TEACHERS' PERCEPTION OF SECONDARY SCHOOL STUDENTS' DIFFICULTIES IN UNDERSTANDING GAS LAWS

OYELEKAN, Oloyede Solomon,
OLORUNDARE, Adekunle Solomon,
ANYIMIGBO, Auguster Oluchi
Department of Science Education,
University of Ilorin, Ilorin, Nigeria
E-mail: solomonoyelekan@hotmail.com
Phone No: +234-806-054-9228

Abstract

This study was conducted to find out teachers' perception of students' difficulties in understanding gas laws. One hundred chemistry teachers comprising fifty three males and forty seven females were selected from twenty seven secondary schools in Lagos metropolis. The instrument used for this study is a questionnaire named Questionnaire on Teachers' Perception of Students' Difficulties in Understanding Gas Laws. Results indicate that teachers perceived that students have difficulties in understanding graphs, formulae and derivations in gas laws, solving simple calculations on gas laws, and stoichiometry relating to Avogadro's law. They indicated the sources of these difficulties to include the abstract nature of gas laws, students' personal anxieties and conflicts, misconceptions students have about some other concepts in chemistry and inappropriate teaching methods used by teachers when teaching gas laws. It was recommended that Chemistry teachers should improve their mathematical and pedagogical knowledge to enable them apply appropriate mathematics teaching skills when teaching chemistry topics involving mathematical calculations.

Introduction

One of the most popular topics in school certificate chemistry is 'gas laws'. The Nigerian senior school chemistry curriculum is formulated around four main themes organized in a spiral form across the three years of senior secondary school education. These themes are: Chemistry and industry, the chemical world, chemistry and environment, and the chemistry of life (Federal Ministry of Education FME, 2007). Gas laws as a topic comes under the theme of the chemical world and it is taught during the first year of senior secondary education. The performance objectives listed for the study of gas laws in the chemistry curriculum are that students should be able to:

(i) Demonstrate diffusion of gases
(ii) State the relationship between rate of diffusion and density gas/vapour;
(iii) Show how heat affects the volume of a given mass of gas;
(iv) Explain the Kelvin scale of temperature and its relationship to Celsius Scale;
(v) Explain the effect of pressure on the volume of a gas;
(vi) Explain the effect of temperature and pressure on a given volume of gas
(vii) Show that PV= nRT is the general gas equation. (FME, 2007).

The gas laws normally studied at this level are: Boyle's law, Charles' law, Dalton's law, Gay Lussac's law, Avogadro's law, Graham's law, and the ideal gas law. While Boyle's law explains the relationship between the volume and pressure of a gas at constant temperature, Charles' law explains relationship between volume and temperature at constant pressure. Dalton's law establishes the relationship between partial pressures of gases in a container and the total pressure of the entire medium, while Gay Lussac's law explains the ratio of the volumes of reacting gases at constant temperature and pressure. The relationship between volume and moles of gases is established by Avogadro's law while Graham's law explains the relationship between the diffusion rate of gases and density at constant temperature and pressure. The ideal gas law and equation were formulated from Boyle's, Charles' and Avogadro's laws.

There is no controversy over the notion of the abstract nature of Chemistry. The abstract nature of Chemistry brings along concept learning difficulties e.g. the mathematical nature of chemistry and chemistry curricula commonly incorporate abstract concepts like the gas law which are central to further learning and other sciences. When these concepts like gas laws in chemistry cannot be easily understood by the students, it discourages them from doing further research on it (Nakhleh, 1992).It could also contribute significantly to their poor performance in their school examinations and public examinations. For instance, the performance of Nigerian students in School Certificate chemistry over the years has not been encouraging. Figure 1 presents the performance of Nigerian students in Chemistry in the May/June School Certificate Examinations conducted by the West African Examinations Council between 2005 and 2010.

