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Influence of Class Size and School Location on Students' Level of Conceptual Understanding in Secondary School Chemistry

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Abstract

It is obvious that chemistry students go about with incorrect conceptions of science concepts which will continue to hinder their conceptual understanding of chemistry concepts. Thus, the study seeks to find out how class size and school location influence students' level of conceptual understanding in secondary school chemistry in Gusau, Zamfara State. Two research questions and two null hypotheses guided the study. The study adopted ex-post facto research design. 1102 senior secondary school three (SSS3) chemistry students' of 2020/2021 session in all the 25 public secondary schools in Gusau, formed the population for the study. The sample size of 240 senior secondary three (SS3) students were used for the study. Purposive sampling and proportionate stratified random sampling techniques were used obtain the sample size. Students' Conceptual Understanding Test (SCUT), having 20 objective items, was developed by the researchers. The instrument was validated by 3 experts from the Department of Science Education and Educational Foundation, Federal University Gusau, Zamfara State. The reliability was computed using Cronbach Alpha formula and the internal consistency index of the instrument was calculated to be 0.79. Frequency and percentage were used to answer all the research questions and Chi-square were used in testing the two null hypotheses of the study. The study revealed that class size has significant influence on students' level of conceptual understanding in secondary school chemistry in Gusau. On this basis, the following recommendations were made among others, that: school administrators should strive to maintain teacher to students' ratio as stipulated in the National Policy on Education.

Keywords: Class Size, School Location, Conceptual Understanding, Secondary School Chemistry

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Introduction

The importance of education has been well accentuated in all human societies whether developed or developing, ancient or modern. It is as a result of this that every country accords great emphasis to education both in terms of quality and access. The role of secondary education in national educational system cannot be underrated. It is the intermediate level between the primary and tertiary education. As a conciliator, it absorbs the product of primary education, and serves as an input unit for tertiary education. As a midpoint in the pecking order of education, (i.e. secondary education) its quality influences the standard of tertiary education and the level of literacy in the country.

At the upper level in Nigerian secondary schools, Chemistry is one of the science subjects that senior secondary school students take (Federal Republic of Nigeria, 2013). It is a very important science subject and a requirement for further learning of a number of science-related professional courses, like medicine, agriculture, pharmacy, etc. Today, Chemistry pervades literally every field of human endeavor, and plays a fundamental role in educational advancement. It occupies a unique position among various science subjects offered at the senior secondary school level, because it is a fundamental requirement for most core science-based courses (Oloyede, 2010).

Unfortunately, students' conceptual understanding vis-à-vis students' performance in chemistry has declined. According to Ogunleye (2011) students' performance in Chemistry is substantially fluctuating with a decline occurring more often than improvement. Evidence from the chief examiner's reports of West Africa Senior School Certificate Examination (WASSCE) from 2016 to 2019 revealed that the performance of students was below average with the raw mean scores of 43.0, 47.0, 29.0, 40.0 and standard deviation values of 15.36, 16.0, 13.78, and 14.46 respectively. It means that students' performance in chemistry in 2017 was slightly better than that of 2016, but students' performance in 2018 was worse than those of both 2016 and 2017. In 2019, however, students' performance was significantly better than that of 2018 but was not as good as that of 2017.

To this end, the chief examiner's reports have consistently revealed that candidates did not show basic understanding of simple concepts in chemistry. For instance, they could not correctly define fermentation reaction or explain the chemistry behind the rate of corrosion of tin-coated plate and galvanized plate; they lacked adequate knowledge of chemical concepts; they also often thought that a hydrogen bond is simply a covalent bond to hydrogen, when actually it is a type of intermolecular bond that is not necessarily limited to hydrogens; they assume isomers are always members of the same class of compounds; and they expect all freezing temperatures to be experienced as cold, and all melting temperatures (even for the same substances) to always be experienced as hot.

Conceptual understanding in science means understanding the principles of science, especially the concepts used to explain and predict observations of the natural world and knowing how to apply this understanding efficiently in the design and execution of scientific investigations and in practical reasoning, (National Assessment of Educational Progress, NAEP, 2005). In cognitive science, how concepts are formed in students' minds and most importantly how they are connected might imply students' conceptual understanding (Ogundeji, et.al. 2019). Student' conceptual understanding will require both knowledge of, and the ability to use scientific concepts to develop mental models about the way the world operates following a current scientific theory. The feeling here is that this ability to use scientific concepts in students (known as students' conceptual understanding) may differ with respect to class size and location of school. That is, class size and school location might have some influence on student' conceptual understanding.

Class size is the number of students per teacher in a given class, or the population of a class (Ajayi, et.al. 2017). It has been identified universally by educators as an important and desirable attribute for effective educational system (Mokobia & Okoye, 2011). It is considered as one of the important determinants of academic performance which teachers in schools have little or no control over. The size of a class could be large or small. The National Policy on Education (NPE, 2014) stipulates that the number of students in a class should be 40. It follows then that, a class can be said to be large when the number of students in it is more than 40, and small when the number is lower than that.

However, it has been argued that increasing the intake of senior secondary school students in a large class has numerous benefits for the schools and the country as a whole. For instance, it helps reduce the cost of building additional classrooms, something that few owner of schools as well as the country have the resources to do. Also, there is usually a lot of fun and excitement in a large class size. Students learn to work well in groups, since group work is a necessity in large class size (Azigwe, 2016). In Nigeria, however, class size is becoming increasingly unmanageable, putting teachers in an impossible position of giving individual students required attention. In Nigerian public schools of today, the situation has grown worse that poorly motivated students often form a number of committees at the back of the classroom thus engaging in non-school discussions while teaching is going on. And, regular assignments and home works are dreaded by teachers considering the staggering number of books to mark and record.

