International Journal of Education and Practice
2014 Vol. 2, No. 3, pp. 51-66
ISSN(e): 2310-3868
ISSN(p): 2311-6897
DOI: 10.18488/journal.61/2014.2.3/61.3.51.66

GENDER AND LOCATION INFLUENCE ON GHANAIAN STUDENTS' PERCEPTIONS OF ENERGY AND CLASSROOM LEARNING

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ABSTRACT

This study used descriptive survey design to find out Senior High School students' perceptions of energy and examined influences of gender and geographical location on students' perceptions of energy. Data from 720 students in 18 Senior High Schools in Ghana was collected using a questionnaire comprising seven frameworks of energy. The collected data was analysed using frequency counts and percentages. Chi-square and multiple comparison tests were used to examine any significant differences of gender and geographical location on students' perceptions of energy. The result shows that Senior High School students in Ghana perceive energy as anthropocentric, depository, an ingredient, an activity, a product of processes, functional and flow. In general, no significant differences exist between female and male students' perceptions of energy except for energy as depository. No significant differences exist among urban, semi-urban and rural area students perceptions of energy as 'depository', ingredient, process and functional. However, students' perceptions of energy as anthropocentric, activity and flow of fluid differ significantly between urban and semi- urban as well as urban and rural. In the physics or science classroom, when teaching energy, a better strategy is to build on what students perceive of energy and try to help them modify their perceptions in the appropriate manner rather than simply contradicting their perceptions.

Keywords: Scientific literacy, Frameworks of energy, Energy as anthropocentric, Ingredient, Depository, Activity product and process, Gender influence, Geographical location.

Received: 13 January 2014/ **Revised:** 12 February 2014/ **Accepted:** 15 February 2014/ **Published:** 18 February 2014

1. INTRODUCTION

In today's world, humans are confronted daily with situations that require the useof scientific information to make informed choices and decisions at every moment of their lives.One of the current challenges facing humans around the world focuses on energy and its understanding (Boylan, 2008). In this modern life, humans require general scientific literacy. In this sense therefore, every Ghanaian citizen in the country needs training in science to be able to develop a scientific mind and a scientific culture so as to deal objectively with phenomena and other practical issues, prevent reliance on superstition for explaining the nature of things, and help to construct and build the present and the future on pragmatic scientific basis (Ministry of Education Youth and Sports (MOEYS), 2012). For Ghana to develop at a faster rate, it is imperative for students to be taught science process skills so that they can seek answers to problems that come their way through scientific investigations and experimentation. The integrated science syllabus is a conscious effort to raise the level of scientific literacy of all students and equip them with the relevant basic scientific knowledge needed for their own living and secondly, for making valuable contributions to production in the country. One of the central concepts in school science is *Energy* and is often perceived alternatively and scientifically by students as difficult. As a core concept, energy covers about 20% of the Ghanaian *Integrated Science syllabus*of the Senior High School (SHS) in Ghana (Ministry of Education Youth and Sports (MOEYS), 2012). Noticeably, energy both from the SHS Integrated Science syllabus and in the classroom is presented in the Physics perspective. In the syllabus for instance, emphasis of energy is placed on definitions, forms and mathematical formulation. There is little in the syllabus that is related to students' perceptions about energy. As such it is difficult for students to learn and apply energy in their everyday lives. However, when students come out from the classroom, they perceive energy differently from the scientific definitions they have learnt and also, most often, do not see any applications of the mathematical formulations in their daily lives. For example, in the students' everyday language, we hear of 'the country is having energy crises', 'the energy supplied by the motor'; 'I need some rest to gain lost energy', 'burning energy', 'used up energy', 'waste energy', and 'save energy'. Understanding how energy alternatives work is further complicated by the abstract nature of energy itself, as well as the everyday use of the term (Kishore and Kisiel, 2013). Although energy is a fundamental concept of science, creating a pathway towards its proper instruction seem to remain inappreciably low. Due to the fact that students already have some ideas about how the natural world works, high school science teachers, as Kishore and Kisiel (2013) put it, often face a daunting question such as "What do students know and how can teachers use that information to support instruction?" (p.522). What teachers should strive for is that public understanding of energy should not be multifaceted and operationalized in several ways as found by Southwell *et al.* (2012) in their study, but that the perceived public understanding of energy be equivalent to actual understanding in most cases.