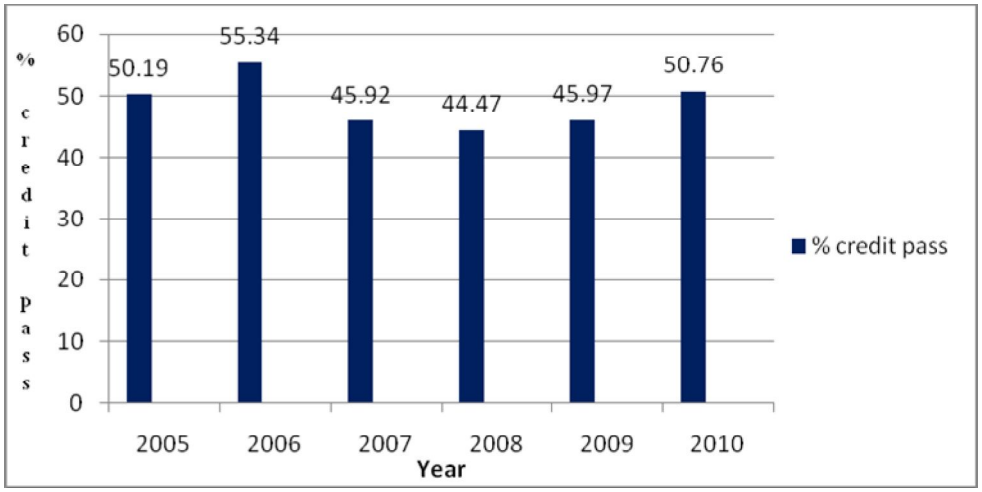

Figure 1: Performance of Nigerian students in Chemistry in the School Certificate Examinations conducted by the West African Examinations Council between 2005 and 2010. Source: WAEC Office, Ilorin.

The data in figure 1 indicates that the percentage credit pass in Chemistry during the period reviewed was 44.47% in 2008 and highest in 2006 at 55.34%. The percentage credit pass fluctuates and had falling far below 50% in previous years. There is therefore an obvious need to find ways of remedying this repeated dismal performance.

Perception is said to be "the way you think about something and your idea of what it is like; the natural ability to understand or notice things quickly" (Longman, 2007 p.1219). Eggen and Kauchak (2004) simply defined perception as the process by which people attach meaning to experiences. Adediwura and Bada (2007) also defined it as the reaction elicited when an impression is perceived from without after making connection with other materials in the consciousness (memory) while Falex (2009) defined it as "a way of conceiving something" or "becoming aware of something via the senses". According to him, the cognitive processes involved in this are awareness and understanding. It is usually the result of the interaction between past experiences, one's culture and interpretation of the perceived.

Teachers' perception of students' difficulties in understanding gas laws could therefore be defined as how teachers see and understand the difficulties students have in understanding gas laws, and the value placed on it based on their professional experience. Gulbahar and Guven (2008) asserted that teacher's perception and skills are important factors in the successful integration of technology in classroom instruction. The factors that affect perception include past experience, culture and interpretation of the experience (Adebayo, 2010). Perception is very important because it affects the

information that enters the working memory. Perception does not come in a vacuum, it always depend on the background information which will trigger up a particular reaction. For instance, the way students perceived their teachers in terms of the knowledge of the content of the subject matter is likely to affect the students' attitude and consequently their performance in subject area (Adediwura & Bada, 2007).

In spite of the various studies earlier conducted by researchers on difficulties in understanding gas laws, the difficulties still seem to persist as Kautz, Heron, Loverude and McDermott (2005) also indicated in the findings of their study that many students could not interpret or apply the ideal gas law after instruction on introductory physics and chemistry as well as more advanced courses. The perception of teachers on students' difficulties in understanding gas laws can assist in finding ways of improving their understanding and improve students' performance in both school and public examinations. This current study was designed to find out teachers' perception of students' difficulties in understanding gas laws, with the aim of providing some plausible solutions that could ameliorate the problem.

Purpose of the Study

The main purpose of this study was to find out teachers' perception of students difficulties in understanding gas laws. Specifically, the study sought to find out:

(i). the difficulties students have in understanding the various gas laws as perceived by teachers.
(ii). the perception of the teachers on the likely causes of these difficulties.

