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Students' Conception on Heat and Temperature: A Study on Two Senior High Schools in the Central Region of Ghana

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Abstract:
This study investigated the conceptions of students on heat and temperature. The target population was all Senior High School (SHS) students in the Central Region and the accessible population were SHS students in the Efutu Municipality and Agona District in the region. A descriptive survey was employed. The sample for the study was second year students' from Winneba Senior High and Swedru Senior High schools. A simple random technique was used to select two hundred (200) students. Questionnaire was the main instrument used to collect data for the study. The results indicated that most students have the right conception about heat. Students' conceptions of temperature is only partially correct since few of the students gave a positive response that, a solid ball and a hollow ball made of the same material and temperature is increased by the same amount, and the two balls will have the same energy. More males have a right conception of heat and temperature than the females. More science students have the right conceptions of heat and temperature than the non-science students. Most of the non-science students do not have a right conception about heat and temperature. The study recommended that programmes should be organized to assess the teachers' needs since they may have different understanding of some concepts which can influence their instructional strategies.

1. Introduction

Heat and temperature are some of the scientific concepts in school science that are often perceived interchangeably in their meanings by students. A good knowledge of the concepts, heat and temperature and applications of these concepts becomes even crucial since they cover a large portion of Integrated Science syllabus in Senior High School (SHS) in Ghana (Ministry of Education, Science & Sports [MOESS], 2007).

As already mentioned, the summary of the chief examiner's Reports on the West African Senior Secondary Certificate of examination/Senior Secondary School Certificate of Examination (WASSCE/SSSCE) on Integrated Science identified the candidates' major weakness as the lack of knowledge of the basic principles of heat and temperature (WAEC, 2005). The questions this situation raises are: Are students lacking knowledge and understanding? Do students in the Senior High Schools in the central region have the same conceptions as students from other countries? If their conceptions are different what accounts for that difference? Can the students explain the concepts? If not, what are the reasons?

In this study, there will be a careful examination of some of the conceptions that students at the Senior High School level may have about heat and temperature, which might not help them to understand the basic concepts as they progress to the tertiary institutions of education. A descriptive survey research design was employed in this study in order to determine the students' conceptions of heat and temperature. These points out views in order to describe analyze and interpret. This method describes and interprets what exists in its present form or condition; practice and process, trend, affect and attitude. It deals with the normal or typical condition of a phenomenon under examination. In other words, the method investigates existing conditions or relationships; prevailing viewpoints, attitudes, on-going processes and developing tends. The instrument that will be used will be questionnaire, and frequency and percentage will be used for the analysis.

1.1. Statement of the Problem

The identified problem came out through a tutorial that the researchers were having with the students on "heat of neutralization". Most of these students could not answer some basic questions on heat and temperature and again the observation made reveals that students do not have adequate knowledge in distinguishing between the concept "heat and Temperature". It was based on these that the researchers took it upon themselves to find out the possible cause of the problem of some Senior High School students in the Efutu Municipality and Agona district and suggest measures to improve their performance.

1.2. Significance of the Study
The following are some of the benefits that the findings will bring:
- The finding in this study is likely to provide insight into students' conceptions of heat and temperature.
- The study may be useful in teaching and learning of heat and temperature as instructors will be exposed to misconceptions students hold on the concept of heat and temperature.
- Again, the study will aid book writers to know what exactly they need to write on and identify the problems associated with lack of understanding of the pre-requisite concepts such as heat and temperature.

1.3. The Objectives of the Study
1. To find out students' conceptual understanding of heat and temperature.
2. To determine conceptions science students have of heat and temperature differ from those of non-science students.
3. To determine whether or not the conceptions male students have of heat and temperature differ from those that female students have.

1.4. Research Questions
The following research questions were raised to guide the study:
1. What conceptions do students have of heat and temperature?
2. What differences do science and non-science students have on the concepts of heat and temperature?
3. What differences do male and female students have on the concepts of heat and temperature?

1.5. Delimitation of the Study
The need of the study is to minimize the misconceptions which students hold of heat and temperature**.** Two schools werechosen because the environments of these schools were familiar to the researchers. This will also enhance cooperation to get access to the needed information. To obtain a credible data in this era of financial constraints in preparing questionnaires, the researchers brought all second year students and randomly selected from the group for questionnaires to be administered.