Thus, literature have documented the influence of class size and school location on students' academic achievement. For example, Yara (2010) study on class size and academic achievement of students in mathematics in South western Nigeria found out that the performance of students in large classes was very low (23%) compared to those students in smaller classes (64%). In the same vein, Glass and Smith (2007) reported that reduced class size and greater academic achievement are related after using meta-analysis on 80 research studies. Adeyela (2000) concluded that large class size is not conducive for serious academic work. This implies that class size might have some influence on students' conceptual understanding in chemistry.

School location refers to where a given school is situated. It is the particular place, in relation to other areas in the physical environment (rural or urban), where the school is sited (Abiam, 2004). Pascarella and Terenzini (2013) argue that a school located in a rural area will have all the characteristics of a rural environment; similarly, an urban school will have an environment-based activities peculiar to its environment but different from a rural location. They further attributed students' conceptual understanding to school environment (location) and, thus, asserted that conceptual understanding may also differ since environment influences learning. Belanger (2000) stated that people's educational life histories are influenced not only by provision of learning opportunities, but also by the quality of the environment where they live or learn. Graff (2003) warned that the environment in which the learner acquires knowledge has a great influence on the cognitive achievement of the learner. Bosede (2010) stated that gender and location of school influence students' conceptual understanding and academic achievement in some areas. However, this viewpoint was substantiated in Piaget theory of intellectual development which stresses active interaction with the environment as the most basic requirement for proper intellectual development.

On the contrary, Considine and Zappala (2002) found out from Australia that geographical location does not significantly predict outcomes in school performance. The studies of Aborisade (2013) showed no difference in academic achievement of students with regards to school location. In the same vein, Agbir (2004) showed that rural students performed better on practical skills in chemistry than their urban counterparts did. Thus, the influence of class size and school location on students' conceptual understanding and students' academic achievement remains controversial and inconclusive. It is therefore against this background that this study seeks to find out the influence of class size and school location on students' level of conceptual understanding in secondary school chemistry in Gusau.

Objectives of the Study

The main objective of the study is to determine the influence of class size and school location on students' level of conceptual understanding in secondary school chemistry in Gusau.
The specific objectives of this study intend to find out:

1. The influence of class size on students' level of conceptual understanding in secondary school chemistry in Gusau.
2. The influence of school location on students' level of conceptual understanding in secondary school chemistry in Gusau.

Research Questions

The study seeks to answer the following questions:

1. What is the influence of class size on students' level of conceptual understanding in secondary school chemistry in Gusau?
2. What is the influence of school location on students' level of conceptual understanding in secondary school chemistry in Gusau?

Hypotheses

1. There is no statistically significant influence on students' level of conceptual understanding in secondary school chemistry in Gusau based on class size.
2. There is no statistically significant influence on students' level of conceptual understanding in secondary school chemistry in Gusau based on school location.

Methodology

Research design for this study was descriptive survey design. This research design aimed at collecting data on, and describing in a systematic manner the characteristics, features or facts about a given population (Nworgu, 2015). This study was conducted in public secondary schools in Gusau Local Government Area of Zamfara State. The location is selected for this study because, one, as far as the researchers can tell, no study of this kind has ever been conducted in this location. As well, there has been significant fluctuations in the performance of students in chemistry in this location. The population of the study comprised 1,102 SS3 students of the 2020/2021 session in 25 public secondary schools in Gusau, Zamfara State (Zamfara State Ministry of Science and Technology, 2021). The sample size for this study was 240 students drawn from the total population. Simple random sampling technique was used to select 8 schools from the urban and 4 from the rural settlement. While, 20 students were selected from each of this 12 schools using proportionate stratified random sampling technique, giving a total number of 240 respondents to be considered for data collection.

The research instrument used for this study is a 20-item multiple choice question test, titled: Students' Conceptual Understanding Test (SCUT). This instrument was developed by the researchers which is made up of two sections: section A and section B. Section A of the instrument contains demographic information of the students and their schools, and section B contains the 20 multiple choice questions with options A-D. These options consisted of students' conception rubrics having: scientific/sound Understanding (SC), Partial Understanding (PU), Alternative Conception (AC) and Novice Conception (NC), having the following scoring: 4, 3, 2, 1 respectively. The instrument was subjected to face and content validity. For face validity, three copies of the instrument were presented to 3 experts: two in chemistry education from the department of science education, and one from measurement and evaluation unit under educational foundation department, Federal University, Gusau. Corrections given by the experts were promptly rectified during the final draft of the instrument. Likewise, the content validation was done using a table of specification.

To assess the reliability of the instrument, 20 copies of the instrument were administered to senior secondary school three (SS3) chemistry students outside the study area. The instrument, SCUT, was reliable using Cronbach Alfa formula with a reliability index of 0.79, indicating that the instrument was reliable. Prior to conducting the study, appointments were made by the researchers with the sampled schools and then they visited the schools to acquire the approvals of the heads of the schools to conduct the study in their schools. The researchers then visited the sampled schools on different days to distribute the instruments to SS3 students of the schools for data collection. A sum of 240 copies of the instrument are distributed at the different schools. The method of delivery employed was direct delivery method, whereby the researchers administers and retrieves the filled instruments. This is done to guarantee the collection of all the distributed instruments. The researchers then finally score and record the retrieved instruments. The research questions were answered using frequency and percentages, while the hypotheses were tested using Chi-square.