Research Questions

(i) What are the perceptions of teachers on the difficulties students have in understanding gas laws?
(ii) What are the perceptions of teachers on the causes of these difficulties?

Research Methodology

The study was a descriptive one of the survey type. The population for the study comprised all the chemistry teachers in all secondary schools in Lagos metropolis. However, one hundred chemistry teachers were randomly selected from twenty seven secondary schools.

Furthermore, the gender of the respondents was taken into consideration to avoid a wide disparity in the number of male and female respondents. The teachers were not evenly distributed along the line of gender in the schools, hence, while more male chemistry teachers were available in some schools, more female chemistry teachers were available in others. The number of male and female teachers in the each school was taken into consideration in selecting the teachers along gender line. Due to the dearth of chemistry teachers in schools, in a few instances, all the chemistry teachers in the schools were selected. In the end, fifty three males and forty seven female teachers were involved in the study.

The instrument used for this study is a researcher-designed questionnaire named Questionnaire on Teachers' Perception of Students' Difficulties in Understanding Gas Laws. The questionnaire is divided into two sections, A and B. Section A requested for biographical information of the respondents while section B consisted of thirty six statements on students difficulties in understanding gas laws. The response modes to these statements were formulated on a four point Likert Scale of strongly agree, agree, disagree and strongly disagree. The items in the questionnaire were drafted by the researchers based on their personal experiences and knowledge from the literature. The questionnaire was validated by four lecturers in the Department of Science Education, University of Ilorin for thorough scrutiny. The reliability of the questionnaire was determined using test, re-test method of three weeks interval, in which the questionnaire was administered to twenty

teachers selected from another area not covered by the main study. Using Pearson Product Moment Correlation, a reliability coefficient of 0.71 was obtained.

Copies of the questionnaire were directly administered to the teachers in each of the schools and retrieved same day the school was visited. This enabled the researchers to explain the items in the questionnaire to the teachers where necessary before they were completed. The data obtained from the questionnaires were coded and subjected to statistical analysis using the frequency count and percentage.

Data Analysis and Results

The data obtained in respect of each of the research questions are presented and explained as follows:

Research question 1: What are the difficulties students have in understanding gas laws?

The results obtained in respect of this research question are presented on table 1.

Table 1: Teachers' perception of the difficulties students have in understanding gas laws

S/N	Items	SA	A	Positive response (SA+A)	D	SD	Negative response (D+SD)
1.	Conceptual and reasoning difficulties concerning gas laws.	16	43	59	33	8	41
2.	An understanding of the behavior of gases.	30	41	71	24	5	29
3.	Understanding volume-pressure relationship.	18	47	65	25	10	35
4.	Understanding mathematical expressions or mathematical representations of gas laws	21	39	60	27	13	40
4.	Temperature-volume relationship in Charles and Gay- Lussac's laws.	20	48	68	27	5	32
5.	Students' inability to understand graphs, formulae and derivations	39	37	76	18	6	24
6.	Solving simple mathematical calculations.	28	43	71	15	14	29
7.	Stoichiometric difficulties relating to Avogadro's law	28	42	70	17	13	30
8.	Students have difficulties in understanding ideal gas law due to their inability to describe the relationship among pressure, volume and temperature.	16	50	66	26	8	36

Table 1: Teachers' perception of the difficulties students have in understanding gas laws.(Continued).

