AN ANALYSIS OF MISCONCEPTIONS IN ORGANIC CHEMISTRY AMONG SELECTED SENIOR SECONDARY SCHOOL STUDENTS IN ZARIA LOCAL GOVERNMENT AREA OF KADUNA STATE, NIGERIA

Efe M. Omwirhiren, Esq.[Ph.D] [1,2*]
* omwirhirenefe83@gmail.com
+234-806-676-6686

and

Augustine O. Ubanwa[1**]
** ubanwaaugustine@yahoo.co.uk
+234-806-871-4909

1. Chemistry Department, Federal College of Education, P.M.B. 1041, Zaria, Nigeria.
2. .Present address of Correspondence:, Department of Biochemistry, Kaduna State University [KASU],P.M.B. 2339, Kaduna, Nigeria.

* Author for correspondence

ABSTRACT

The purpose of this study was to investigate the misconception in organic chemistry among senior secondary chemistry students in Zaria Local Government Kaduna state, Nigeria. A total of 120 senior secondary III (SS3) chemistry students with a mean of 17 years were randomly selected from two public single sex (male and female only) and one private co-educational senior secondary schools in Zaria Local Governmant Area of Kaduna State. Organic Chemistry Misconception test (OCMT) and a structural questionnaire were used as instrument to collect data. The OCMT contained 30 multiple choice questions with four options (A-D) designed to identify students' misconception while the questionnaire contained 23 questions designed to determine students' awareness and attitude towards organic chemistry. The data was analyzed using frequencies, percentages, mean, standard deviation and t-test statistics at $P<0.05$. The result of the study revealed that students have misconception in organic chemistry and there was no significant difference in the level of misconception between male and female students ($t.cal=0.48 < t.crit=1.96$). There was no significant difference between male or female students' misconception in organic chemistry and their academic performance ($t.cal=0.32 < t.crit=1.96$) and ($t.cal=0.57 < t.crit=1.96$). There was no significant difference between the academic performance of male and female students in organic chemistry ($t.cal=0.57 < t.crit=1.96$). Based on the findings, it was recommended among others that the teaching of organic chemistry should start as early as SS1 so as to allow full coverage of its content and hence familiarize the students with it components.

Keywords : Misconception, Gender, Academic performance, Attitude,Organic chemistry

1. Introduction

The purpose of this study was to investigate the misconception in organic chemistry among senior secondary chemistry students in Zaria Local Government Area of Kaduna state, Nigeria.

1.1 Background to the study

Chemistry is one of the three main branches of pure science, others being biology and physics. Chemistry has been defined differently by various authors. Ababio (2004), defined chemistry as the branch of science that deals with the composition, properties and uses of matter. It probes into the principles governing the changes that matter undergoes. Encyclopedia (2015), chemistry is a branch of science concerned with the properties, composition, and structure of substances and the changes they undergo when they combine or react under specified conditions. Furthermore, chemistry can be characterized and studied under its varying branches; organic, inorganic, physical, analytical, industrial, nuclear.

Organic chemistry in its simplest term is the chemistry of carbon compounds, excluding carbon oxides, metal carbonyls, metallic carbonates and other related compounds (Inikori, 2004). Organic chemistry is the chemistry of hydrocarbon and its derivatives (Omwirhiren, 2006). Organic compounds are any of a large class of chemical compounds in which one or more atoms of carbon are covalently linked to atoms of other elements, most commonly hydrogen, oxygen, or nitrogen (Encyclopedia Britannica, 2015).

