CONCEPTIONS OF THERMODYNAMICS HELD BY CHEMISTRY STUDENTS OF COLLEGES OF EDUCATION IN NORTH CENTRAL GEOPOLITICAL ZONE, NIGERIA

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Abstract
This study was undertaken to identify conceptions of Thermodynamics held by Chemistry students of Colleges of Education in North Central geopolitical zone of Nigeria. The study was a descriptive one of the survey type. Five Colleges of Education in the zone were randomly selected for the study. A total of one hundred and forty students formed the sample for the study. The instrument for data collection was a 10 item Thermodynamics Conception Test (TCT) which was validated by three senior lecturers in Department of chemistry in Federal University of Technology, Minna. The reliability co-efficient of the instrument was found to be 0.84 Two hypotheses were formulated and data collected were analyzed using mean, standard deviation, t-test and analysis of variance (ANOVA). The findings of the research revealed that most students misconceived thermodynamics. A total of 630 misconceptions in Thermodynamics were identified. It is recommended that there must be good quality teachers to deliver correct and accurate knowledge to help students' in the colleges of education to have a good knowledge of thermodynamics or any topic in Physical chemistry.

Keyboard: Conceptions; Thermodynamics; Chemistry; Colleges of Education;

Introduction

The world is dominated by activities of science and technology and as such Science affects the socio - economic development of nations. Adeyegbe (2003) reiterated the importance of science and technology by stating that it is the fundamental and basic tool for man's process and development. Man lives in a science driven world that is both exciting and challenging, making great demands on individual and societies. The importance of chemistry as a requirement for technological development therefore, cannot be over-emphasized. It is one of the bedrocks of all scientific and technological breakthroughs. Chemistry as an integral aspect of physical science has been considered as a pre-requisite for students' admission into tertiary institutions to pursue medicine, pharmacy, architecture, engineering, geology, biochemistry, agricultural science, home economics and food science and nutrition, etc. Besides, it is a functional subject which is applicable to different industrial processes like manufacturing of herbicides, drugs, cosmetics, iron products and fertilizers (Oyelekan, 2002).

The role of chemistry in national development is acknowledged in the world (Petrucci, Harwood & Herring, 2002). The significance of chemistry in all field of science and technology has made chemistry imperative to be included in the curriculum of senior secondary school to be offered as a subject. Objectives of chemistry curriculum if achieved, would prepare a student to adapt to the technologically developing world, understand her economic aspirations and be in a better position to positively contribute to her development. The typical secondary school chemistry curriculum consists of various branches: Physical, Organic, Inorganic, Analytical, and Industrial Chemistry.

The quality of chemistry teaching and learning in secondary school has a great influence on the performance of students at the higher institution especially Colleges of Education. The general objectives of studying chemistry at the N.C.E level are the production of highly qualified middle-level manpower who are knowledgeable in the field of chemistry and posses the ability to inculcate this knowledge in the students (NCCE 2002). N.C.E Chemistry students are therefore expected to have competencies in chemistry including the ability to:

(i) Develop functional knowledge of chemistry concepts and principles
(ii) Observe and explore the chemistry environment
(iii) Apply the skills and knowledge gained through the study of chemistry to solve day-to-day problem.
(iv) Develop scientific attitudes such as curiosity and precision.
(v) Manipulate simple apparatus for the purpose of demonstrating chemistry processes, and
(vi) Improvise simple equipment from available resources in the environment for the teaching and learning of chemistry.

The objective of producing chemistry graduates at the NCE level, in essence, is to turn out competent, effective and efficient personnel into the teaching profession. To achieve this goal, the Federal Government of Nigeria stated that the minimum qualification a teacher should have in Nigeria is Nigeria Certificate in Education (NCE), (FRN 2004). This is to ascertain that the teachers produced are trained as professionals. In an attempt to have a qualitative science education, chemistry education inclusive, the Federal Government had done the following:

(i) Establishment of the Teacher Registration Council of Nigeria (TRCN) in 1993. The Council ensures that all (including science teachers) that have been trained as teachers are registered.
(ii) Upgrading of some schools to special science secondary schools, with specific focus on the teaching and learning of science. These schools are specially equipped with materials and human resources to boost the study of science
(iii) At the NCE level, the curriculum and objectives of science education were put on a uniform pedestal through the NCCE minimum standard. The NCCE supervises the Colleges of Education, to improve and standardize all areas of academic studies including chemistry education.

