	1.387	2	0.500
	F1	151	79.47	39	20.53	190			
	F3	106	74.13	37	25.87	143			
Kilifi	Std 7	20	43.48	26	56.52	46	21.483	2	0.000
	F1	66	81.48	15	18.52	81			
	F3	54	75.00	18	25.00	72			
Kwale	Std 7	42	82.35	9	17.65	51	0.622	2	0.733
	F1	61	80.26	15	19.74	76			
	F3	49	76.56	15	23.44	64			
Nandi	Std 7	26	60.47	17	39.53	43	6.628	2	0.036
	F1	108	79.41	28	20.59	136			
	F3	108	77.14	32	22.86	140			
Bomet	Std 7	58	64.44	32	35.56	90	3.772	2	0.152
	F1	100	76.34	31	23.66	131			
	F3	97	69.78	42	30.22	139			
Nyeri	Std 7	12	75.00	4	25.00	16	8.499	2	0.014
	F1	32	35.96	57	64.04	89			
	F3	36	43.37	47	56.63	83			
Kuria	Std 7	-		-		-	-		
	F1	15	60.00	10	40.00	25	6.963	2	0.008
	F3	32	88.89	4	11.11	36			
Rachuonyo	Std 7	45	58.44	32	41.56	77	3.390	2	0.184
	F1	138	67.98	65	32.02	203			
	F3	103	60.23	68	39.77	171			

Relationship between Level of Education and Type of Response (YES or NO)

Objective 2 of the study was to find out if there is a relationship between pupils' beliefs in cultural interpretations of scientific phenomenon of ' heat' associated with anger and level of education. This was done by grouping the types of responses (YES or NO) into contingency tables for each district. The results indicate that the relationship was inconsistent, in some districts there appears to be a significant relationship while in others there was no significant relationship. For example, in some districts the number of F1 pupils disagreeing with the cultural interpretations was greater than that of F3

pupils. The relationship was further investigated using chi-square (χ^2) statistic. The values of the χ^2 for each district as well as the overall value for all the districts combined are presented in Tables 2 and 3 respectively.

It can be noted from table 2 that there is a statistically significant relationship between pupils' beliefs in cultural interpretations of heat related to ANGER in six out of the ten districts. Results given in table 2 show that four out the ten districts used for the study showed no statistically significant relationship between education level and types of response (YES or NO) which imply belief or no belief in cultural interpretations of heat related to ANGER. The implication of this finding is that pupils from those particular districts still hold the cultural interpretations even though they have been exposed to formal science in school.

It was also evident from the districts which showed significant relationships that education level reduces beliefs in cultural interpretations but does not eradicate them. For example, the percentages of form three pupils who disagreed with cultural interpretations from Kilifi, Nandi, Embu, Meru South and Kuria were all below 50%.

Table 3. Chi-square Test, output for all the respondents

Education level	Responses				
	YES	%	NO	%	TOTAL
Std 7	418	72.95	155	27.05	573
F1	923	70.30	390	29.70	1313
F3	812	67.27	395	32.73	1207
χ^2– value	Df		Asymp. Sig (2-sided)		
6.426	2		0.040		

The χ^2 value for the relationship between the level of education and pupils' beliefs in cultural interpretations for all the 3462 pupils was significant as indicated in table 3.

Relationship between Pupils' Beliefs in Cultural Interpretations of Heat associated with Anger and Different Communities

Objective 3 of the study was to compare cultural interpretations of the scientific phenomenon of 'heat' associated with anger from ten ethnic communities in Kenya. Responses regarding agreeing or disagreeing with the idea that an angry person is hot are given in table 4.

Table 4. Relationship between type of response and the district from which the samples were drawn

District	**Response**				
	YES	**%**	**NO**	**%**	**Total**
Embu	262	66.33	133	33.67	395
Meru South	217	62.72	129	37.28	346
Kisii	252	76.60	77	23.40	329
Rachuonyo	236	64.84	128	35.16	364

Kilifi	120	78.43	33	21.57	153
Kwale	110	78.57	30	21.43	140
Nyeri	68	39.53	104	60.47	172
Nandi	216	78.26	60	21.74	276
Bomet	197	72.96	73	27.04	270
Kuria	47		14		61
Total	1725		781		2506

Chi-Square Test (χ^2)

Pearson χ^2	Value	Df	Asymp Sig. 2-sided
	116.663	8	.000

Results in table 4 show that there is a statistically significant relationship between pupils' beliefs in cultural interpretations of heat associated with anger and the ethnic communities. This implies that this belief is confirmed within specific communities.

Relationship between Pupils' Beliefs in Cultural Interpretations of Heat associated with Anger and Gender

Objective 4 of the study was to find out the relationship between pupils' beliefs in cultural interpretations of the scientific phenomenon of 'heat' associated with anger and gender. The relationship was investigated by use of chi-square statistic. The values for the χ^2 for each district are given in Table 5.