Results

Research Question One

What is the influence of class size on students' level of conceptual understanding in secondary school chemistry in Gusau?

Table 1: Frequency and Percentage Analysis of the Influence of Class Size on Students' Level of Conceptual Understanding in Secondary School Chemistry in Gusau

	Low Class Size (n = 40)				Moderate Class Size (n = 40)				High Class Size (n = 160)			
Item No.	**SU f (%)**	**PU f (%)**	**AC f (%)**	**NC f (%)**	**SU f (%)**	**PU f (%)**	**AC f (%)**	**NC f (%)**	**SU f (%)**	**PU f (%)**	**AC f (%)**	**NC f (%)**
1	10(4.2)	24(10.0)	3(1.2)	3(1.2)	3(1.2)	9(3.8)	27(11.2)	1(0.4)	8(3.3)	13(5.4)	67(27.9)	72(30.0)
2	8(3.3)	26(10.8)	4(1.7)	2(0.8)	2(0.8)	12(5.0)	26(10.8)	0(0.0)	10(4.2)	23(9.6)	72(30.0)	55(22.9)
3	2(0.8)	35(14.6)	1(0.4)	2(0.8)	2(0.8)	1(0.4)	37(15.4)	0(0.0)	16(6.7)	19(7.9)	53(22.1)	72(30.0)
4	6(2.5)	30(12.5)	2(0.8)	2(0.8)	1(0.4)	1(0.4)	38(15.8)	0(0.0)	14(5.8)	16(6.7)	55(22.9)	75(31.2)
5	8(3.3)	23(9.6)	6(2.5)	3(1.2)	8(3.3)	6(2.5)	26(10.8)	0(0.0)	11(4.6)	20(8.3)	51(21.2)	78(32.5)
6	7(2.9)	22(9.2)	8(3.3)	3(1.2	6(2.5)	19(7.9)	13(5.4)	2(0.8)	12(5.0)	25(10.4)	63(26.2)	60(25.0)
7	3(1.2)	35(14.6)	1(0.4)	1(0.4)	0(0.0)	1(0.4)	39(16.2)	0(0.0)	12(5.0)	14(5.8)	63(26.2)	71(29.6)
8	7(2.9)	31(12.9)	0(0.0)	2(0.8)	0(0.0)	8(3.3)	32(13.3)	0(0.0)	13(5.4)	13(5.4)	60(25.0)	74(30.8)
9	7(2.9)	32(13.4)	1(0.4)	0(0.0)	0(0.0)	4(1.7)	36(15.1)	0(0.0)	16(6.7)	18(7.5)	50(20.9)	75(31.4)
10	4(1.7)	34(14.2)	1(0.4)	1(0.4)	0(0.0)	3(1.2)	37(15.4)	0(0.0)	14(5.8)	13(5.4)	49(20.4)	84(35.0)
11	9(3.8)	21(8.8)	5(2.1)	5(2.1)	8(3.3)	10(4.2)	20(8.3)	2(0.8)	15(6.2)	33(13.8)	55(22.9)	57(23.8)
12	6(2.5)	31(12.9)	1(0.4)	2(0.8)	0(0.0)	2(0.8)	37(15.4)	1(0.4)	16(6.7)	16(6.7)	58(24.2)	70(29.2)
13	4(1.7)	35(14.6)	0(0.0)	1(0.4)	0(0.0)	6(2.5)	34(14.2)	0(0.0)	10(4.2)	18(7.5)	46(19.2)	86(35.8)
14	4(1.7)	33(13.8)	2(0.8)	1(0.4)	0(0.0)	1(0.4)	38(15.8)	1(0.4)	15(6.2)	12(5.0)	50(20.8)	86(34.6)
15	10(4.2)	25(10.4)	3(1.2)	2(0.8)	7(2.9)	14(5.8)	19(7.9)	0(0.0)	17(7.1)	14(5.8)	64(26.7)	65(27.1)
16	6(2.5)	28(11.7)	4(1.7)	2(0.8)	1(0.4)	7(2.9)	30(12.5)	2(0.8)	11(4.6)	24(10.0)	56(23.3)	69(28.7)
17	10(4.2)	27(11.2)	1(0.4)	2(0.8)	0(0.0)	12(5.0)	28(11.7)	0(0.0)	15(6.2)	13(5.4)	67(27.9)	65(27.1)
18	12(5.0)	24(10.0)	4(1.7)	0(0.0)	3(1.2)	2(0.8)	35(14.6)	0(0.0)	6(2.5)	29(12.1)	65(27.1)	60(25.0)
19	6(2.5)	27(11.2)	4(1.7)	3(1.2)	4(1.7)	7(2.9)	27(11.2)	2(0.8)	13(5.4)	16(6.7)	62(25.8)	69(28.7)
20	7(2.9)	31(12.9)	1(0.4)	1(0.4)	3(1.2)	1(0.4)	36(15.0)	0(0.0)	12(5.0)	21(8.8)	53(22.1)	74(30.8)
O/No. of Std	**6(2.8)**	**29(12.0)**	**3(1.2)**	**2(0.8)**	**2(0.8)**	**6(2.8)**	**31(12.8)**	**1(0.2)**	**13(5.3)**	**18(7.7)**	**58(24.1)**	**71(29.5)**

O/No. of Stdts: Overall number of students. n = Number of Respondents; NC= Novice Conception; AC = Alternative Conception; PU = Partial Understanding; SU = Scientific/Sound Understanding; F =frequency; % = Percentage.