2. Review of Related Literature
Over several decades science educators such as Confrey (1990), and Duit and Treagust (1998) have studied students' conceptions, often termed alternative conceptions. Findings from both studies indicated that most often these alternative conceptions are non-congruent with accepted scientific understanding. One of the critical requirements is that teachers should be able to gauge reliably what conceptions their students have on concepts and principle so that students will build up their conceptions as they move from the lower levels to the higher levels.
The summary of WASSCE/SSSCE Chief Examiners' Reports on Integrated Science also identified the candidates' major weakness as the lack of knowledge of the basic principles of heat and temperature (WAEC, 2005) and suggested ways teachers must employ to improve on the understanding of these concepts. Choksin, Ratchapak and Chernchok (2010) in their case study on science students' conceptions ofheat and temperature in Thaiposed the question below to a sample of students. The question was:
"A piece of metal rod and a piece of wood are kept inside a room for a long time. Which of the object feels colder when touched?"
Most students responded that the metal rod was colder than the wood, but could not give any satisfactory explanation.
Physics is a conceptual subject. Knowledge of subject matter includes a lot of more understanding than just facts, terms and general concepts. It includes knowledge about organizing ideas, connections among ideas, ways of thinking and arguing, patterns of change within a discipline, beliefs about the discipline and the ability to carry ideas from one discipline to the other (Amoani, 2005: Anderson, 2006).
Many researchers are interested in studying students' conceptions about heat and temperature. At the basic level, the obvious problem is that students are unable to distinguish clearly between the concepts of heat and temperature (Carlton, 2000; Yeo &Zadnik, 2001). Most students are unable to offer correct reason for their answer.
According to Fisher and Wandersee (2001), research on students' conceptions has proliferated in the last twenty years and enhanced our understanding about the preconceptions, misconceptions or alternative conceptions that students bring with them to the classroom. By now, it is well accepted that alternative conceptions or misconceptions are common among students and that these interfere with subsequent learning and are resistant to change. Overcoming misconceptions is crucial to students learning. When misconceptions are changed directly and students are provided with opportunities to re-construct their world-view, the proportion of students that are able to use science conceptions to explain phenomenon increases significantly.

2.1. Students' Alternative Conceptions of Heat and Temperature
The processes by which "misconception" arise from a combination of prior knowledge and instructed subject matter are not unique to Newtonian mechanics. Also, children have concepts that differ from what scientists believe in when it comes to heat and temperature (Lewis, 1991). Concepts related to heat and temperatures are directly related to the physical environment of living organisms. Hence,

heat and temperature are not directly observable quantities. Concepts developed by students originated from the interpretation of ideas and experiences (Leura, Otto &Zitzewitt, 2005). In addition, culture and language are the effectual factors for developing concepts related to heat and temperature (Lubben, Nethisaulu&Campell, 1999). On the other hand, textbooks may contribute and/or strengthen students' alternative conceptions in heat and temperature (Leite, 1999).

Alternative conceptions in thermodynamics usually arise from substance-based conceptions (Harrison, Grayson &Treagust, 1999). For example students thought that heat is a substance, something like air or stream which could be added or removed from an object, very similar to the caloric theory of heat held by scientist in the 8th century. Students may answer questions in a test correctly in formal settings but these students usually fall back to their alternative conceptions while applying to everyday situations (Kolari&Savander-Ranne, 2000).

2.2. Changing Students Alternative Concepts in Heat and Temperature

Some studies basically use constructivist and/or conceptual change teaching strategies to promote conceptual understanding. Most of them used cognitive/conceptual conflict as a key concept (Leura, Otto&Zezewitz, 2005; Thomaz,Malaquias, Valente &Antunes, 1995). Stavy and Berkovitz(1980) used cognitive conflict in developing a teaching strategy which is aimed at advancing children's understanding of the concept of temperature. Their findings indicated that training by conflict did improve children's understanding of the concept of temperature both in individual and in classroom training situations.

Another inquiry-based teaching method was used by Jabot and Kautz (2003), who showed the impacts of teaching and preparation of physics teacher in the case of thermodynamics. Their results suggested that guided-inquiry group had greater learning gains. Clark and Jorde (2004) analyzed the effect of an integrated sensory model within thermal equilibrium visualizations. They found that students in the experimental tactile group significantly outperformed their control group counterparts on post-tests and delayed post-tests. Leura, Otto and Zezewitz (2005) developed pedagogy, called misconception-guided instruction, based on conceptual change theory. Their results suggest that misconception-guided instruction promotes students' understanding of heat and temperature concepts.

Consequently, it can be said that instruction aimed to change students' alternative conceptions in heat and temperature is somewhat effective.

2.3. Teaching and Learning in the Science Classroom

According to Schwab (1964), science had been taught as rhetoric of conclusion, a presentation of facts already known, so students often fail to integrate the content of one science with another. Simply telling students what scientists have discovered, for example, is not sufficient to support changes in their preconceptions about important scientific phenomenon. Similarly, asking students to follow the steps of the scientific method is not scientific to help them develop the knowledge, skills, and attitudes that will enable them to understand what it means to do science and participate in the larger scientific community (Donovan & Branford, 1999).

Learning science is a dynamic process of shaping and reshaping thoughts based on new knowledge and experiences. It is the creative, ongoing synthesis of observations, reflection and information about the physical and social world (Hammerman, 2006). In addition science learning as a process of conceptual change is a perspective that fundamentally concerns itself with issues about the growth of scientific knowledge (Duschil& Hamilton, 1998). Vygotsky's (1978) conceptual change pedagogy is a view of learning that recognises student's science learning as making sense of new information based on prior experiences and ideas.

Pedagogical strategies are important for supporting students in the process on construction, reflection, and evaluation of ideas; in other words, instructional activities are mediated in the science classroom (Scott & Driver, 1998). Johnson (2007) mentioned that teachers should utilize effective teaching strategies to ensure conceptual understanding of science. Good teachers' help students learn meaningfully to achieve quality over quantity, meaning over memorization and understanding over awareness (Mintzes, Wanderse& Novak, 1998). Donovan and Brandford (1999) suggested that the science classroom should be learner-centred, knowledge-centred, assessment-centred and community-centred which is useful framework in the design of instruction. In summary, the learner-centred classroom, in other words, student-centred, encourages attention to preconceptions, and offers instruction on what students think and know.