Continued

S/N	Items	SA	A	Positive response (SA+A)	D	SD	Negative response (D+SD)
9.	Gas laws are abstract and do not relate to students' day to day activities in life	17	60	77	21	2	23
10.	Difficulties with mechanics and incorrect ideas about the particle of gases and processes at the microscopic level often interfere with the development of coherent understanding of gas laws.	34	50	84	14	2	16
11.	Difficulties involving problem –solving in gas laws	25	48	73	17	10	27
12.	Understanding gas laws depend heavily on students' prior knowledge which is often inadequate.	35	40	75	21	4	25
13.	Difficulties in understanding that gas behavior is a function of attractive and repulsive forces between molecules.	24	49	73	15	12	27
14.	Interpretation and application of gas laws after instruction.	2	39	61	31	8	39

Key: SA = Strongly agree, A=Agree, D=Disagree, SD=Strongly disagree

Since the total number of respondents is 100, each of the figures in table 1 also represents a percentage value, hence 70% and above of the teachers indicated that students had the following difficulties in understanding gas laws, looking at the column for positive response:

1. Difficulty in understanding the behavior of gases.
2. Difficulty in understanding graphs, formulae and derivations resulting in their inability to interpret graphical representations of gas laws.
3. Difficulty in solving simple calculations on gas laws.
4. Stoichiometric difficulties relating to Avogadro's law.
5. The perception that gas laws are abstract and do not relate to students' day to day life activities.
6. The interference between the difficulties in mechanics and incorrect ideas about the particles of gases and processes at the microscopic level with the development of coherent understanding of gas laws.
7. Difficulty with problem-solving relating to gas laws.
8. Difficulty bordering on inadequate prior knowledge.

Since 70% and above of the teachers perceived that students have the above listed difficulties, the researchers concluded that these difficulties actually exist among the students. The study went further to inquire from the teachers the likely causes of these difficulties and this is addressed in research question 2.

Research question 2: What are the perceptions of teachers on the causes of these difficulties? The data obtained in respect of this research question are presented on table 2.

Table 2: Summary of responses according to questions on the questionnaire

S/N	Items	SA	A	Positive response (SA+A)	D	SD	Negative response (D+SD)
1.	The difficulties students face is due to the abstract nature of gas laws.	38	40	78	19	3	22
2.	Inadequate prior knowledge related to gas laws.	35	46	81	16	3	19

Continued

Table 2: Summary of responses according to questions on the questionnaire (Continued)

S/N	Items	SA	A	Positive response (SA+A)	D	SD	Negative response (D+SD)
3.	Our laboratory activities focus only on the development of laboratory skills and techniques and not on constructing new scientific ideas.	40	40	80	11	9	20
4.	Lack of creative thinking.	30	48	78	11	11	22
5.	Some teachers tend to do much in a lesson and so indulge the brain of the students with much work and thus limit their understanding of gas laws.	26	44	70	25	5	30
6.	Many teachers do not use concrete manipulative skills, materials and familiar events to help students directly experience scientific phenomena because they don't have the time for that.	30	48	78	20	2	22
7.	Teachers attitude toward students affect their level of assimilation.	38	37	75	20	5	25
8.	Some gases are dangerous to health and this prevents students from studying them.	27	35	62	23	15	38
9.	Students have difficulty with gas laws because these laws are not connected with their interests, personal lives, societal issues and cultural backgrounds.	13	49	62	26	12	38

Continued

Table 2: Summary of responses according to questions on the questionnaire (continued)

S/N	Items	SA	A	Positive response (SA+A)	D	SD	Negative response (D+SD)
10.	Students' sensitivity to teachers' belief about them whether as "low-ability" or "high-ability" affect their understanding in gas laws.	29	39	68	22	10	32
11.	Students' personal anxieties and conflicts affect their understanding generally.	24	53	77	12	11	23
13.	The misconceptions students have about certain concept in chemistry affect their understanding of gas laws.	24	53	77	20	3	23

14.	Students' difficulties are due to some inappropriate teaching methods some teachers use when teaching gas laws.	36	43	79	9	12	21	

Since the total number of respondents is 100, each of the figures in table 2 also represents a percentage value, hence, based on the results presented on table 2, 70% and above of the teachers indicated the following as the causes of students' difficulties in understanding gas laws:

1. The abstract nature of gas laws.
2. Inadequate prior knowledge related to gas laws.
3. The focus of our laboratory activities giving more attention to the development of laboratory skills and techniques and not on the construction of new scientific ideas.
4. Lack of creative thinking.
5. Teachers doing much in a lesson thereby indulging the brain of the students in much work.
6. Teachers' inability to use concrete manipulative materials and familiar events to help students directly experience scientific phenomena due to time factor.
7. Teachers' attitude toward students.
8. Students' personal anxieties and conflicts.
9. The misconceptions students have about some other concepts in chemistry.
10. Inappropriate teaching methods used by teachers when teaching gas laws.