1.1. The Research Problem

In Ghana, students learn energy in science with little consideration to their perceptions. The SHS teaching syllabus which serves as a guide in the learning of energy does not show any reflection on students' perceptions of energy. Energy in the syllabus is presented basically in simple definitions and mathematical formulations. Equally, the most common textbooks used in the SHS schools in the learning of energy present energy in mathematical formulations with little considerations on the students' perceptions of energy. More profoundly, the current mode of teaching energy in science where the focus is basically on mathematical formulations and definitions does not promote meaningful learning. As a result students find energy in school science abstract and cannot apply it to their daily lives. The main focus is how instruction in energy can reflect the students' perceptions of energy which can be helpful in developing accurate and applicable energy perceptions. The focus is not to replace students' perceptions with more sophisticated ones, rather, it is to fit them into a broad consistent framework in which the most explanatory and general perceptions are given a high cuing preference in appropriate contexts and be able to relate their scientific ideas to make sense of experiences and observations and to explain new situations.

1.2. Research Questions Guiding the Study

Two research questions were posited to guide the study:

1. What is the extent to which gender influence students' perceptions of energy?
2. What is the extent to which geographical location influence students' perceptions of energy?

1.3. Research Hypotheses

Two null hypotheses were formulated in line with the research questions. These are:

1. H_{01}: There is no statistical significant difference between male and female students' perception about energy.
2. H_{02}: There is no statistical significant difference between urban, semi-urban and rural students' perception about energy.

2. STUDENTS' PERCEPTIONS OF ENERGY AND CLASSROOM LEARNING

The aim of successful science teaching is to support the student to build an understanding that is in general, consistent with conventional scientific theory (Chambers and Andre, 1997). One distinct major cause for unproductive communication in science classrooms is the difference involving the teacher's use of scientific meanings for words and the students' everyday language understanding of those words. Regularly, such students' everyday language perception is often called misconceptions (Nicoll, 2001). Many researchers do not support the expression misconception, since it implies some kind of wrong perceptive with students, although their ideas may possibly be totally consistent with their experiences. Consequently, some researchers use terms such as alternative frameworks/conceptions,preconceptions, and children's science when recounting students' ideas with reference to science concepts that are not congruent with conventional scientific perceptive (Confrey, 1990). If these terms are studied for similarities, they have more or less the similar connotation. Nevertheless, using a variety of expressions results from distinctiveness of students' ideas (Calık and Ayas, 2005). Students relate with and learn about their environment from birth. They build up ideas, concepts and theories to appreciate occurrences in their environment by instinct. Such concepts are more often than not different from the conventional scientific concept for the same occurrences, but demonstrate good sense and makes sense to the student. These are typically powerfully embraced by the student from infancy to maturity, a reality many instructors are unaware of(Clemison, 1990). Such alternative ideas have the tendency to have unhelpful control on classroom learning.

The function of alternative ideas in learning science has been comprehensively studied. The study of students' ideas has covered a varied series of learners' ages commencing at two year olds (Ault *et al.*, 1988) and four year olds (Gelman, 1988) all the way through to college undergraduates (Barak *et al.*, 1997; Lavoie, 1997) and newly graduated students and experienced teachers (Pedro, 2000). Other results by means of pre- and post-test studies reveal students' concepts can be changed (Osborne, Black, Meadows and Smith, 1993; Grayson, 1994). More so, research has established that students will yet concomitantly hold a number of diverse perceptions related to different concepts (Gunstone, 1994a). Chambers and Andre (1997) have noted that a number of students' perceptions are extremely opposed to modification. Some students continue to give answers consistent with their unconventional scientific ideas still after several instructions. Whereas a number of students' perceptions might better be conceptualized as straightforward misunderstanding or misinformation and therefore easily changed with instructions, others appear extra persistent. More frequently, students relinquish the effort to comprehend science content. The new information time and again seems to oppose their understanding and does not fit their pattern of belief. As a result, students think that science does not make sense to them and therefore resort to memorization to deal with the requirement of science lessons (Anderson and Helms, 2001; Hart, 2002).