2.4. Gender and Science Learning

Dominant issues in the relationship between gender and achievement have been examined, such as assessment procedures (Gipps& Murphy, 1995; Murphy, 1991), pupil attitudes (Clarke & Trafford, 1996), teacher expectations (Blatchford, 1996; Skelton, 1997) among others.

In a study by the American Association of University Women (AAUW) to consider gender equity in advancing education and career prospects for females, proof was presented to confirm that girls were not getting the similar quality of education as boys (Bleuer&Walz, 2002). Nevertheless, researches gave evidence that the AAUW report was wrong, (Kleinfield, 1998; Sommers, 2000). According to Kleinfield (1998), from grade school through college, females at present obtain higher grades and achieve higher-class ranks. They also get more honours in all fields with the exception of science and sports.

In the general population of males and females, gender differences in attainment assessment are usually minute. This claim is further supported by Sommers (2000) that "the representation of American girls as frightened and academically weakened is not accurate to the essentials". He has the same opinion with Kleinfeld that only in sports are the boys still ahead. There is therefore no significant disparity in gender variation in the academic performance of males and females.

Schibeci (1984) reported that females exhibit more positive attitudes towards biology and males towards physics. Current data from the American Association of University Women indicate the need to focus more attention on the development of positive attitudes towards science with females (AAUW, 1992). As females progress through secondary grades, they become less confident of their academic skills; thus, their career aspirations are narrowed (AAUW, 1992; Linn & Hyde, 1989). Data from the National Research Council (1996) indicate that females comprise 46% of the labour force with only 22% of the scientists being female.

A study sought to determine disparities and associated factors in students' performance in Physics and Chemistry at the Kenya Certificate of Secondary Education (KCSE) examination in Nandi North District. The research objectives included determining differences in students' performance at KCSE in Physics and Chemistry, self-concept (perception) of, attitude towards, and perception of the usefulness of Physics and Chemistry as subjects. Students were classified according to gender, using a causal-comparative design. Majority of the students aged between 15 and 19 years. Three questionnaires were administered to the form four students, and KCSE results for the years 2000–2004 were obtained from the District Education Office. These were analysed using descriptive and inferential statistics. They concluded that boys reflected better academic achievement as compared to the girls in both physics and chemistry. The boys and girls had comparable self-concept in physics. The girls had a higher self-concept in chemistry than the boys. With regard to attitude towards chemistry and physics, the boys and girls had the same attitude, mixed and single-sex school students had comparable attitude towards physics and chemistry (Majerel, Role &Makewa, 2012).

Barba and Cardinale (1991) have investigated students' questioning interactions in secondary school science classrooms. Results of the study suggest that female students have fewer interactions with science teachers and receive less attention than males. The question was open-type questions. Questions asked of female students were predominantly low-level questions. Males received more teachers' interaction, including more questions of higher levels. This trend in questioning female students seems to give females a signal that they have low ability in the sciences. It is also apparent that such behaviour occurs before the secondary school level is reached, causing many females to believe that they are incapable of success in science.

3. Method

A descriptive survey research design was employed in this study in order to determine the students' conceptions on heat and temperature. The purpose of this design is to obtain information that can be analysed by extracting patterns with which comparisons can be made.

3.1. Setting of the Study

This study covers students from two selected Senior High Schools in the Effutu and Agona Municipalities of Central Region of Ghana. The choice of these schools was based on the assumption that most of the teachers in these schools are professionally trained and they are of equitable level in terms of academic performance, equipment and infrastructure. The accessible population was all the second year students in these selected schools because they study integrated science which has heat and temperature as part of their curriculum. Both males and females offer the course. Again these students offered science programmes such as General Science and Home Economics and non-science (Arts and Business). Out of the six hundred and fifty students (650) a simple random technique was used to select the two hundred (200) students so as to give the opportunity to have homogeneous representation of the population. This was done by giving every student the chance to pick papers with YES or NO written on them with replacement. Those who pick YES were picked for the study. The sampling was done in such a way that each element of the population had an equal chance of being selected. The two hundred (200) students were made up of hundred (80) females and hundred (120) males.

The main instrument used for the collection of data in this study was the close-ended questionnaire. The items in the questionnaire were in two parts. The first part labelled (A) consisted of items that was used to determine the respondents characteristics such as gender, class or course offered. The second section (B) consisted of items to elicit students' conceptions on heat and temperature (Appendix 1). This section had twenty (20) items. Each questionnaire item was scored on a three (3) Likert scale (Agree, Disagree and Not sure). This format was meant to offer the respondents fixed alternative responses and the respondents were required to give answers by choosing the alternative most appropriate to the view. Ten (10) out of the twenty (20) items on heat and the other ten (10) on temperature as shown in Appendix 1 indicating the questionnaire items numbered from 1 to 20.

A letter of introduction from the supervisor was sent to the head teachers of the selected schools before the questionnaire was administered. The questionnaire which was administered to the students after school was collected the same day after completion.