Despite the proceeding plan and efforts of the government to improve science education at different levels of education, the performances of students in chemistry have not been encouraging. For example, table 1 shows the declining trend in the performance of final year chemistry students in some Colleges of Education in North Central geopolitical zone.

Table 1: NCE (III) Chemistry Results of Colleges of Education in Kwara and Niger States

Year	No Enrolled	Physical No with Credit Pass and (%)		Organic No with Credit Pass &(%)		Inorganic No With Credit Pass & (%)	
2005	96	39	(41)	49	(51)	66	(69)
2005*	29	17	(59)	18	(62)	18	(62)
2006	119	53	(45)	53	(48)	72	(61)
2006*	31	18	(58)	16	(52)	25	(81)
2007	82	40	(49)	40	(49)	33	(40)
2007*	84	40	(48)	48	(57)	68	(81)
2008	96	56	(58)	71	(74)	58	(60)
2008*	105	53	(50)	58	(55)	53	(50)
2009	106	51	(48)	59	(56)	58	(55)
2009*	90	50	(55)	51	(56)	56	(62)
2010	84	40	(48)	48	(57)	68	(81)
2010*	110	51	(46)	50	(45)	70	(64)
Average for Kwara State		48.16		55.83		61	
Average for Niger State		52.66		54.5		66.66	

Source: Examination Office, Colleges of Education Kwara and Niger States

The total credit pass in Table 1 reveals that 50% of the Chemistry students in Kwara and Niger States Colleges of Education had credit pass in the chemistry examinations from 2005-2010. A critical look at Table 1 reveals that for the years considered, for College of Education Kwara and

Niger State respectively, the percentage credit pass was lowest for physical chemistry with an average of 48.16%, and 52.66%, whereas organic was 55.83 % and 54.5 and inorganic 61% and 66% respectively. This implies that physical chemistry which includes (Thermodynamics) is one of the difficult aspects of Chemistry. At the NCE level, physical chemistry is offered in the second semester of year III. For a country like Nigeria, which is yearning for technological breakthrough, poor performance cannot contribute positively to scientific advancement in the nation. Scholars such as Adeyegbe (2004), Elizabeth and Esther (2010) and the West African Examinations Council (WAEC) Chief Examiners' Reports (2006) revealed that sources of students failure varied. For example, in a study conducted by Adeyegbe (2004), students were found to perform poorly in chemistry at G.C.E 'A' level due to the difficult nature of some chemistry topics attributed to students and in some cases teachers. According to Adeyegbe (2004) teachers lacked the competence and skill to communicate such topics just as students found it difficult to comprehend.

The factors identified by different scholars as responsible for students poor performance include: the difficulty in understanding chemistry concepts such as quantum mechanics, electrochemistry, chemical bonding and thermodynamics (WAEC, 2004). By implication, topics not understood cannot be applied to problem solving. Of all the reasons suggested by the scholars and corporate bodies for the poor performance of the students, students inability to understand chemistry concepts as well as inability to apply the knowledge learnt featured prominently and are of importance to this study.