3.METHODOLOGY

3.1. Research Design

The research design used in this study is descriptive survey. This is because it is efficient and accurate means of determining relatively inexpensive, quicker andreliable information about a given population. Again, findings related to perception are noted to be reliable if data are drawn from wider and representative sample which is a typical characteristic of survey design.

3.2. Population

The population of the study is all students enrolled at the Senior High Schools in the ten regions of Ghana. In order to collect reliable data from students who have a well-formed concept about energy, second year students were targeted by the researcher as appropriate for the study. Third year students were not selected because they had written their final West African Senior Secondary Certificate Examination (WASSCE) and were not available in schools at the time of this study. The students (both males and females) who are located in schools with rural, semi-urban and urban settlements either studied science programmes, that is, Science, Home Economics, Agriculture and Technical or non-science programmes (Arts and Business). The target population therefore included two factor levels, i.e. geographical location and gender of the students. In all, 720 students constituting 240 students each from urban,240 students from semi-urban and 240 students from rural area in SHS2 were used for the study.

3.3. Sample and the produre used in the sampling process

Lottery method was used to select three regions out of the ten regions in Ghana for the study. The regions were labeled on pieces of paper, folded and drawn out at random. Western, BrongAhafo and Ashanti were selected for the study. The choice of location of schools was done based on settlements considered urban, semi-urban and rural. Six (6) schools each from the three geographical locations making up a total of eighteen (18) schools, were selected. To reflect the three types of settlements, that is, urban, semi-urban and rural, two schools each from the three regions were purposively chosen to form the population for the study. All the schools selected were made up of male and female students; hence no single sex school was used in the study. In the schools, stratified random sampling was used to select students from SHS 2 which was considered most appropriate category that possessed well-formed perception of energy. This sampling procedure was used to ensure there was increase chance of representativeness of gender since the sample were not of the same size (Fraenkel and Wallen, 2003). Forty (40) students from each school were selected from each of the four programmes namely science, arts, business and home economics/technical to include perception by programmes.

3.4. Research Instrument

Questionnaire was used to survey students' perception of energy in line with sevenframeworks. It was adopted from Trumper and Gorsky's (1993) and Watts' (1983) distinct conceptual framework of energy and modified to determine the students' perception of energy in the Ghanaian setting. It was made up of two main sections; Section A which focused on the biographic data of the respondents that included class and sex, and Section B which was made up 21 items. Three of the 21 items were framed to illustrate instances of each of the seven frameworks of energy perception by Watts. Watts' (1983) seven frameworks, which were later substantiated by Gilbert and Pope (1986) and Trumper (1990b) are consistent with Trumper and Gorsky's (1993) nine distinct conceptual frameworks for energy. These are:

1. *Anthropocentric* - which finds out how a student perceive energy to be associated with human beings;
2. *Depository* – which finds out how the student perceives that some objects have energy and some, needs it;
3. *Ingredient* - whether the student can perceive energy as being dominant within some objects and can be activated and released.
4. *Activity* -this deal with energy being identified by overt displays, and the display itself is actually called energy;
5. *Product* - whether the student does perceive energy as a by-product of some situation and is relatively short lived.
6. *Functional* - whether the student thinks about energy as a general kind of fuel;

7. *Flow transfer* – energy is some sort of physical fluid that is transferred in certain processes.

The items described each of these seven frameworks and took into consideration the common use of energy in everyday life in Ghana.

3.5. Collection of data

A total of six weeks was used to collect data from the three regions. In each school, a teacher was assigned by the head or assistant headmaster to assist in identifying the required male and female proportions and select 10 students each from the four programmes needed for the questionnaire administration. The selected students were often conveyed to one classroom and briefed on the purpose of the study. Each student was told to opt out if s/he did not want to be involved in answering the questionnaire. In all the schools visited, the selected students were excited about the conception of energy in its daily use and participated keenly. They were given the opportunity to ask questions to clarify issues that were not clear to them. A maximum of 20 minutes was used by students to answer the items in the questionnaire in all the 18 schools visited.