All students expected to answer the questionnaire were put in one classroom and briefed. No student was forced to answer the questions. They were given the opportunity to ask the researcher questions to clarify issues that were not clear to them. In order to ensure independent responses, students also consented to have completed the questionnaire before leaving the class. A maximum of 20 minutes were used by the students to respond to the items in the questionnaire in each of the two schools. The return rate was 100%.

3.2. Validity of the Instrument

Content validity was used to determine the validity of the instrument. The research objectives were well noted and the questionnaire was given out to other instructors in physics and experts in heat and temperature to review and comment on the questionnaire items. The researchers ensured that the words and sentences were clear and also all corrections were made after receiving the commentsfrom physics instructors and experts.

3.3. Reliability of the Instrument

The test-retest Method was used to check the reliability of the questionnaire. In this approach the questionnaire items were administered to a group of students outside the research area. The same items were re-administered to the same group of students after a period of two weeks. The test-retest results were then compared and the relationship between the scores was similar, making the reliability of the questionnaire to be higher.

4. Data Analysis

The responses from the questionnaire items were analysed. The analysis was done through the use of frequency counts and percentages in the form of tables. This was done to identify students' conceptions of heat and temperature, to compare the science and the non-science students' understanding of heat and temperature and compare the females' and males' conceptual understanding of heat and temperature by frequencies and percentages.

Sex	Number of students	Percentages (%)
Males	120	60
Females	80	40
Total	200	100

Table 1: Distribution of respondents by sex

Table 1 shows the distribution by sex of the students whose conceptions on heat and temperature were sought in the study. The result showed that, there were more males (60%) than their female counterparts (40%). The number of males in the school was more than the females.

4.1. Programmes Offered by Students

The second item in part A of the questionnaire for the students sought to find out the academic programmes of the selected students.

Programme respondents pursued at the Senior High School	Number of students	Percentage (%)
General Science	50	25
Home Economics	50	25
General Art	50	25
Business	50	25
Total	200	25

Table 2: Programmes pursued at the senior high school by the students

From Table 2 the selection was made in such a way to get equal number of students from the various courses offered at the Senior High School to participate in the studies. Business, Art, Science and Home Economics students all gave a percentage frequency of 25% respectively.

5. Analysis of Results

5.1. Research Question 1: What conceptions do students have on heat and temperature?

In answering this question, data on the conceptions students have of heat and temperature were collected through the questionnaire. The students had to select one of the three optional responses – agree, disagree and not sure to each of the statements given. As shown in Table 3, the responses vary from student to student. The data collected were analyzed using percentages. The summary of the findings is shown in Table 3.

Item	N	Agree %	Disagree %	Not Sure %
1	200	**78.0**	19.5	2.5
2	200	**30.0**	68.5	1.5
3	200	**73.0**	25.5	1.5
4	200	**56.5**	39.0	4.5
5	200	**63.5**	32.0	4.5
6	200	74.5	**22.0**	3.5
7	200	**70.0**	25.5	4.5
8	200	15.5	**81.0**	3.5
9	200	**71.0**	21.5	7.5
10	200	80.5	**15.5**	4.0
11	200	8.5	**42.0**	49.5
12	200	**52.5**	28.5	19.0
13	200	**26.0**	50.0	24.0
14	200	**71.5**	26.0	2.5
15	200	**55.5**	10.0	34.5
16	200	**64.5**	11.5	24.0
17	200	20.5	**77.5**	2.0
18	200	**51.5**	45.0	3.5
19	200	80.0	**17.5**	2.5
20	200	**57.5**	32.0	10.5

Table 3: Conceptions students have on Heat and Temperature
Note: Bold figures indicate the percentages of students who have the right conceptions

As indicated in Table 3, the respondents had statements describing the characteristics of heat and temperature. Items 1, 2, 3, 4, 5, 7, 9, 12, 13, 14, 15, 16, 18 and 20 are items on heat and temperature which are correct so students who agree on the statement have correct conceptions, students who disagree have wrong conceptions and students who are not sure also do not have the right conceptions of heat and temperature. Items 6, 8, 10, 11, 17 and 19 are wrong statements and students who disagree have the correct response and have correct conceptions while students who are not sure do not have the right conceptions of heat and temperature.

Of all the conceptions of heat, the conception having the highest response was "in a chemical reaction, heat is always initially absorbed", (item 8), which had 162 respondents (81.0%) disagreeing. It was then followed by (item 3) which had 146 respondents (73.0%) agreeing. Item 10 had 80.5% of the respondents agreeing to the statement which is wrong, "that increase in heat will not increase the mass and the specific capacity of a body".

The respondents had seven items out of the last ten (11-20) statements on temperature correct. The conception of temperature that attracted the highest response was, "before a chemical change can take place, the system and the surrounding must not be at the same temperature" (item 17), which had 155 respondents (77.5%) disagreeing. It was followed by the conception that "temperature is not one of the forms of energy" (item 14). In all, the least response was on (item 19), which had 35 respondents (17.5%) which was "there is a relationship between specific heat capacity and temperature".

5.2. Research Question 2: Are there differences in the conceptions males and females students have on heat and temperature?

In answering this question, data on the conceptions male and female students have of heat and temperature were collected from the respondents through the questionnaire. The data collected were analyzed using simple percentages. The findings are indicated in Tables 4 and 5.