Table 1 shows the item analysis of students' level of conceptual understanding in chemistry based on their class size and are presented in frequencies and percentages. On the overall, it was revealed that students whose Low Class Size were 6(2.8%) on SU; 29(12%) on PU; 3(1.2%) on AC and 2(0.8%) on NC; out of 40. The result indicates that a very small number of students were on Alternative Conception (AU) and Novice Conception (NC) while more than half of the students were on Partial Understanding (PU) but moving toward a scientific conceptual understanding. Although, students in the Moderate Class Size were 2(0.8%) on SU; 6(2.8%) on PU; 31(12.8%) on AC and 1(0.2%) on NC; out of 40. The result indicates that, a very small number of students were on Scientific Understanding (SU) and Partial Understanding (PU) while, more than half of the students were on Alternative Conception (AU) and Novice Conception (NC). But, students in the High Class size were 13(5.3%) on SU; 18(7.7%) on PU; 58(24.1%) on AC and 71(29.5%) on NC; out of 160. The result indicates that a very small number of students were on Scientific Understanding (SU) and Partial Understanding (PU) while, more than half of the students were on Alternative Conception (AU) and Novice Conception (NC).

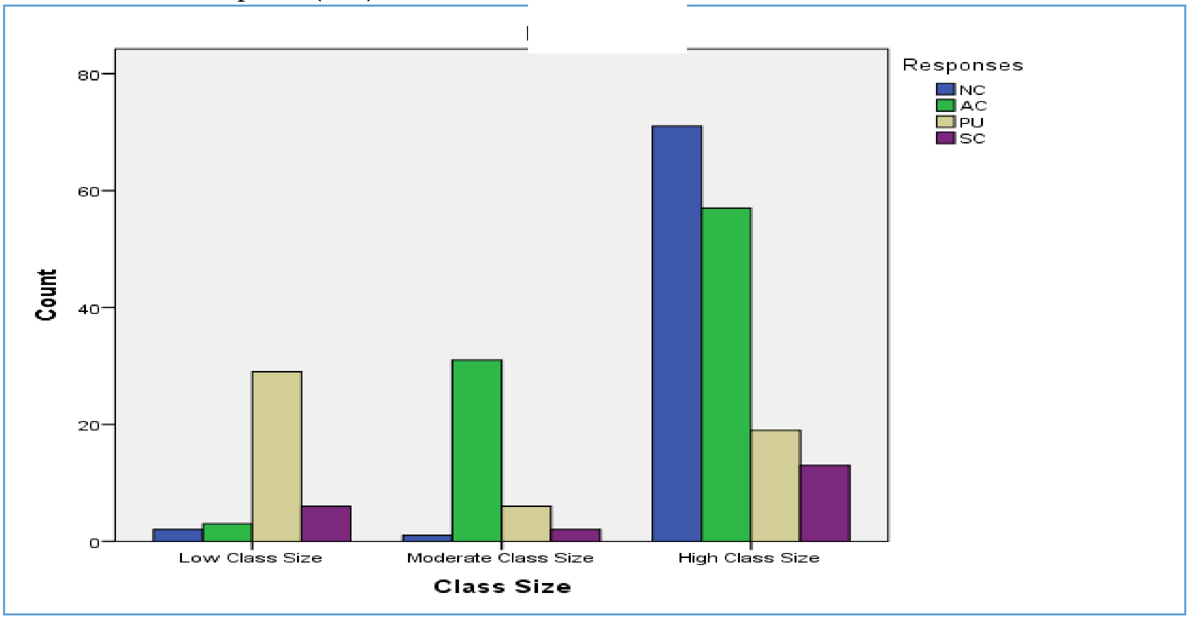

Fig. 1: Histogram Showing the Distribution of Class Size on Overall Students' Level of Conceptual Understanding in Secondary School Chemistry in Gusau.

However, the chart above (Fig.1) revealed how students' response with categorizes been distributed among class size. The chart showed clearly that high class size seems to promote NC and AC (i.e. bars with blue and green) compared to moderate and low class size. However, the chart revealed that low and moderate class sizes promote PU and SU when compared with High class size. Nevertheless, the influence of class size on students' level of conceptual understanding in secondary school chemistry in Gusau was further investigated by testing the hypothesis below.

Research Question 2

What is the influence of school location on students' level of conceptual understanding in secondary school chemistry in Gusau?

Table 4: Frequency and Percentage Analysis of Influence of location on students' level of conceptual understanding in secondary school chemistry in Gusau.