The classroom teacher is therefore faced with the challenge of teaching to attain an effective conceptual change, since any incorrect conception whether misconception or alternative conception would hinder effective learning. Conception has been defined previously in this study as the process of organizing experience into a particular mode of thought or ideas. Conception is a stage which the learner has to attain in order to learn meaningfully since it involves understanding of an idea or concept. It has been found that there is a relationship between conception and prior knowledge of students,(Novak, 1978 in Elizabeth & Esther 2010). .Misconception is an idea that is at variance with accepted view by chemistry experts .It is an idea held about a concept that is considered wrong and clearly in conflict with acceptable scientific explanations and hence, it is wrong. While an alternative conception is a student's idea/ knowledge, which has its own value and cannot be considered wrong. Misconception and alternative conceptions are carry-overs from wrong conceptions from previous knowledge and both impact negatively on students understanding of a concept. It is therefore pertinent that a teacher should have knowledge of student's conception in order to enhance the handling of the problem of incorrect previous ideas. Based on this knowledge, the teacher will be able to select what could foster better understanding of a given concept. Many concepts are viewed differently by students, if students are given a problem to solve, they might understand the concepts involved and difficulties often arise when students' idea differ from the definitions idea accepted by experts.

In the present study, effort was made to identify student's conception of chemistry of thermodynamics. There are three types of conceptions: correct, misconception and alternative conceptions. Educators and psychologist have explored learner's conceptions of learning and epistemological beliefs about the nature of knowledge (Hornby, 2000 & Hurst, 2002, Adamu, 2010). These researchers provided evidence that conceptions or beliefs have a profound influence on the learning process (Oversby, 2000, Petrucci, 2002, Kurt & Somchai, 2004). These studies have revealed that students have a variety of conceptions of learning that may thus be related to their approaches to learning itself. Thermodynamics is a difficult aspect that students do not do well in examination. Thermodynamics is the branch of chemistry concerned with interrelationship and inters conversion of different forms of energy. Students' understanding of heat and thermal phenomena otherwise known as thermodynamics has been subject to considerable investigation in the science education literature. Research on students' conceptions of entropy has revealed various misconceptions among several students. Difficulty imagining

"reversibility" is another problem area for students, who come up with many alternative explanations to work around their lack of understanding. Many students fail to see state changes, dissolution and other physical changes as reversible. For example (Hewson 1977) observes that students fail to see that recrystallized sugar is the same as the sugar which was added to the water originally. This contributes to the student's difficulty in distinguishing physical changes from chemical changes. The reversibility of chemical reactions poses serious conceptual challenges to the students, leading to an inability for example to grasp the reciprocal relationship between acids and bases and the concept of an equilibrium At a still deeper level, inability to grasp reversibility may be related to students difficulties in picturing two things going on at once.

The knowledge of science is very important for science and technological development of any nation. Chemistry is a major area of science. It is an important and relevant part of the study of science in Colleges of Education. The performance of students in science generally and chemistry in particular has been unsatisfactory (Maikano, 2007). The report of the Chief Examiners (WAEC, 2004 & 2007) revealed that students' performance was poor in area of thermodynamics. They further reported that the poor performance is as a result of poor understanding of some general principles and concepts like heat, work, and thermodynamics. This poor performance as indicated by their results can be attributed to many factors which includes lack of understanding of the concepts.

Studies were conducted by Nigerian researchers on conceptions of chemistry in the area of quantum chemistry, organic chemistry, nature of matter and chemical equilibrium (Jimoh, 2000 & Musa, 2004). However, not much work was done in the area of conceptions of thermodynamics at NCE level and in North Central geopolitical zone. The researcher therefore found it necessary to focus on the different conceptions of thermodynamics held by NCE students in North Central geopolitical zone of Nigeria.

Purpose of the Study

The purpose of the study was to determine the conceptions of thermodynamics held by students of chemistry in selected College of Education in the North Central geopolitical zone. This was done by identifying conceptions of thermodynamics held by the N.C.E students and determining whether there is gender difference in the student's conception in thermodynamics

Research Questions

The study specifically sought answers to the following questions:

(i) What are the conceptions of thermodynamics held by chemistry students in the Colleges of Education in North-Central geo-political zone of Nigeria?

(ii) Is there any gender difference in the conception of thermodynamics held by N.C.E Chemistry Students?