Table 5. Relationship between gender and Pupils' cultural interpretations of Heat associated with Anger

District	Gender	Response YES	%	NO	%		χ^2 value	Asymp. Sig (2-sided)
Embu	Male	129	64.50	71	35.50	200	.168	.682
	Female	123	66.49	62	33.51	185		
Meru South	Male	96	53.04	85	46.96	181	15.204	.000
	Female	121	73.33	44	26.67	165		
Kisii	Male	140	78.65	38	21.35	178	.472	.492
	Female	117	75.48	38	24.52	155		
Rachuonyo	Male	122	58.65	86	41.35	208	6.843	.009
	Female	119	71.69	47	28.31	166		
Kilifi	Male	62	83.78	12	16.22	74	2.427	.119
	Female	58	73.42	21	26.58	79		
Kwale	Male	44	73.33	16	26.67	60	1.711	.191
	Female	68	82.93	14	17.07	82		
Nandi	Male	128	70.33	54	29.67	182	19.758	.00
	Female	88	93.62	6	6.38	94		
Bomet	Male	59	68.60	27	31.40	86	1.215	.27
	Female	138	75.00	46	25.00	184		
Nyeri	Male	31	34.83	58	65.17	89	1.707	.191
	Female	37	44.58	46	55.42	83		

It can be noted from Table 5 that only three out of the nine districts gave statistically significant relationship between pupils' beliefs in cultural interpretations of heat with anger and gender. Secondly, the numbers of the respondents from the three districts are not high enough to be generalized to the populations in the districts from which the samples were drawn.

Discussion

Lewis (2003) argued that students rely on intuitive conceptions to explain events not specifically studied in class. Intuitive conceptions refer to ideas developed as the result of interacting with the natural world. He gave an example of pupils who explained that wool has the ability of being able to warm things up so that a cold object wrapped in wool would spontaneously become warmer. In our study, we realized that some of the pupils were using intuitive conceptions to explain why an angry person is hot. For example, some of them said that a hot tempered person can easily start a fight and that this is the anticipated behaviour of such a person. And some of the pupils said that an angry person sweats and this is caused by a rise in temperature.

Anamuah-Mensah (1998) explored the extent of native science beliefs among students in secondary schools and tertiary institutions. The study revealed that native science beliefs seem to be held firmly by quite a substantial proportion of students. Results from our study supported Anamuah-Mensah's findings. For example, in four out of the ten ethnic communities that were studied there was no significant relationship between pupils beliefs in cultural interpretations of heat associated with anger and level of education. This implies that education does not change pupils' beliefs in cultural interpretations. In six out of the ten ethnic communities there was a significant relationship between pupils' beliefs in cultural interpretations of heat associated with anger and level of education. However, the percentages of form three pupils that believed in cultural interpretations were above 50 percent in those ethnic communities. This implies that education reduces beliefs in cultural interpretations but does not eradicate them.

Ogunniyi (1984) observed that gender, tribe or level of education of the people does not have any significant influence on their world view. This is in agreement with our results with regard to the level of education, but not tribe. This is because in some of the ethnic communities we studied, there was a significant relationship between pupils' beliefs in cultural interpretations of heat associated with anger and level of education. Ogunniyi also suggested that the scientific and African world views are not necessarily mutually exclusive of each other, for example, it is possible to hold a scientific as well as a traditional view of the world, perhaps in the same way in certain scientists in the West hold the scientific and the Christian world view. This suggestion agrees with our findings. In our study we noted that some pupils held both scientific meanings of heat and the cultural interpretations, for example, heat is a transfer of energy from one point to another point as a result of temperature difference between the two points ; and that a hot tempered person has hot blood.

Conclusions

The first objective of the study was to find out if primary and secondary school pupils believe in cultural interpretations of the scientific phenomenon of heat associated with anger. Empirical data have shown that pupils believe in the cultural interpretations of scientific phenomenon of 'heat'. Objective two was to investigate the relationship between pupils' beliefs in cultural interpretations of the scientific phenomenon of 'heat' associated with anger and level of education. Empirical data have shown that there is a relationship between pupils' beliefs in cultural interpretations and level of education in some

communities but not in others. But even in those communities where there was a relationship between the two variables, the percentages of form three pupils who believed in the cultural interpretations were over fifty. This implies that education reduces pupils' beliefs in cultural interpretations but does not eradicate such beliefs. The third objective was to compare pupils' beliefs in cultural interpretations of the scientific phenomenon of 'heat' associated with anger from various ethnic communities. The results obtained indicate that some of the cultural beliefs are common among various ethnic communities whereas others are confined within specific communities. The fourth objective was to investigate the relationship between pupils' beliefs in cultural interpretations of the phenomenon of 'heat' associated with anger and gender. The results have shown a relationship between pupils' beliefs in cultural interpretations of 'heat' and gender in three ethnic communities only. More boys than girls believe in the cultural interpretations of physical phenomenon of 'heat' associated with anger.

Recommendations

(i) Cultural beliefs in interpretations of scientific phenomena should be considered when science curricula are being developed. Teachers should be made aware of such beliefs so that they may use them as advance organizers before introducing the topics whose conceptualizations are likely to be affected by the cultural interpretations.

(ii) There should be a two-pronged attack on reducing the influence of cultural beliefs in science learning. First, the pupils should be made aware of such beliefs and their limitations. Second, adult literacy curricular should incorporate cultural beliefs of scientific phenomena. This will make the public aware of the limitations of such beliefs.

(ii) The relationship between the level of education and pupils' beliefs in cultural interpretations of the scientific phenomenon of 'heat' associated anger implies that such beliefs could be reduced further if teachers emphasize their limitations during science lessons.

(iv) The fact that there is a relationship between pupils' beliefs in the cultural interpretations and gender implies that the topic of physical phenomenon of heat is not receiving equal attention in girls' school' as compared to the' boys' schools. Teachers should therefore provide equal learning opportunities to boys and girls when teaching all science topics.

Limitations

It should be noted that some of the cultural beliefs discussed in this paper were confined within specific communities whereas others were common among the ethnic communities. Therefore, the findings cannot be generalised to all Kenyan communities. The findings of this study are based on pupils' responses and have not been corroborated with responses from adults who are more conversant with cultural beliefs in the respective communities.

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