Item No.	Rural (80)				Urban (160)			
	SU f (%)	PU f (%)	AC f (%)	NC f (%)	SU f (%)	PU f (%)	AC f (%)	NC f (%)
1	4(1.7)	9(3.8)	29(12.1)	38(15.8)	8(3.3)	10(4.2)	57(23.8)	85(35.4)
2	6(2.5)	13(5.4)	30(12.5)	31(12.9)	6(2.5)	16(6.7)	62(25.8)	76(31.7)
3	10(4.2)	11(4.6)	22(9.2)	37(15.4)	8(3.3)	11(4.6)	34(14.2)	107(44.6)
4	6(2.5)	9(3.8)	27(11.2)	38(15.8)	10(4.2)	10(4.2)	35(14.6)	105(43.8)
5	5(2.1)	8(3.3)	26(10.8)	41(17.1)	9(3.8)	26(10.8)	39(16.2)	86(35.8)
6	7(2.9)	13(5.4)	28(11.7)	32(13.3)	10(4.2)	26(10.8)	61(25.4)	63(26.2)
7	7(2.9)	13(5.4)	28(11.7)	32(13.3)	10(4.2)	26(10.8)	61(25.4)	63(26.2)
8	6(2.5)	10(4.2)	31(12.9)	33(13.8)	9(3.8)	3(1.2)	44(18.3)	104(43.3)
9	9(3.8)	9(3.8)	25(10.5)	37(15.5)	7(2.9)	10(4.2)	36(15.1)	106(44.4)
10	10(4.2)	7(2.9)	25(10.4)	38(15.8)	5(2.1)	7(2.9)	31(12.9)	117(48.8)
11	10(4.2)	18(7.5)	25(10.4)	27(11.2)	12(5.0)	28(11.7)	49(20.4)	71(29.6)
12	12(5.0)	9(3.8)	24(10.0)	35(14.6)	7(2.9)	8(3.3)	42(17.5)	103(42.9)
13	5(2.1)	10(4.2)	24(10.0)	41(17.1)	6(2.5)	8(3.3)	32(13.3)	114(47.5)
14	11(4.6)	8(3.3)	19(7.9)	42(17.5)	6(2.5)	6(2.5)	36(15.0)	112(46.7)
15	8(3.3)	8(3.3)	32(13.3)	32(13.3)	11(4.6)	16(6.7)	56(23.3)	77(32.1)
16	8(3.3)	14(5.8)	25(10.4)	33(13.8)	7(2.9)	15(6.2)	44(18.3)	94(39.2)
17	8(3.3)	10(4.2)	33(13.8)	29(12.1)	9(3.8)	4(1.7)	56(23.3)	91(37.9)
18	3(1.2)	18(7.5)	30(12.5)	29(12.1)	3(1.2)	18(7.5)	49(20.4)	90(37.5)
19	9(3.8)	6(2.5)	26(10.8)	39(16.2)	9(3.8)	18(7.5)	49(20.4)	84(35.0)
20	8(3.3)	13(5.4)	19(7.9)	40(16.7)	5(2.1)	12(5.0)	42(17.5)	101(42.1)
O/N Stdts	**8(3.2)**	**11(4.5)**	**26(11)**	**35(14.7)**	**8(3.2)**	**14(5.8)**	**46(19.1)**	**92(38.5)**

O/No. of Stdts: Overall number of students. n = Number of Respondents; NC= Novice Conception; AC = Alternative Conception; PU = Partial Understanding; SU = Scientific Understanding; F =frequency; % = Percentage.

Table 4 shows the item analysis of students' level conceptual understanding in chemistry based on school location and are presented in frequencies and percentages. On the overall, it was revealed that students in schools located in rural centers were 8(3.2%) on SU; 11(4.5%) on PU; 26(11%) on AC and 35(14.7%) on NC; out of 80. The result indicates that, a very small number of students were on Scientific Understanding (SU) and Partial Understanding (PU) while, more than half of the students were on Alternative Conception (AU) and Novice Conception (NC). Similarly, students in the schools located in urban centers were 8(3.2%) on SU; 14(5.8%) on PU; 46(19.1%) on AC and 92(38.5%) on NC; out of 160. The result indicates that, a very small number of students were on Scientific Understanding (SU) and Partial Understanding (PU) while, more than half of the students were on Alternative Conception (AU) and Novice Conception (NC). There is no much difference in the students' level conceptual understanding in secondary school chemistry based on school location. Therefore, any difference observed in the frequencies and percentages is due to chance or difference in the number of respondents with regard to location (i.e. 80 students in rural against 160 students in urban).

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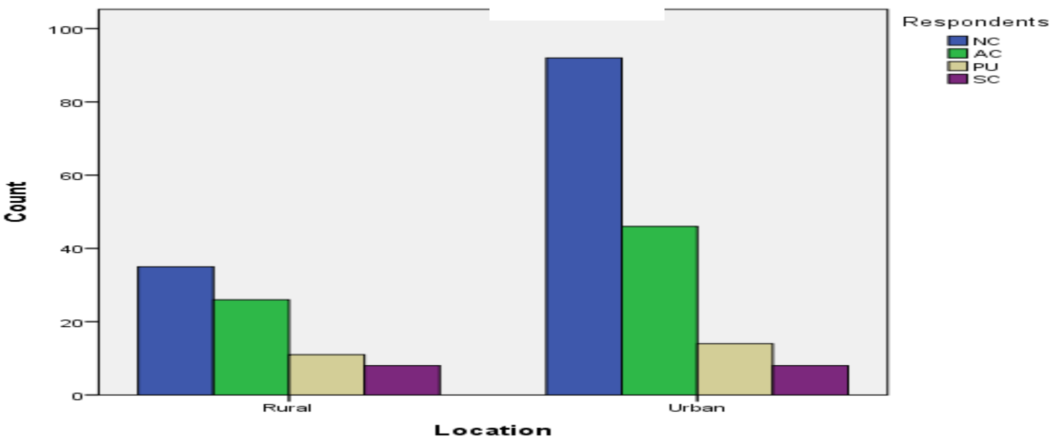

Fig. 2: Histogram Showing the Distribution of Location on Overall Students' Level of Conceptual Understanding in Secondary School Chemistry.