3.6. Determination of the reliability and validity of the questionnaire

A pilot test was carried out on forty SHS 2 students in one school in the Central Region. The sample was made up of twenty students offering Home Economics, ten students offering Business and ten students offering Art programmes. The items were rearranged in such a way that items under each framework were placed to follow other frameworks. This was done to ensure discrimination of responses from students. To address the reliability of the questionnaire, data from the pilot test were fed into SPSS computer software and reliability coefficients computed. The reliability coefficients ranging from 0.728 to 0.770, at 0.05 level of significance, were found for the 21 items addressing students' perception of energy indicating that the items had internal consistency. This was done to test internal consistency of the questionnaire.

3.7. Analysis of data

The questionnaire items were arranged serially. Under each item, code numbers were assigned to the Likert scale as follows: no perception (0), little perception (1), some perception (2) and large perception (3). Based on these codes, data were then fed into SPSS for processing into tables of frequencies and percentages. This was done to ensure clear description of gender location and perception of the students by frequency and percentages. In order to address the two hypotheses stated in the study, values of Chi square were processed using SPSS to determine any statistical differences of perception in relation to gender and location of the students. The differences were computed in relation to the seven frameworks.

4. PRESENTATION AND DISCUSSION OF RESULTS

4.1. Students' biographic data

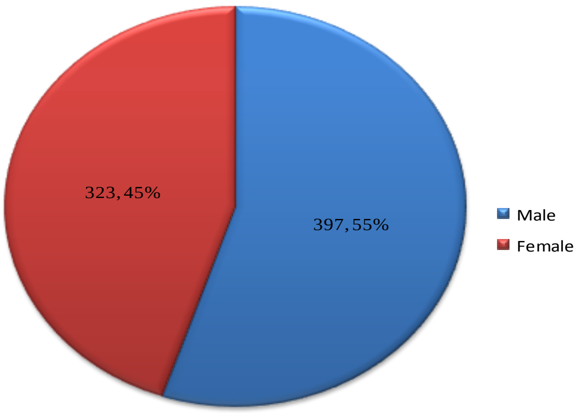

Figure 1: Frequencies and percentages of students by gender

Figure 1 shows the distribution of students whose perceptions of energy were sought for in the study. The result illustrates that there were more male students (55 %) than female students (45%).

4.2. Students' geographical location

Table 1 presents the frequency and corresponding percentage of students by geographical location of school.

Table-1. Frequencies and corresponding percentages of students: geographical location

Location of School	Frequency	%
Urban	240	33.3
Semi-Urban	240	33.3
Rural	240	33.3
Total	720	100.0

Table 1 illustrates the geographical locations of selected schools used in the study. The equal numbers (33.3%) depict a fair representation of location of schools of students in the Ghanaian second cycle schools.

4.3. Descriptive analysis of the results

4.3.1. Extent of Influence of Gender on Students' Perception of Energy

Research question 1 was to find out the extent to which gender of students influence their perceptions of energy. Table 2 shows frequencies and percentages of male and female students' perceptions categorized under the seven frameworks.

Table-2. Students' perception of energy according to gender

Gender of students	Extent of perception as measured by the seven frameworks				Total
	No perception	Little perception	Some perception	Large perception	
	Anthropocentric				
Male	4(1.01%)	39(9.82%)	139(35.01%)	215(54.16%)	397(100.0%)
Female	2 (0.62%)	20(6.21%)	109(33.86%)	191(59.32%)	322(100.0%)
	Possess and expend				
Male	0(0.0%)	4(1.01%)	42(10.61%)	350 (88.38%)	396(100.0%)
Female	1(0.31%)	6(1.86%)	56(17.34%)	260(80.50%)	323(100.0%)
	Ingredient				
Male	1(.25%)	2 (0.51%)	53 (13.38%)	340 (85.86%)	396 (100.0%)
Female	0 (0.0%)	5 (1.55%)	43 (13.31%)	275 (85.14%)	323 (100.0%)
Male	**Activity**				
Female	0 (0.0%)	6(1.51%)	65(16.37%)	326(82.12%)	397(100.0%)
	0 (0.0%)	5(1.56%)	68(21.18%)	248(77.26%)	321(100.0%)
	Process/Product				
Male	8(2.02%)	57(14.36%)	162(40.81%)	170(42.82%)	397(100.0%)
Female	5(1.56%)	54(16.88%)	133(41.56%)	128(40.00%)	320(100.0%)
	Fuel				
Male	0 (0.0%)	8(2.02%)	50(12.63%)	338(85.35%)	396(100.0%)
Female	0 (0.0%)	3(0.93%)	49(15.26%)	269(83.80%)	321(100.0%)
	Flow				
Male	0(0.0%)	6(1.51%)	79(19.90%)	312 (78.59%)	397(100.0%)
Female	3(0.93%)	8(2.49%)	61(19.00%)	249(77.57%)	321(100.0%)