Since 70% and above of teachers indicated the above listed factors as responsible for the difficulties students have in understanding gas laws, the researchers then concluded that these factors actually contribute to the difficulties students have.

Discussion

This study focused on teachers' perception of students' difficulties in understanding gas laws at the School Certificate level. Some of the difficulties students have in understanding gas laws have been revealed in this study. One of the difficulties identified in this study was the difficulty in understanding the behavior of gases which was also identified several decades ago by Novick and Nussbaum (1981). This is an indication that this difficulty may have persisted for a long time. So also, the National Research Council (1996) indicated that students had difficulty in understanding graphs, formulae and derivations. This study confirms the finding. In this study, teachers also indicated that students have difficulty in deriving formulae or solve simple calculations on gas laws unless they memorize and this is in agreement with the findings of Carin, Bass, and Contant(2005). The finding of Abell and Lederman (2001) that students had difficulties with problem solving in gas laws has been further confirmed in this study. There is also a relationship between the findings in this study and that of Stavy (1988) on the abstract nature of gas laws presenting as a difficulty for students.

Combs (1999) asserted that students' learning capability depended heavily on their prior knowledge and experiences in chemistry. In this study, inadequate prior knowledge was identified as one of the factors responsible for the difficulties students have in understanding gas laws. Hence, teachers need to be aware of the place of prior knowledge in the understanding of this topic, and then seek to find out the prior knowledge of their students before proceeding to teach gas laws.

Similarly, the National Research Council (1999) presented the focus on the development of laboratory skills and techniques only to the detriment of constructing new scientific ideas, as one of the factors responsible for the difficulties students have in understanding gas laws and this has been further confirmed in this study. There is also an agreement between the current study and that of Scharmann (1990) and Anderson (2007) that students' anxieties and conflicts could present as a reason for the difficulty they have in understanding chemistry concepts. Beyond the agreements

between the findings of the current study and some previous ones, other difficulties that students have with gas laws have been identified as presented on table 1 and many more causes of these difficulties have been revealed as presented on table 2.

A critical examination of the causes of students' difficulties as found out in this study reveals such causes to include teacher-related causes, student-related causes, facility-related causes and concept-related causes. For instance, the abstract nature of gas laws is concept-related, teacher's attitude towards students is teacher-related cause and students' personal anxieties and conflicts is a student-related factor. Hence, efforts at tackling these difficulties should be all encompassing.

Conclusion

From the findings of this study, it is obvious that a lot of difficulties are still being experienced by students in understanding gas laws as revealed by the teachers who participated in this study and many of the difficulties indicated by the teachers are those bordering on poor students' mathematical competence. Hence, these difficulties contribute to their poor performance in schools' internal Chemistry examinations as well as School Certificate Chemistry examinations. This is because gas laws constitute an important aspect of the School Certificate Chemistry. The root causes of these difficulties cuts across teacher factors, student factors, facility-related factors and concept-related factors as indicated in the results earlier presented.

Recommendations

Based on the results of the findings in this study, the following recommendations are advanced to tackle some of the difficulties encountered by students in understanding gas laws:

(i) Mathematics is a service subject to all science subjects, hence there is need for schools to strengthen their mathematics department with qualified and experienced teachers, and provide necessary instructional materials for the teaching of mathematics.

(ii) Chemistry teachers should improve their mathematical and pedagogical knowledge to enable them apply appropriate mathematics teaching skills when teaching chemistry topics involving a lot of mathematical calculations. Teachers should ensure that students understand graphs, formulae and derivations to enable them interpret graphical representations of gas laws.