Human beings naturally learn from natural and social environment through the observation using their five senses. This learning process, whether aware or not, occurs continuously from the beginning until the end of human life. In this case, human being especially students, grow and develop various ideas and conceptions about everything they receive from their environment. Consequently, students do not enter the classrooms as blank vessel, but they enter classrooms with preexisting knowledge or ideas of science concepts that will be delivered by teacher (Gonen & Kocakaya, 2010). These ideas, from the students' point of view, can be understood in such a way that is strongly held by the students. These ideas and conceptions are possibly correct, but most of them are significantly different from accepted scientific viewpoints and tend to be rationalized by students arbitrarily by only considering what they receive from their five senses. Therefore, the concepts they construct cannot correctly explain the scientific phenomena and, finally, deviate from scientific concepts. These differences between the students' views and the scientifically accepted views are called misconceptions (Ozmen, 2004; Barke et al., 2009), alternative conceptions (Pedrosa & Dias, 2000; Talanquer, 2006), commonsense reasoning (Talanquer, 2006), preconceptions (Barke et al., 2009), or naive conception (Reiner et al., 2000). Some of these misconceptions can be removed easily, but most of them are strongly held by students and usually not affected by regular classroom teaching because these are something students believe. If the misconceptions are not corrected, new concepts would be difficult to be learnt (Gonen & Kocakaya, 2010). This is the focus of the study.

1.2 Concept and Sources of Misconception among students

Concepts are ideas, notions or thoughts which can be regarded as the emerging image of the mental process (Lakpini, 2006). It may be a product of some intuitive re-appraisal; the only problem is that a concept could be concrete, abstract or even blurred. Pella (1977) in Adamu (2011) defined concepts as a summary of the essential characteristics of a group of ideas.

Misconception might also be referred to as preconceived notions, non scientific beliefs, naïve theories, mixed conceptions or conceptual misunderstandings. Basically, in science, there are

instances where the ideas in the mind of individuals may be different from what is scientifically correct (Sani, 2010).What is of great concern about misconceptions is that individuals continue to build knowledge on their current understanding which may have negative impact on future learning.

The study of misconceptions has generated considerable interest among science educators such as it is essential for a successful teaching and learning interplay. Various authorities have different views on what misconception is, for instance, Kopnicek and Watson (1990) in Sani (2010), described misconceptions as personal constructions, which are formed on what an individual feels or sees. These experiences have profound effect on the learner's willingness and ability to accept other more scientifically grounded explanations of how the world works. They opined also that misconceptions are erroneous beliefs or alternative views of scientific principles or wrong notions about certain scientific concepts. Chiu (2005) agreed that students do not grasp fundamental ideas covered in classroom teaching instructions. Even some of the best students give the right answers but only using correctly memorized words. When questioned more closely, these students reveal their failure to understand fully the underlying concepts.

Many studies have shown that students develop their scientific misconceptions from many sources (Dikmenli and Carak, 2004; Soyibo, 2008; Sani, 2010). Those sources have always created inconsistent frameworks or incorrect representation of the scientific concepts. The sources include but not limited to personal experiences (such as observation), gender, peer interaction, media, language, symbolic representation, textbooks, laboratory works, environmental, social, religion among others (Posner 1982 in Adamu, 2011).

A number of researchers also revealed that students at different ages held similar misconceptions that influence their understanding of more complex concepts (Lee, 2004; Gonen and Kocakaya, 2010). Deshmukh (2009) posits that language can cause or increase misconception because the meanings of the same word in chemistry are different from the language used in daily life. Also, Oversby (2000) argued that models used in textbooks only provide explanations of phenomena, and they have their strengths and limitations in relation to misconception.

Hwang (2004) found that not only students of secondary schools have misconception in identifying whether a substance is an acid or a base, but their teachers had misconception as well. Voska and Heikkinen (2000) in their study noted that even college students did not understand or misconceive how adding a solid to the solution influences the equilibrium state. Students' aversion to certain key concepts in chemistry is on the increase. Such concept includes hybridization, chain reaction, chemical equation, polymerization and even nomenclature of organic compounds.