The results in Table 2 show the extent to which gender has influence on the seven frameworks (perception of energy). Higher percentage (59.32%) of female students showed a larger perception of the anthropocentric framework than male students. With the exception of the anthropocentric framework, a higher percentage of the male students indicated a larger perception of the other six frameworks. Regarding possess and expend framework, the male students' percentage (88.38%) was higher compared to (80.50%) percentage of the female students having a large perception. On energy as an ingredient, the percentage (85.14%) of female students and male students (85.86%) indicating large perception is almost equal. With respect to the perception that energy is associated with activity, the percentage (82.12%) of the male students is seen to be higher than the percentage (77.26%) of the female students. Also, on energy as a process framework, the female students' percentage (40.00%) on a larger perception appeared lower than that of the male students' percentage (42.82%). Regarding energy as a fuel and energy as a flow, female students' percentages (83.80% and 77.57%) are only slightly lower than the male students' percentages, that is, 85.35% and 78.59% respectively.

From the results, it is clear that perception of energy in the seven frameworks is influenced by gender to a large extent. However, this result seem not to provide statistical prove about significant differences between male and female students' perception of energy frameworks. Further analysis of significant gender differences in perceptions of energy is addressed by hypothesis 1.

4.3.2. Extent of Influence of Geographical Location of Schools of Students on their Perceptions of Energy

Research question 2 sought to find out the extent geographical location influences student perception of energy. Table 3 shows frequencies and percentages of students' perception of energy categorised into urban, semi-urban and rural.

Table 3. Students' perception of energy according to geographical location

Geographical Location	Extent of perception as measured by the seven frameworks				
	No perception	Little perception	Some perception	Large perception	Total
	Anthropocentric				
Urban	6(2.51%)	26(10.88%)	86(35.98%)	121(50.63%)	239(100.0%)
Semi-urban	0(0.0%)	16(6.67%)	86(35.83%)	138(57.50%)	240(100.0%)
Rural	0(0.0%)	17(7.08%)	76(31.67%)	147(61.25%)	240(100.0%)
	Possess and Expend				
Urban	0(0.0%)	5(2.09%)	26(10.88%)	208(87.03%)	239(100.0%)
Semi-urban	0(0.0%)	4(1.67%)	34(14.17%)	202(84.17%)	240(100.0%)
Rural	1(0.42%)	1(0.42%)	38(15.83%)	200(83.33%)	240(100.0%)
	Ingredient				
Urban	0(0.0%)	2(0.83%)	26(10.83%)	212(88.33%)	240(100.0%)
Semi-urban	0(0.0%)	2(.84%)	35(14.64%)	202(84.52%)	239(100.0%)
Rural	1(0.42%)	3(1.25%)	35(14.58%	201(83.75%)	240(100.0%)
	Activity				
Urban	0(0.0%)	2(0.84%)	38(15.83%)	200(83.33%)	240(100.0%)
Semi-urban	0(0.0%)	1(0.42%)	45(18.91%)	192(80.67%)	238(100.0%)
Rural	0(0.0%)	8(3.33%)	50(20.83%)	182(75.83%)	240(100.0%)
	Process/Product				
Urban	5(2.09%)	29(12.13%)	98(41.00%)	107(44.77%)	239(100.0%)
Semi-urban	7(2.94%)	43(18.07%)	95(39.92%)	93(39.08%)	238(100.0%)
Rural	1(0.42%)	39(16.25%)	102(42.50%)	98(40.83%)	240(100.0%)
	Fuel				
Urban	0(0.0)	5(2.08%)	31(12.92%)	204(85.00%)	240(100.0%)
Semi-urban	0(0.0)	2(0.84%)	39(16.32%)	198(82.85%)	239(100.0%)
Rural	0(0.0)	4(1.68%)	29(12.19%)	205(86.13%)	238(100.0%)
	Flow				
Urban	1(.42%)	9(3.75%)	54(22.50%)	176(73.33%)	240(100.0%)
Semi-urban	2(0.84%)	5(2.10%)	44(18.49%)	187(78.57%)	238(100.0%)
Rural	0(0.0%)	0(0.0%)	42(17.50%)	198(82.50%)	240(100.0%)