(iii) Teachers should demonstrate the various gas laws practically for students and also allow them to try and investigate the laws practically on their own rather than teaching the topic by way of lecturing alone. More time should be given for practical and experiments to make students know the behavior of gases better.

(iv) Teachers should make gas laws real by relating it to the everyday life of students.

(v) The use of computer simulations in teaching gas laws should be considered by teachers to debunk the perceived abstract nature of gas laws and enhance better understanding of the topic. This may alleviate the problem because such simulations have been found to enhance students' understanding.

(vi) Since the learning capabilities of students depend heavily on their prior knowledge and experiences, excursions, field trips and visitation to standard laboratories, factories, pharmacy etc. should be organized for them.

(vii) The curriculum should be geared towards the construction of new scientific ideas and new teaching techniques but not on the development of laboratory skills and techniques alone.

(viii) As regards students 'personal anxieties and conflicts, a school counselor should be employed in each school so as to take care of this.

References

Abell, S. K. & Lederman, N. G. (2007). *Handbook of research on science education*. Mahwah, NJ: Lawrence Erlbaum Associates Publishers.

Adebayo, R. F. (2010). *Science teachers' perception towards using information and communication technology for instruction in Kwara State secondary schools, Nigeria.* Unpublished Ph.D. thesis submitted to the Department of Science Education, University of Ilorin, Ilorin, Nigeria.

Adediwura, A. A., & Bada, T. (2007). Perception of teachers' knowledge, attitude and teaching skills as predictor of academic performance in Nigerian secondary schools. *Educational Research and Reviews, 2(7)*, 165 – 171. Retrieved January 3, 2012 from www.academicjournals.org

Anderson, R. D. (2007. Teaching the theory of evolution in social, intellectual, and pedagogical context. *Science Education*, *9(4),* 664–677.

Carin, A. A., Bass, J. E., & Contant, T. L. (2005). *Methods for teaching science as inquiry* (9th ed.). Upper Saddle River, NJ: Pearson Prentice Hall.

Combs, A. W. (1999).*Being and becoming: A field approach to psychology*. New York, NY: Springer Publishing Company, Inc.

Eggen, P. D. & Kauchak, D. P. (2004). *Introduction to teaching: Becoming a professional:* United States: Prentice Hall PTR.

Farlex, T. (2009).*The free dictionary.* Retrieved June 28, 2012 from *www.thefreedictionary.com*

Federal Republic of Nigeria (2004). *National policy on education*. Lagos: NERDC Press.

Federal Ministry of Education (2007). *Senior secondary education curriculum (Chemistry).* Abuja: NERDC Press.

Gulbahar, Y., & Guven, I. (2008). A survey on ICT usage and the perceptions of social studies teachers in Turkey. *Educational Technology and Society, 11(3)*, 37 – 51.

Kautz, C. H., Heron, C. R. L., Loverude, M. E. & McDermott, L. C. (2005). Student understanding of the ideal gas law, Part I: A macroscopic perspective. *American Journal of Physics, 73(11), 1055-1063. [DOI: 10.1119/1.2049286]*.

Longman Dictionary of Contemporary English (2005). Essex: Pearson Education Limited.

Nakhleh, M. (1992). Why some students don't learn chemistry. *Journal of Chemical Education, 69(3)*, 191-196.

National Research Council (1996). *National science education standards*. Washington, DC: The National Academies Press.

National Research Council. (1999). *Selecting instructional materials: A guide for K-12 science*. Washington, DC: The National Academies Press.

Novick, S., & Nussbaum, J. (1981). Pupils' understanding of the particulate nature of matter: A cross-age study. *Science Education 65(2),* 187-196.

Scharmann, L. C. (1990). Enhancing an understanding of the premises of evolutionary theory: The influence of a diversified instructional strategy. *School Science and Mathematics*, *90(2),* 91–100.

Stavy, R. (1988). Children's conception of gas. *International Journal of Science Education 10,* 553-60.