Item	N	Agree %	Disagree %	Not Sure %
1	120	**79.5**	18.3	2.2
2	120	**36.7**	61.7	1.6
3	120	**78.3**	20.0	1.7
4	120	**84.2**	11.7	4.1
5	120	**62.5**	33.3	4.2
6	120	66.7	**30.0**	3.3
7	120	**65.8**	28.3	5.9
8	120	16.6	**81.7**	1.7
9	120	**72.5**	20.8	6.7
10	120	77.5	**20.0**	2.5
11	120	5.8	**55.8**	38.4
12	120	**58.3**	41.7	0.0
13	120	**19.2**	57.5	23.3
14	120	**88.3**	10.0	1.7
15	120	**63.3**	17.5	19.2
16	120	**66.7**	22.5	10.8
17	120	20.8	**78.3**	0.9
18	120	**66.7**	32.5	0.8
19	120	75.0	**20.8**	4.2
20	120	**90.8**	8.3	0.9

Table 4: Conceptions male students have on heat and temperature
Note: Bold figures indicate the percentages of students who have the right conceptions

Item	N	Agree %	Disagree %	Not Sure %
1	80	**76.3**	21.2	2.5
2	80	**20.0**	78.8	1.2
3	80	**65.0**	33.8	1.2
4	80	**15.0**	80.0	5.0
5	80	**65.0**	30.0	5.0
6	80	86.2	**10.0**	3.8
7	80	**76.2**	2.5	21.3
8	80	12.5	**81.3**	6.2
9	80	**68.8**	22.5	8.7
10	80	85.0	**8.8**	6.2
11	80	12.5	**21.3**	66.2
12	80	**43.8**	8.7	47.5
13	80	**36.2**	38.8	25.0
14	80	**46.2**	3.8	50.0
15	80	**43.8**	8.7	47.5
16	80	**73.8**	12.5	13.7
17	80	26.2	**61.3**	12.5
18	80	**28.8**	7.5	63.7
19	80	87.5	**12.5**	0.0
20	80	**7.5**	67.5	25.0

Table 5: Conceptions female students have on heat and temperature
Note: Bold figures indicate the percentages of students who have the right conceptions

From Table 4 and 5, the findings showed similarity between the responses of the males and the females on some of the conceptions of heat and temperature. The similarities were in the fact that some conceptions that the males have of heat and temperature are the same conceptions that the females also have. For instance item for 17, 61.3% of the females and 78.3% of the males disagreed that “before a chemical reaction can take place, the system and the surrounding must not be at the same temperature which is correct”. The findings, however, showed some disparities between the responses of the males and those of the females. The disparities could be observed in the low percentage in the number of females as against the high percentage in the number of males who had the right conception. For instance for item 15 only 43.8% of the females agreed to the item (correct of course) that “temperature is a property of the material and does not depend on the type of material while as high as 63.3% of the males gave the same response. While only 28.8% of the females agreed that "the unit of temperature is Kelvin", 66.7% of the males agreed to the same statement in item 18. In the case of item 20, 7.5% of the females agreed that the "normal body temperature is 37^oC", while 90.8% of the males agreed to the same statement which is also correct statement. This suggests that more males have right conceptions of heat and temperature than their female counterparts.

5.3. Research Question 3: What differences do science and non-science students have on the concepts of heat and temperature?

In answering this question, data on the responses given by science and non-science students to questionnaire items on heat and temperature were aggregated and analysed using simple percentages. The findings are shown in Tables 6, 7, 8 and 9.

Item	N	Agree %	Disagree %	Not Sure %
1	50	**86.0**	10.0	4.0
2	50	**86.0**	10.0	4.0
3	50	**80.0**	18.0	2.0
4	50	**84.0**	16.0	0.0
5	50	**70.0**	28.0	2.0
6	50	70.0	**28.0**	2.0
7	50	**72.0**	24.0	4.0
8	50	10.0	**86.0**	4.0
9	50	**80.0**	12.0	8.0
10	50	86.0	**14.0**	0.0
11	50	10.0	**88.0**	2.0
12	50	**90.0**	10.0	0.0
13	50	**28.0**	68.0	4.0
14	50	**90.0**	10.0	0.0
15	50	**96.0**	4.0	0.0
16	50	**92.0**	6.0	2.0
17	50	18.0	**80.0**	2.0
18	50	**88.0**	12.0	0.0
19	50	84.0	**14.0**	2.0
20	50	**94.0**	6.0	0.0

Table 6: Science students' conceptions of heat and temperature
Note: Bold figures indicate the percentages of students who have the right conceptions

Item	N	Agree (%)	Disagree (%)	Not sure (%)
1	50	**82.0**	16.0	2.0
2	50	**12.0**	88.0	0.0
3	50	**76.0**	24.0	0.0
4	50	**84.0**	10.0	6.0
5	50	**58.0**	40.0	2.0
6	50	88.0	**12.0**	0.0
7	50	**80.0**	12.0	8.0
8	50	16.0	**78.0**	6.0
9	50	**78.0**	18.0	4.0
10.	50	92.0	**2.0**	6.0
11	50	10.0	**60.0**	30.0
12	50	**16.0**	14.0	70.0
13	50	**16.0**	14.0	70.0
14	50	**36.0**	58.0	6.0
15	50	**94.0**	4.0	2.0
16	50	**8.0**	14.0	78.0
17	50	10.0	**90.0**	0.0
18	50	**76.0**	14.0	10.0
19	50	84.0	**16.0**	0.0
20	50	**6.0**	94.0	0.0