However, the chart above (Fig.2) revealed how students' response with categorizes been distributed among school location (urban or rural). The chart showed clearly that large number of chemistry students in both urban and rural schools go about with Novice and Alternative conceptual understanding. And, there is little or no difference in Scientific Understanding and Partial Understanding in secondary school chemistry based on school location. Nevertheless, the influence of school location on students' level of conceptual understanding in secondary school chemistry in Gusau will be further investigated by testing the hypothesis below.

Hypothesis One

There is no statistically significant influence on students' level of conceptual understanding in secondary school chemistry in Gusau based on class size.

Table 2: Chi-square Analysis of Class Size on Students' Level Conceptual Understanding in Senior Secondary School Chemistry in Gusau

Item No.	Low Class Size (40)				Moderate Class Size (40)				High Class Size (160)				χ^2	p-value	Dec
	SU f (%)	PU f (%)	AC f (%)	NC f (%)	SU f (%)	PU f (%)	AC f (%)	NC f (%)	SU f (%)	PU f (%)	AC f (%)	NC f (%)			
1	10(4.2)	24(10.0)	3(1.2)	3(1.2)	3(1.2)	9(3.8)	27(11.2)	1(0.4)	8(3.3)	13(5.4)	67(27.9)	72(30.0)	9.83	0.13	NS
2	8(3.3)	26(10.8)	4(1.7)	2(0.8)	2(0.8)	12(5.0)	26(10.8)	0(0.0)	10(4.2)	23(9.6)	72(30.0)	55(22.9)	22.31	0.00	S
3	2(0.8)	35(14.6)	1(0.4)	2(0.8)	2(0.8)	1(0.4)	37(15.4)	0(0.0)	16(6.7)	19(7.9)	53(22.1)	72(30.0)	46.50	0.00	S
4	6(2.5)	30(12.5)	2(0.8)	2(0.8)	1(0.4)	1(0.4)	38(15.8)	0(0.0)	14(5.8)	16(6.7)	55(22.9)	75(31.2)	35.78	0.00	S
5	8(3.3)	23(9.6)	6(2.5)	3(1.2)	8(3.3)	6(2.5)	26(10.8)	0(0.0)	11(4.6)	20(8.3)	51(21.2)	78(32.5)	10.16	0.12	NS
6	7(2.9)	22(9.2)	8(3.3)	3(1.2	6(2.5)	19(7.9)	13(5.4)	2(0.8)	12(5.0)	25(10.4)	63(26.2)	60(25.0)	9.34	0.16	NS
7	3(1.2)	35(14.6)	1(0.4)	1(0.4)	0(0.0)	1(0.4)	39(16.2)	0(0.0)	12(5.0)	14(5.8)	63(26.2)	71(29.6)	52.61	0.00	S
8	7(2.9)	31(12.9)	0(0.0)	2(0.8)	0(0.0)	8(3.3)	32(13.3)	0(0.0)	13(5.4)	13(5.4)	60(25.0)	74(30.8)	25.93	0.00	S
9	7(2.9)	32(13.4)	1(0.4)	0(0.0)	0(0.0)	4(1.7)	36(15.1)	0(0.0)	16(6.7)	18(7.5)	50(20.9)	75(31.4)	35.03	0.00	S
10	4(1.7)	34(14.2)	1(0.4)	1(0.4)	0(0.0)	3(1.2)	37(15.4)	0(0.0)	14(5.8)	13(5.4)	49(20.4)	84(35.0)	31.55	0.00	S
11	9(3.8)	21(8.8)	5(2.1)	5(2.1)	8(3.3)	10(4.2)	20(8.3)	2(0.8)	15(6.2)	33(13.8)	55(22.9)	57(23.8)	7.58	0.27	NS
12	6(2.5)	31(12.9)	1(0.4)	2(0.8)	0(0.0)	2(0.8)	37(15.4)	1(0.4)	16(6.7)	16(6.7)	58(24.2)	70(29.2)	39.39	0.00	S
13	4(1.7)	35(14.6)	0(0.0)	1(0.4)	0(0.0)	6(2.5)	34(14.2)	0(0.0)	10(4.2)	18(7.5)	46(19.2)	86(35.8)	27.17	0.00	S
14	4(1.7)	33(13.8	2(0.8)	1(0.4)	0(0.0)	1(0.4)	38(15.8)	1(0.4)	15(6.2)	12(5.0)	50(20.8)	86(34.6)	33.53	0.00	S
15	10(4.2)	25(10.4)	3(1.2)	2(0.8)	7(2.9)	14(5.8)	19(7.9)	0(0.0)	17(7.1)	14(5.8)	64(26.7)	65(27.1)	13.25	0.04	S
16	6(2.5)	28(11.7)	4(1.7)	2(0.8)	1(0.4)	7(2.9)	30(12.5)	2(0.8)	11(4.6)	24(10.0)	56(23.3)	69(28.7)	19.97	0.00	S
17	10(4.2)	27(11.2)	1(0.4)	2(0.8)	0(0.0)	12(5.0)	28(11.7)	0(0.0)	15(6.2)	13(5.4)	67(27.9)	65(27.1)	20.37	0.00	S
18	12(5.0)	24(10.0)	4(1.7)	0(0.0)	3(1.2)	2(0.8)	35(14.6)	0(0.0)	6(2.5)	29(12.1)	65(27.1)	60(25.0)	35.86	0.00	S
19	6(2.5)	27(11.2)	4(1.7)	3(1.2)	4(1.7)	7(2.9)	27(11.2)	2(0.8)	13(5.4)	16(6.7)	62(25.8)	69(28.7)	15.28	0.02	S
20	7(2.9)	31(12.9)	1(0.4)	1(0.4)	3(1.2)	1(0.4)	36(15.0)	0(0.0)	12(5.0)	21(8.8)	53(22.1)	74(30.8)	34.23	0.00	S