Hypotheses

To guide this research, the following hypotheses were formulated

$Ho_{1.}$ There is no significant difference in conceptions of thermodynamics held by NCE chemistry students.

$Ho_{2.}$ There is no significant difference in the conceptions of thermodynamics held by male and female NCE chemistry students.

Methodology

A descriptive survey method was used for this study. The design was used because it determines and reports the way things are. This study sought to determine conceptions of thermodynamics held by students of chemistry in North Central Geopolitical Zone Colleges of Education. The population of this study was all Colleges of Education chemistry students in North Central geopolitical zone of Nigeria. The Colleges of Education are fourteen and have a total of four hundred and seventy nine (479) chemistry students **.**Random sampling techniques were used to obtain five (5) Colleges of Education from the population. The sampled schools are similar in

terms of recruitment of teachers, admission of students, equipment of chemistry laboratories, curriculum, and are coeducational. A total of one hundred and forty (140) NCE III final year student studying chemistry (76 boys and 64 girls) were involved in this study.

Instrumentation

The instrument used for data collection was a Thermodynamics Conception Test (TCT) designed by the researcher to determine the different conceptions of thermodynamics held by students. The tests items required students to give detailed and concise explanation of the ten chemistry concepts covering the whole area of thermodynamics. The concepts are system, internal energy, heat, work, first law of thermodynamics, change in enthalpy, spontaneous change, entropy, second law of thermodynamics and application of thermodynamics in real life. The test items were preceded by demographic information such as the name of the school, sex of students and level of the students and subject combination. The Thermodynamics Conception Test (TCT) with the marking schemes were validated by five senior lecturers in the department of Science Education, Federal University of Technology, and two Principal lecturers in the Department of Chemistry College of Education, Based on the observations, necessary corrections were made.

Results and Discussion

Hypothesis One

HO_1: There is no significant difference in conception of thermodynamic held by NCE chemistry students. In order to test this hypothesis, ANOVA was used.

Table 2: ANOVA Results on Different Conceptions in Thermodynamics

Source of variation	SS	df	MS	F	P
Between Groups	2189.094	2	1094.547	5.390	.011
Within Groups	5482.909	27	203.071		
Total	7672.003	29			

*Significant at P< 0.05

Table 2 presents the ANOVA results. The results showed that analysis of variation for the data on conception yielded an F - ratio of 5.390 and a significant value of 0.011. This indicates that there is statistically significant difference in the conceptions (correct, alternative and misconception) of Thermodynamics held by NCE chemistry students (F = 5.390, df = 29, P<0.05). To determine the main sources of difference, the data were subjected to Scheff's Post-hoc Test as show in Table 3.

Table 3: Scheffe Multiple Comparisons Results of Correct Conception(1), Alternative Conception(2), and Misconception(3)

(I)1, (J) 1, 2 2 & 3 & 3		Mean Difference (I-J)	Std Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1	2	5.42920	6.37292	.699	-11.0769	21.9353
	3	-14.78560	6.37292	.086	-31.2917	1.7205
2	1	-5.42920	6.37292	.699	-21.9353	11.0769
	3	-20.21480*	6.37292	.014*	-36.7209	-3.7087
3	1	14.78560	6.37292	.086	-1.7205	31.2917
	2	20.21480*	6.37292	.014*	3.7087	36.7209

*The mean difference is significant at P< 0.05 level

1,2,3, represent correct, alternative conception and misconception. Scheffe's analysis on Table 3 indicated that the observed significant difference was between alternative conception and

misconception with the highest mean differences of 20.21 and highest upper boundary of 36.72 at 95% confidence level. On this basis, hypothesis one is rejected. There is therefore significant difference in the NCE chemistry student's conception of thermodynamics. This significant difference was between 2 & 3.