Table 7: Business students' conceptions on heat and temperature
Note: Bold figures indicate the percentages of students who have the right conceptions

Item	N	Agree (%)	Disagree (%)	Not sure (%)
1	50	**74.0**	26.0	0.0
2	50	**22.0**	76.0	2.0
3	50	**68.0**	28.0	4.0
4	50	**58.0**	34.0	8.0
5	50	**58.0**	32.0	10.0
6	50	60.0	**32.0**	8.0
7	50	**54.0**	42.0	4.0
8	50	22.0	**74.0**	4.0
9	50	**64.0**	24.0	12.0
10.	50	68.0	**28.0**	4.0
11	50	6.0	**4.0**	80.0
12	50	**88.0**	8.0	4.0
13	50	**28.0**	42.0	30.0
14	50	**76.0**	20.0	4.0
15	50	**18.0**	14.0	68.0
16	50	**68.0**	20.0	12.0
17	50	34.0	**60.0**	6.0
18	50	**32.0**	64.0	4.0
19	50	76.0	**20.0**	4.0
20	50	**78.0**	20.0	2.0

Table 8: General Art students' conceptions on heat and temperature
Note: Bold figures indicate the percentages of students who have the right conceptions

Item	N	Agree (%)	Disagree (%)	Not Sure (%)
1	50	**70.0**	26.0	4.0
2	50	**0.0**	0.0	100.0
3	50	**68.0**	32.0	0.0
4	50	**78.0**	18.0	4.0
5	50	**68.0**	32.0	0.0
6	50	80.0	**16.0**	4.0
7	50	**74.0**	24.0	2.0
8	50	14.0	**86.0**	0.0
9	50	**62.0**	32.0	6.0
10.	50	76.0	**18.0**	6.0
11	50	8.0	**92.0**	0.0
12	50	**16.0**	82.0	2.0
13	50	**32.0**	58.0	10.0
14	50	**84.0**	14.0	2.0
15	50	**20.0**	70.0	10.0
16	50	**90.0**	6.0	4.0
17	50	20.0	**80.0**	0.0
18	50	10.0	90.0	0.0
19	50	76.0	**20.0**	4.0
20	50	52.0	8.0	40.0

Table 9: Home Economics students' conceptions on heat and temperature
Note: Bold figures indicate the percentages of students who have the right conceptions

From Tables 6, 7, 8 and 9, the respondents gave correct responses for some of the items on the conceptions of heat and temperature. The item having highest response was item 15 with 48 respondents (96.0%) for the science students; 47 respondents (94.0%) for the business students. The respondent gave a correct response to the statement that temperature is a number that is related to the average kinetic energy of the molecules of a substance. For the General Art and the Home Economics students, the highest responses were for questionnaire items 12 with 44 respondents (88.0%) agreeing and items 16, with 45 respondents (90.0%) agreeing. They also gave correct response that "when temperature of water reaches the normal boiling point, the water begins to change from liquid to gas". All these conceptions with the highest respondents were statements on temperature.

The findings however showed some similarities and differences in the pattern of responses. There were similarities in items, 1, 3, 4, 5, 6, 7, 8, 9, 10, 11, 13, 17, and 19. For example in item 1 all the categories of students gave a correct response that “when ice melts heat is taken in”. All the category of students agreed to the wrong statement that “increase in heat will increase the mass and specific capacity of a body”. There were however differences in the responses among the group. In item 2, which is a conception of heat, majority of the science students (43, that is 86.0%) gave correct response, 6 (12.0%) of the business students gave correct response, 11 (22.0%) of the General Art students gave a correct response and none of the Home Economics students gave correct response. For items 16 and 20, the results showed that Business students’ had wrong conceptions with responses of 4 (8.0%) and 3 (6.0%) for item 16 and for item 20, Science, General Art and Home Economics students actually gave correct response with 46 (92.0%), 34 (68.0%) and 45 (90.0%) responses respectively. Item 16 had 47 (94.0%), 39 (78.0%) and 26 (52.0%) responses by Science, General Art and Home Economics respectively. Another difference was found in the response given by the General Art and Home Economics students as compared to the Science and Business students for item 15. For General Art and Home Economics, 9 respondents (18.0%) and 10 respondents (20.0%) respectively gave correct response while the Science and Business students respectively had 48 (96.0%) and 47 (94.0%) correct responses.

6. Discussion

6.1. Students’ Conceptions on Heat and Temperature

Fourteen of the items on heat and temperature were answered correctly by the students. Seven of the questionnaire items were on heat while the other seven were items on temperature. Majority of the respondents gave correct response to items 8, (81.0%), item 1, (78.0%), item 3, (73.0%), item 9, (71.0%) and item 7, (70.0%) respectively. These percentages showed that the students had correct conceptions of heat. Item 19 also on heat had the lowest correct response (17.5%). Most of the students (80.5%) agreed to the wrong statement. This indicates that even though the students know the relationship between heat, change in temperature, specific heat capacity and mass, they do not know their implications.