From the analysis in Table 3, a high percentage of students in rural location (61.25%) largely perceive energy as *anthropocentric* (human centered). Both students at the semi-urban and rural location indicated a large perception (84.17% and 83.33%) of energy regarding possessing and expending energy framework but a higher percentage (87.03%) of the students in the urban settlement largely hold this perception. Again, more students in the urban location (88.33%) than those in semi-urban and rural location (84.52%and 83.75% respectively) perceive energy as an ingredient. More students in urban location (83.33%) largely perceive energy as an activity. Also higher percentage (44.77%) of students in urban location have a large perception that energy is a process than about an equal percentage of those in semi-urban and rural location (39.08% and 40.83%). However, about an equal percentage of urban and rural settlement students (85.00% and 86.13%) have large perception of energy as fuel than a lower percentage (82.85%) of those in the semi urban settlements. A higher percentage (82.50%) of students in rural location has the larger perception that energy flows compared to 73.33% of urban students and 78.57% of students located in semi-urban settlements. From the results, it is realized that students from rural schools largely perceive energy as a human centered, as a fuel and as a flow while students in the urban schools largely perceive energy as an ingredient, an activity, possess and expend and as a product of processes. However, what remains unclear is whether there exist any significant differences in the perceptions of students based on these geographical locations.

4.4. Testing of hypotheses

These hypotheses were formulated to test whether there are any statistically significant differences between students' perception in relation to their gender, geographical location and the programme they offer.

4.4.1. Difference between Male and Female Students Perceptions of Energy

Hypothesis 1 sought to test whether there is any significant difference between the male and female students' perception of energy. Chi-square was used in testing this hypothesis at the $\alpha = 0.05$ level of significance. Table 5 below presents χ^2 values with corresponding significant values of the frameworks.

Table-5. Chi-square values of gender of students and their perception of energy

Framework	Chi-square Value	df	Asymp. Sig. (2-sided)
Anthropocentric	4.05	3	0.256
Possess and expend	9.36	3	0.025*
Ingredient	2.82	3	0.421
Activity	2.74	2	0.254
Process	1.29	3	0.732
Fuel	2.31	2	0.316
Flow	4.68	3	0.197

* The significance was tested at α= 0 .05 level.

From the Table 5, except for possess and expend (i.e. $\chi^2=9.36$, $\alpha = 0.05 < .025$), all other chi-square values were not significant at 0.05 level of significance. The research hypothesis is thus rejected, meaning that there is no statistical significant difference between male and female students' perceptions of energy in all the seven frameworks except possess and expend (0.025). This therefore means that male and female students do not differ significantly in their perceptions of energy. The difference only exists in their perception of energy as a depository model by Watts (1983).

4.4.2. Differences in Geographical Location and Students' Perception of Energy

Hypothesis 2 was formulated to determine whether there exists any statistically significant difference among urban, semi-urban and rural area students' perception of energy. Chi-square was used to test this hypothesis at the α= 0.05 level of significance.

Table-6. Chi-square values of students' perception of energy according to their geographical location.

Framework	Pearson Chi-Square Value	df	Asymp. Sig. (2-sided)
Anthropocentric	18.49	6	0.005*
Possess and expend	7.06	6	0.316
Ingredient	4.33	6	0.632
Activity	10.28	4	0.036*
Process	8.38	6	0.212
Fuel	3.10	4	0.541
Flow	13.74	6	0.033*

* The significance was tested at α= 0 .05 level.