NB: n = Number of Respondent; NC = No Conception; AC = Alternative Conception; PU = Partial Understanding; SC = Sound/Scientific Understanding; f = Frequency; % = Percentage; $\chi2$ = Chi-Square; p-value = Probability value; df = Degree of freedom; Dec = Decision

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The result presented in Table 2 revealed that items 1, 5, 6 and 11 were not significant (NS) since the probability values ranges from (p= 0.12 to 0.27) which is greater than the level of significance (p = 0.05). However, items 2-4, 7-10 and 12-20 whose probability values ranges from (p = 0.00 to 0.04) which is less than the level of significance (p=0.05) were significant (S). Hence, the above result calls for overall trace analysis so as to draw a unified conclusion on the influence of class size on students' conceptual understanding in secondary school chemistry.

Table 3: Overall Trace Analysis of Influence of Class Size on Students' Level of Conceptual Understanding in Senior Secondary School Chemistry in Gusau

Class Size	Response				Total	Mean	df	p-value	Dec.
	SU	PU	AC	NC					
Low	2	3	29	6	40				
Moderate	1	31	6	2	40	111.1	6	0.00	S
High	71	57	19	13	160				
Total	74	91	54	21	240				

NB: n = Number of Respondent; NC = No Conception; AC = Alternative Conception; PU = Partial Understanding; SU= Sound/Scientific Understanding; $\chi 2$ = Chi-Square; p-value = Probability value; df = Degree of freedom; Dec

The result presented in Table 3, revealed the result on influence of class size on students conceptual understanding in secondary school chemistry. The probability value (0.00) was less than the level of significance (0.05). This gave the decision that the hypothesis is S (Significant). To this effect, the null hypothesis was rejected by the researcher. Thus, students' understanding in senior secondary school chemistry is significantly influenced by Class Size.

Hypothesis Two:

There is no statistically significant influence on students' level of conceptual understanding in secondary school chemistry in Gusau based on school location.

Table 5: Chi-square Analysis of Influence of location on students' level of conceptual understanding in secondary school chemistry in Gusau

	Rural (80)				Urban (160)						
Item No.	SU f (%)	PU f (%)	AC f (%)	NC f (%)	SU f (%)	PU f (%)	AC f (%)	NC f (%)	χ^2	p-value	Dec.
1	4(1.7)	9(3.8)	29(12.1)	38(15.8)	8(3.3)	10(4.2)	57(23.8)	85(35.4)	2.02	0.57	NS
2	6(2.5)	13(5.4)	30(12.5)	31(12.9)	6(2.5)	16(6.7)	62(25.8)	76(31.7)	4.16	0.25	NS
3	10(4.2)	11(4.6)	22(9.2)	37(15.4)	8(3.3)	11(4.6)	34(14.2)	107(44.6)	11.42	0.01	S
4	6(2.5)	9(3.8)	27(11.2)	38(15.8)	10(4.2)	10(4.2)	35(14.6)	105(43.8)	7.66	0.05	S
5	5(2.1)	8(3.3)	26(10.8)	41(17.1)	9(3.8)	26(10.8)	39(16.2)	86(35.8)	2.87	0.41	NS
6	7(2.9)	13(5.4)	28(11.7)	32(13.3)	10(4.2)	26(10.8)	61(25.4)	63(26.2)	0.62	0.89	NS
7	7(2.9)	13(5.4)	28(11.7)	32(13.3)	10(4.2)	26(10.8)	61(25.4)	63(26.2)	27.94	0.00	S
8	6(2.5)	10(4.2)	31(12.9)	33(13.8)	9(3.8)	3(1.2)	44(18.3)	104(43.3)	18.85	0.00	S
9	9(3.8)	9(3.8)	25(10.5)	37(15.5)	7(2.9)	10(4.2)	36(15.1)	106(44.4)	10.63	0.01	S
10	10(4.2)	7(2.9)	25(10.4)	38(15.8)	5(2.1)	7(2.9)	31(12.9)	117(48.8)	17.89	0.00	S
11	10(4.2)	18(7.5)	25(10.4)	27(11.2)	12(5.0)	28(11.7)	49(20.4)	71(29.6)	3.63	0.30	NS
12	12(5.0)	9(3.8)	24(10.0)	35(14.6)	7(2.9)	8(3.3)	42(17.5)	103(42.9)	14.77	0.00	S
13	5(2.1)	10(4.2)	24(10.0)	41(17.1)	6(2.5)	8(3.3)	32(13.3)	114(47.5)	10.32	0.02	S
14	11(4.6)	8(3.3)	19(7.9)	42(17.5)	6(2.5)	6(2.5)	36(15.0)	112(46.7)	13.68	0.00	S
15	8(3.3)	8(3.3)	32(13.3)	32(13.3)	11(4.6)	16(6.7)	56(23.3)	77(32.1)	1.80	0.62	NS
16	8(3.3)	14(5.8)	25(10.4)	33(13.8)	7(2.9)	15(6.2)	44(18.3)	94(39.2)	8.96	0.03	S
17	8(3.3)	10(4.2)	33(13.8)	29(12.1)	9(3.8)	4(1.7)	56(23.3)	91(37.9)	15.68	0.00	S
18	3(1.2)	18(7.5)	30(12.5)	29(12.1)	3(1.2)	18(7.5)	49(20.4)	90(37.5)	10.32	0.02	S
19	9(3.8)	6(2.5)	26(10.8)	39(16.2)	9(3.8)	18(7.5)	49(20.4)	84(35.0)	3.21	0.36	NS
20	8(3.3)	13(5.4)	19(7.9)	40(16.7)	5(2.1)	12(5.0)	42(17.5)	101(42.1)	10.27	0.02	S