The result of hypothesis one (Ho_1) showed that there is a significant difference in the correct conception, alternative conception and misconception of thermodynamics held by N.C.E. chemistry students. The finding of this study is in agreement with the earlier finding of Akpani (1996) in Elizabeth (2010) Sozbilir and Bennett (2007) who found that there is a significant difference in the conception of students in thermodynamics. This finding also agrees that of Greenbowe & Maltzer (2003) who also found that there is a significant difference in the conceptions of students in chemistry.

Types and Number of Different Conception

On separating the different conceptions into correct, alternative conception and misconceptions, the number of each conception was determined/obtained as follows:

Correct Conception	283
Alternative Conception	347
Misconception	630

Table 4: Examples of alternative Conceptions

S/N	Concept	Alternative Conception
1.	**System**	1. Process where there is a change 2. A container on which various material is acting upon.
2.	**Internal Energy**	1. Energy required in producing motion. 2. Energy produced in a system.
3	**Heat**	1. Rate of coldness or hotness of matter 2. Rate of flow of heat per meter per second

Table 5: Examples of Misconceptions

S/N	Concept	Misconception
1.	**System**	1. Process which undergoes a chemical reaction. 2. Process which is doing work.
2.	**Internal Energy**	1. Is the heat change of a system. 2. Is the energy which produces kinetics energy.
3.	**Heat**	1. Total change in the temperature of a system by 1^0c 2. Is the transfer of forms of energy.

Ho_2. There is no significant difference in the conceptions of thermodynamics held by male and female NCE chemistry students.

To test this hypothesis, means, standard deviation and t-test were used.

Table 6: t-test Analysis of Gender on Thermodynamics Conceptions

Variable	N	df	X	SD	t-value	P	Remarks
Male	10	9	17.30	6.06	1.67 ^{ns}	0.13	Not Significant
Female	10		13.30	5.83			

ns = not significant at p> 0.05

The result on Table 2 presents the t-test result of male and female NCE students conceptions on Thermodynamics. The t-test was conducted to determine if the mean difference of 17.30 for males and 13.30 for females is significant or not. The t-value of 1.63 was however found not significant at 0.05 level (t = 1.67, df = 9, P>0.05). It means that there is no significant

difference in male and female NCE student's conceptions of thermodynamics. Hence, the null hypothesis 2 was upheld. As such, there is no gender difference in NCE chemistry student's conception of Thermodynamics.

The results of hypothesis 2 showed that there is no difference in NCE Male and Female student's conception of Thermodynamics. This results is in agreement with those findings of Fouchugh (2006), Agommouh and Nzewi (2003), Aiyedun (2000), Adebayo (2002), Osborne (2003) and Iliyasu and Rilwan (2006), who reported that there was no gender difference in students conception of chemistry concepts. On the contrary, this finding disagree with the findings of Ukwungu (1996), Mari (2004), Omosewo (2006) and Okwo and Otubah (2007) who found that there is gender effect on the conception of NCE in Thermodynamics. Hence, finding on the effect of gender on conception of NCE students in Thermodynamics remains inconclusive. Finding of this study support the submissions that gender has no significant effect on the conception of Thermodynamics held by chemistry students.

Conclusion

Based on the findings of this study, the following conclusions are drawn;.

(i) There was significant difference in the conception of NCE chemistry students in thermodynamics.

(ii) There is no gender related difference in NCE chemistry students conception of Thermodynamics.

Recommendations

In the light of the finding of this study, the following recommendations were made:

(i) To help students in the Colleges of Education to have proper knowledge of thermodynamics and there must be quality lecturers to deliver correct and accurate knowledge to them. Such lecturers must be knowledgeable, creative and innovative.

(ii) Chemistry lecturers should identify students' prior knowledge and use such to correct misconceptions.

(iii) Science lecturers could mount courses, which focus on students' misconceptions and alternative conceptions in order to correct wrong ideas.

(iv) In the regular review of the NCE curriculum organized by the NCCE, (National Commission for College of Education), attention should be paid to concepts to be included or removed as curriculum is being reviewed. Experienced chemistry lecturers should be invited to have an input in the curriculum review.

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