From Table 6, the computed values for possess and expend (0.316), ingredient (0.632), process (0.212) and fuel (0.541) frameworks are greater than α= 0.05. Thus, the result indicates that there is no statistically significant difference among urban, semi-urban and rural students' perceptions of energy with respect to possess and expend, ingredient, process and fuel. What this means is that students in urban, semi-urban and rural locations do not differ significantly in their perception of energy as far as being possessed and used up, an ingredient, a process and a fuel is concerned. However, statistical significant differences in students' perception of energy among urban, semi-urban and rural locations in terms of anthropocentric (.005< α = 0.05), activity (.036< α = 0.05) and flow (.033< α = 0.05) frameworks existed. The differences were not however high at the α = 0.05 level of significance. Since the locations were three, the test did show which locations the differences resulted from. A multiple comparison test was therefore carried out using the Turkey Post Hoc analysis. Table 7 shows the multiple comparison of urban, semi-urban and rural based on anthropocentric, activity and flow frameworks at the α = 0.05 level of significance. With anthropocentric framework of energy, the result shows that highly significant differences were between urban and semi-urban (.025) as well as urban and rural (.005). It also revealed that the highly significant difference found in the chi-square test came from semi-urban and urban in terms of activity framework. On the flow framework, the differences came from semi-urban and urban as well as urban and rural. It is therefore clear that rural and semi-urban settlements did not contribute to any significant differences in the three frameworks.

Table-7. Multiple Comparisons of differences among geographical locations

Dependent Variable	(I) geography location	(J) geography location	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
Anthropocentric	Urban	semi-urban	-.161(*)	.062	.025	-.31	-.02
		Rural	-.194(*)	.062	.005	-.34	-.05
	semi-urban	Urban	.161(*)	.062	.025	.02	.31
		Rural	-.033	.062	.852	-.18	.11
	Rural	Urban	.194(*)	.062	.005	.05	.34
		semi-urban	.033	.062	.852	-.11	.18
Activity	Urban	semi-urban	.022	.041	.846	-.07	.12
		Rural	.100(*)	.041	.038	.00	.20
	semi-urban	Urban	-.022	.041	.846	-.12	.07
		Rural	.078	.041	.139	-.02	.17
	Rural	Urban	-.100(*)	.041	.038	-.20	.00
		semi-urban	-.078	.041	.139	-.17	.02
Flow	Urban	semi-urban	-.060	.046	.381	-.17	.05
		Rural	-.138(*)	.045	.007	-.24	-.03
	semi-urban	Urban	.060	.046	.381	-.05	.17
		Rural	-.077	.046	.208	-.18	.03
	Rural	Urban	.138(*)	.045	.007	.03	.24
		semi-urban	.077	.046	.208	-.03	.18

* Mean difference is significant at the $\alpha = 0.05$ level of significance.

5. CONCLUSION

In this study, the major findings include:

- Male and female students' perceptions were found to be different with respect to the depository and activity framework. Gender appears to have little influence on the students' perceptions of energy.
- Students from urban, semi urban and rural area perceptions of energy were found to be different with respect to the anthropocentric, activity and flow-model frameworks. Geographically, location appears to influence their perceptions to some extent.
- Male students hold a large perception of the framework that energy is both depository and as an activity whiles female students largely perceive energy as 'human centered' than their male counterparts. However, both categories of students appear to have the same degree of perceptions of energy as an ingredient, a process, a fuel and a flow.
- More students in the urban location largely perceive energy as depository, ingredient, activity and process/product. Most students in rural settings mainly perceive energy as anthropocentric and flow. Both urban and rural students perceive energy as a flow to the same extent.

The *hypotheses* however revealed that *no significant difference exist*:

- between female and male students' perception of energy with the exception of the perception that energy is possessed and used up.
- among urban, semi-urban and rural students' perceptions of energy as 'depository', 'ingredient', 'process' and 'fuel'. However, students' perceptions of energy as

anthropocentric, activity and flow depend on where they are, that is, their geographical location.