NB: n = Number of Respondent; NC = No Conception; AC = Alternative Conception; PU = Partial Understanding; SU = Sound/Scientific Understanding; f = Frequency; % = Percentage; $\chi 2$ = Chi-Square; p-value = Probability value; df = Degree of freedom; Dec = Decision

The result presented in Table 5 revealed that items 1, 2, 5, 6, 11, 15 and 19 were not significant since the probability values ranges from (p = 0.25 to 0.89) which is greater than the level of significance (p = 0.05). However, items 3, 4, 7-10, 12-14, 16-18, and 20 whose probability values ranges from (p = 0.00 to 0.05) which is less than or equal to the level of significance ($p \leq 0.05$) were significant (S). Hence, the above result calls for overall trace analysis so as to draw a unified conclusion on the influence of school location on students' level of conceptual understanding in secondary school chemistry in Gusau.

Table 6: Overall Trace Analysis of Influence of School location on Students' Level of Conceptual Understanding in Senior Secondary School Chemistry in Gusau

		Respondents				Total	χ^2	df	p-value	Dec.
		SU	PU	AC	NC					
Location	Rural	8	11	26	35	80	5.436	3	0.143	NS
	Urban	8	14	46	92	160				
Total		16	25	72	127	240				

NB: n = Number of Respondent; NC = No Conception; AC = Alternative Conception; PU = Partial Understanding; SU= Sound/Scientific Understanding; χ2 = Chi-Square; p-value = Probability value; df = Degree of freedom; Dec

The result presented in Table 6, revealed the result on influence of school location on students' level of conceptual understanding in secondary school chemistry in Gusau. The probability value (0.143) was greater than the level of significance (0.05). This gave the decision that the hypothesis is NS (Not Significant). To this effect, the null hypothesis was not rejected by the researcher. Thus, students' level of conceptual understanding in senior secondary school chemistry in Gusau is not significantly influenced by school location.

Discussion of Findings

From the data collected for this study on the influence of class size and school location on students' level of conceptual understanding in secondary school chemistry in Gusau, a couple of findings have been made. Evidence from the analyses of the research questions and the tests of the hypotheses revealed that class size and school location influenced students' level of conceptual understanding in secondary school chemistry in Gusau. To establish this fact, two research questions were posed and two hypotheses were tested.

The findings of the study showed that class size had significant influence on students' level of conceptual understanding in secondary school chemistry in Gusau; that is, low and moderate class sizes promote scientific and partial understanding when compared with high class size. The finding of Glass and Smith (2007) which revealed that reduced class size and greater pupil achievement corroborate the findings of the present study. Also, finding of Yara (2010), which showed that performance of students in large classes was very low when compared with that of students in smaller classes, supported the finding of this study. As well, finding of Azigwe (2016) who revealed that students' engagement, behavior, and retention are affected in so many ways by the size of the class, agreed with the findings of this present study. Findings of all the studies revealed were in line with the findings of this study, since, students' academic achievement, students' conceptual understanding, engagement behavior and retention, all centred on students' outcome. But, findings of this study differ to the findings of all other studies revealed because finding of this study confirmed the significant influence of class size on students' level of conceptual understanding in secondary school chemistry.

Also, finding of this study revealed that school location has influence on students' level of conceptual understanding in secondary school chemistry in Gusau. However, the influence was not significant as revealed by the findings of the present study. Finding of the present study is similar to that of Nduji and Madu (2020) whose finding revealed that location has no significant influence on students' conception of heat energy in senior secondary school physics. The only difference in the two study is the subject and the area of the study. Against the finding of this present study, are the findings of Ella and Ita (2017), Onoyase (2015), Eraikhuemen (2014), and Obe (2013) which seem to disagree with the finding of the study and that of Nduji and Madu, by showing that the school location could significantly influence the academic achievement of students. Meanwhile, Nduji's study and the present study was on students' conceptual understanding and that of other study reviewed were on students' academic achievement. Therefore, the observed difference might be that, a significant difference exists between students' academic achievement and students' level of conceptual understanding; or the observed differences in their findings might be as a result of differences in design and method of data analysis used, instrument used for data collection, geographical as well as content scope.

Conclusion

It is obvious that chemistry students go about with incorrect conceptions of science concepts which will continue to hinder students conceptual understanding of chemistry concepts. However, several attempts that was made by stakeholders have not yielded much result, hence, the main purpose of the study: influence of class size and school location on students' level of conceptual understanding in secondary school chemistry in Gusau. Findings of the study showed that class size has significant influence on students' conceptual understanding in secondary school chemistry in Gusau. And, Low and Moderate class size promote scientific and partial understanding when compared with High class size. Moreso, findings of the study showed that school location has significant influence on students' level of conceptual understanding in secondary school chemistry in Gusau. On this basis, several recommendations were made.

Recommendations

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

1. Chemistry teachers in various schools in Gusau irrespective of the location should strive to master their subject content knowledge so as to be able to impart in their students sound or scientific conceptual understanding of chemical concepts.
2. School administrators should strive to maintain teacher to students' ratio as stipulated in the National Policy on Education (i.e. the number of students in classes secondary schools should not exceed 40).

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