Only 26.0% of the students agreed to item 13, which states that 1 litre and 15 litres of water will boil at the same temperature. Majority of them disagreed or were not sure. This implies that students’ only learn in abstract without much activities making understanding difficult. This is not surprising as teachers admitted not using activities in teaching the concepts, hence students’ poor participation in science lessons. Many teachers think that it is not realistic to expect that each lesson in an integrated science programme would integrate all of the sciences. They correctly argue that often in a lesson only two of the sciences are integrated and sometimes only one predominates. This feature is important, because in some cases students must have a clear understanding of a basic concept in one of the disciplines before they can explore the concept further in the integrated context.

While between 22.0% and 81.0% of the respondents had items on heat correct, percentage of respondents who had items on temperature correct were between 8.5% and 77.5%. The results showed that the students really performed better on the questionnaire items on heat than that of the temperature.

From the study, it can be said that most of students had the right conception about heat that “in a chemical reaction, heat is initially absorbed (81.0%), their conception of temperature is however partially correct since the students disagree that there is a relationship between specific heat capacity and temperature (17.5%). A few however have the wrong conception of both heat and temperature. For example most of the students were not sure that when a solid ball and a hollow ball,which are made of the same material and their temperature is increased by the same amount, they will have the same energy (8.5%) and increase in heat will increase the mass and the specific heat capacity of a body (80.5%).

6.2. What differences do male and female students have on the concepts on heat and temperature?

The findings on the conceptions on heat and temperature showed some similarities between the responses of males and females. Thirty percent (30.0%) of the males and ten percent (10.0%) of the females, claim that heat is an extensive property and that does not depend on the amount present (item 6). This means majority of them had a misconception about the item, because the number of students who gave correct response was less than 50%. Again for item 13, 19.2 % of the males and 36.2% of the females responded positively that one and fifteen litres of water will boil at the same temperature. Majority of these students think that because the fifteen litres of water is more than the one litre, so the one litre will boil at a faster rate with the boiling point becoming lower than the fifteen litres.

The findings on the conceptions on heat and temperature showed some disparities between the responses of males and females. For example in the case of item 4, while 84.2% of the males indicated that when wood burns heat is released, only 15.0% of the females gave the same answer. This may mean that the females did not understand the concept behind the statement because they could have related it to their daily activities at home. Again for item 18, while 66.7% of the males agreed that the unit for temperature is kelvin, only 28.8% of the females agreed. It was established that the males performed better than their female counterparts. This confirms a study by Chipman, Brush and Wilson (1985) in one school, using a slightly more sophisticated preference ranking system, showed that boys were far more likely to report liking science than girls; a finding given additional salience by the work of Jovanovic and King (1998) which suggests that one of the major factors in girls‟ antipathy towards science is their perception that they are better at other subjects. This perhaps was the reason for the better performance of the boys than girls in the study. It again confirms a study conducted by Gardner (1975). He reported that the most significant factors influencing students’ attitude towards science is gender. He identified a contrast between the number of boys and girls who offer science as a major course. He saw that more boys offer science than girls. It also came to light that among the boys and girls, more boys pass in integrated science than the girls.

Beliefs about what males and females are supposed to do are transmitted through peer relationships. McLaren and Gaskel (1995) interviewed high school girls in physics class about their experiences and found that girls identified more biased treatment by boys than by teachers. McLaren and Gaskell (1995) suggested that boys feel freer to harass girls in science than other classes because of larger cultural messages that science is a male domain. They argue that gender should be official part of science curriculum to effect change in these attitudes, instead of leaving students to deal with it informally.

6.3. What differences do science and non-science students have on the concepts of heat and temperature?

The findings showed some similarities in the pattern of responses for some of the items. For example for item 19, only a few of the students did not agree to the statement that that "there was a relationship between heat capacity and temperature"; these were 7 Business students, 10 General Art students, 8 Science students and 10 Home Economics students representing 14.0%, 20.0%, 16.0% and 20.0% respectively. For this item, the science students who were expected to know better had only 8 respondents while General Art and Home Economics had 10. The question this raises is "have the students ever come across the equation involving heat, temperature, mass and specific heat capacity"? Our students should be also note the difference between "change in temperature" and "temperature". The two are not the same.

Teachers and curriculum designers need to be aware that instruction can actually foster misconceptions that later become problematic. Understanding students' conceptions is essential for designing effective questions and "distracters" for concept evaluation instrument and tests in chemistry and physical science (Yeo &Zadnick, 2001).