6. IMPLICATIONS FOR CLASSROOM PRACTICE WITH REGARD TO THE TEACHING AND LEARNING OF ENERGY

The underlying message from this research suggests that classroom teachers draw attention to how important it is for them to establish what students do know, do not know, and partially know about science concepts as the first step in quality teaching practices. Teachers should therefore design their teaching and learning lessons in ways that build from what the students know and provide opportunities to engage in experiential learning practices that will lead to students developing new and deeper understandings of science concepts. It is also very important that teachers should be aware of the ways their students talk and think about energy so that they may incorporate them when designing their lessons. Hence, in the teaching of energy, rather than simply contradicting students' perceptions, a better strategy is to build on what the students perceive and try to help them modify their perceptions in the appropriate manner.

Funding: This study received no specific financial support.

Competing Interests: The author declares that there are no conflicts of interests regarding the publication of this paper.

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Appendix - Students' Questionnaire on Perceptions of Energy

Questionnaire for Integrated Science Students

This questionnaire is part of a study on "**Gender and location influence on Ghanaian students' perceptions of energy and classroom learning**". The information you provide will help to determine Ghanaian students' perception of energy. The information will be used for the purpose of this study. I would be grateful if you could respond to the items as appropriately as possible. Your anonymity is assured. Thank you for your co-operation.

A. Biographic Data

(Please tick in the appropriate box [ ])

Gender: Male [ ] Female [ ]

Class (Tick as appropriate): Science [ ] Art [ ] Business [ ] Home Economics [ ]

B. Energy concept:

	Perceptions	True	Partly True	Not True
1.	A box has no energy because a person pushing it upwards is doing all the work. If the box has energy, it can help the person to push it upward.	[ ]	[ ]	[ ]
2.	You have to have energy and store it and then use it up. You get energy from oil, petrol and the sun or anything that possesses energy.	[ ]	[ ]	[ ]
3.	Food has energy in it. When we eat food energy is released to the body.	[ ]	[ ]	[ ]
4.	After a hard days work, one needs to sleep/rest to gain energy.	[ ]	[ ]	[ ]
5.	When wood burns, it releases energy.	[ ]	[ ]	[ ]
6.	Energy is what makes something work. Electricity would make a tape recorder work, so energy is fuel.	[ ]	[ ]	[ ]
7.	In the body, blood flows and carries energy to all part of the body.	[ ]	[ ]	[ ]
8.	Two reacting chemicals have energy in them. Although they don't talk to things, they' have got energy in them like humans do. However, in their own way they are living.	[ ]	[ ]	[ ]
9.	If we don't have water, we can't survive. If we drink water, we get energy. Water also has got something to do with power station like Akosombo dam, it gives electrical energy. Therefore, water is a source of energy.	[ ]	[ ]	[ ]
10.	Energy is not stored in charcoal but when it is burnt, it produces energy for cooking.	[ ]	[ ]	[ ]
11.	A boy running fast is displaying energy.	[ ]	[ ]	[ ]
12.	When ice melts it will give off heat. So it produces heat energy.	[ ]	[ ]	[ ]
13.	Energy is provided to our bodies from its chemical reaction with the oxygen we breathe.	[ ]	[ ]	[ ]
14.	In electricity, energy flows into television to make it work.	[ ]	[ ]	[ ]
15.	A student has a lot of energy because he/she can push a desk from the right to the left end of the classroom. Once the desk is there it cannot do anything so the desk definitely has not got energy. Meanwhile, the student can walk away back to the right end of the classroom. So energy is associated with people.	[ ]	[ ]	[ ]
16.	A battery has got energy, the bulb needs it to give light and the wires carry the energy to the bulb. That is things possess and expend energy.	[ ]	[ ]	[ ]
17.	There is energy in things. It is there but it needs another form of energy to make it come out. Like a seed, it has energy inside it to grow but it needs the sunlight.	[ ]	[ ]	[ ]
18.	The hammer is creating energy by hitting fast on the nail. That is energy is associated with activity.	[ ]	[ ]	[ ]
19.	In a chemical change, some energy is released to produce heat. This means energy is created by certain processes.	[ ]	[ ]	[ ]
20.	Energy is something that can make things work. For instance, petrol would make a vehicle to move.	[ ]	[ ]	[ ]
21.	In a circuit, energy comes out from the negative end, flows round the circuit, encountering the light bulb on the way, where it can transfer some of the energy, and it goes back to the battery. Thus, energy is some kind of fluid which is transferred during process.	[ ]	[ ]	[ ]