There were differences in the response given by the General Art and Home Economics students as compared to the Science and Business students to questionnaire item 15. General Art and Home Economics had 9 (18.0%) and 10 (20.0%) respondents respectively giving correct response to the item while the Science and Business students had 48 (96.0%) and 47 (94.0%) respondents respectively. The business students did very well on this particular item indicating that they understood the concept. Again, there was a difference in response to item 20, in which Science, General Art and Home Economics students responded correctly that the normal body temperature is $37^{O}C$ with 47 (94.0%), 39 (78.0%), 20 (40%) responses respectively while only 3 (6.0%) of the business students responded positively to the statement. For item 2, 43 respondents (86.0%) of the science students had correct conception that the unit of heat is joule (J) whereas the Business, General Art and Home Economics students had 6 (12.0%), 11 (22.0%) and no respondents (0.0%) respectively agreeing to the statement. This means the science students knew the unit of heat because they have been working with this unit very often since they were majoring in the science but the rest of the students usually do not come across the unit. For item 18, the science students had correct conception that the unit of temperature is kelvin (K) with 44 (88.0%) whereas the Business, General Art and Home Economics students had 38 (76.0%), 16 (32.0%) and 5 (10.0%) respectively. This confirms that students apply the newly learned concepts to other concepts. The teaching goal is to have students generalize or transfer ideas to other concepts used as illustrations of the central concept. For some students, self-regulation, equilibrium and mental reorganization of concepts may take time. Having several activities where a concept is applied can provide the valuable time needed for learning (Bybee, Powell & Trowbridge, 2008).

From the results obtained, it can be deduced that more of the science students have correct conceptions of heat and temperature than non-science students (Home Economics, Business, General Art students). This confirms a study conducted by Sadava (1976), on attitudes towards science, which has shown that science-major undergraduate have a more positive attitude than do the non-science majors.

Science course normally designed for non-science major students are often oriented towards theory than towards the application in the students' lives. Most of the investigations on students' learning science suggest that students bring their own conceptions of science to explain the natural world (Driver 1983). The non-science students will in one way or the other show some difficulties in understanding some of the science concepts such as the difference between heat and temperature because it is a concept that involves more practical activities.

Research by Yeo and Zadnik, M. (2001)indicates several points bearing on the beliefs and attitudes that school teachers have regarding reading science material. He found that science teachers place high value on reading as an important strategy to promote the learning of science and generally accept responsibility for teaching content reading skills to science students. Many teachers accept the importance of reading science materials as a component of scientific literacy and as a means of improving science achievement.

Learning is an active process, and what students do with facts and ideas with which they have been presented depends to a very high degree on what they already think and believe. Being able to recognize and work with these student-held ideas and conceptions is thus a key component of an effective educational strategy.

7. Conclusion

The study has shown that while some students have right conceptions, others have wrong conceptions of heat and temperature, which need to be addressed if they are to have a sound understanding of the concepts as they move along to the higher levels. In addition, the study also showed that most of the non-science students do not hold right conceptions when it comes to the unit of heat and statements that are more practical.

It can be concluded that regular classroom activities such as demonstration can improve students learning. It helps students to understand concepts in science. It again motivates them to work on their own to retain what they have learnt.

8. Recommendations

From the results of the study the following recommendations are made:

- Programmes should be organized to assess the teachers' needs since they may have different understanding of some concepts which can influence their instructional strategies.
- Finding revealed that lack of practical activities account for the poor participation and performance in integrated science lessons. It is therefore recommended that stakeholders and other non-governmental organizations in education should assist schools to acquire equipment and apparatus required for effective teaching and learning of the science concepts.
- Students' inabilities to ask questions for further explanation during lessons contribute to their inability to participate and perform. It is therefore recommended that students should be motivated to ask questions for further explanation of some science concepts to improve their participation and performance.

9. Limitation of the Study

The study was to cover all senior high schools in the central Region but due to time and financial constraints, the researcher was limited to Winneba Senior High School and Swedru Senior High School, all in the Efutu Municipality and AgonaMunicipality respectively.

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APPENDIX 1
University of Education, Winneba
Faculty of Educational Studies
Department of Psychology and Education
Students' Questionnaire on Conception of Heat and Temperature
Questionnaire for Integrated Science Students

This questionnaire is part of a study on *"Senior High School Students' conception of Heat and Temperature"*. The information you provide will help to determine students' conceptions of heat and temperature of the Central Region. The information will be used only for the purpose of this study. I would be grateful if you could respond to the items as appropriately as possible. 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.

Item	Agree %	Disagree %	Not Sure %
1.When ice melts heat is taken in.			
2. The unit of heat is joules (J).			
3. Heat is a kind of energy so it can be transferred from one place to another.			
4. When wood burns it releases heat.			
5. Heat flows from warm places to cooler places.			
6. Heat is an extensive property that is it does not depend on the amount present.			
7. The way heat travels in a metal rod and wood are not different and it does depend on the conductivity of each material.			
8. In a chemical reaction, heat is initially absorbed.			
9. The three ways in which heat can be transferred are conduction, radiation and convention.			
10. The increase in heat will increase the mass and specific capacity of a body.			
11. A solid ball and a large hollow ball are made of the same material. If their temperature is increased by the same amount, the two balls will have the same energy.			
12. Temperature is a property of a material and does not depend on the type of material.			
13. 1 litre and 15 litres of water will boil at the same temperature.			
14. Temperature is not one of the forms of heat energy.			
15. Temperature is a number that is related to the average kinetic energy of the molecules of a substance.			
16. When temperature of water reaches its normal boiling point, the water begins to change from liquid to gas.			
17. Before a chemical reaction can take place, the system and the surrounding must not be at the same temperature.			
18. The unit of temperature is kelvin (K).			
19. There is a relationship between specific heat capacity and temperature.			
20. The normal body temperature is $37^{o}C$.			