1.4 **Review of related studies on misconception in chemistry**

Previous studies revealed that students hold misconceptions in chemistry. Some of the conceptual areas in which most studies have been conducted are chemical equilibrium (Erdemir et al.,2000; Sendur et al., 2010; Husseini, 2011), acid-base (Kousathana et al., 2005; Sheppard, 2006), chemical bonding (Coll & Taylor, 2002; Ozmen, 2004; Smith & Nakhleh, 2011), nuclear chemistry (Nakibog, Lu & Tekin, 2006), atomic orbital and hybridization (Nakiboglu, 2003), buffer solution (Orgil & Sutherland, 2008), solutions and their components (Çalık & Ayas, 2005; Pinarbasi & Canpolat, 2003), colligative properties (Pinarbasi et al., 2009), inorganic chemistry (Adesoji & Babatunde, 2008; Sani, 2010), organic chemistry (Childs & Sheehan, 2009, Ratcliffe, 2002; Johnstone, 2006) and electrochemistry (Huddle & White, 2000).

Prominent among the factors that have been identified to be responsible for these misconceptions are poor method of instruction, improper exposure to laboratory activities, lack of organizational skills and inadequate exposure to problem solving procedures among others (Sani, 2010).

1.3 Statement of problem

Students' low performance in chemistry at the Senior Secondary School level in Nigeria is a major problem, and many scholars believed that it is hinged on misconception of some aspect in the subject (Jimoh, 2002; Heeman, 2005; Bryan, 2007; Adesoji and Babatunde, 2008; Sani, 2010). One of such aspect is the organic aspect of chemistry (Childs & Sheehan, 2009, Ratcliffe, 2002, Johnstone, 2006).. It is acknowledged that learners actively select and order information and also construct it in order for them to learn meaningfully. All existing knowledge, including concepts and information processing strategies play a vital role in shaping learning outcomes, because they influence new stimuli and the subsequent generation of meaning. As learning is a personal construct, there is likelihood that some constructions will be erroneous and consequently may adversely affect subsequent learning. Identification of these misconceptions will be a first step in trying to look for a way to remedy them. It has been shown that if the right approach or method is used in teaching organic chemistry, the problem of misconception can be minimized (Heeman, 2005; Bryan, 2007).

A student who has a partial understanding of a concept or misconception will likely resort to rote learning. In contrast, a student who properly understands the concept would approach the problem requiring solution in his own way and may be able to tackle most puzzles correctly. There is also a strong indication that lack of awareness of misconception by students in chemistry may be contributing factor to students' poor academic performance in chemistry. Despite the several studies on the such by various science educators, there is as yet little or no study in Kaduna State, Nigeria aimed at establishing the major misconception in the learning of organic chemistry..

2 Purpose of the study

The ultimate goal of this research is to analyze students' misconceptions in learning of organic chemistry. Specifically, the study sought to:

i. Determine the level of misconception of male and female students in organic chemistry.
ii. Determine the effect of the misconception on the academic achievement of male and female students in organic chemistry.

3 Research questions

The study intends to find answers to the following questions:

i. What are the level of misconception of male and female students in organic chemistry?
ii. What is the effect of misconception on the academic achievement of male students?
iii. What is the effect of misconception on the academic achievement of female students?
iv. Is there any significant difference between the academic performance of male and female students in organic chemistry.

4 Null hypotheses

On the basis of the research questions the following null hypotheses were formulated at $P < 0.05$:

H_o1; There is no significant difference in the level of misconception between male and female students in organic chemistry.

H_o2; There is no significant difference between male students' misconception in organic chemistry and their academic performance.

H_o3; There is no significant difference between female students' misconception in organic chemistry and their academic achievement.

H_o4; There is no significant difference between the academic performance of male and female students in organic chemistry.

5. Significance of the study

The study is significant to the upliftment of science education because the findings will provide:

i. Areas students' have misconception and learning difficulties in relation to organic aspect of chemistry. The information will help teachers to seek for better instructional strategies that could help to correct the misconceptions that students have about the organic aspect of chemistry.
ii. Empirical evidence to the presentations of chemistry teaching and learning at senior secondary level especially in relation to organic aspect of chemistry.
iii. Examination bodies and curriculum developers with information that will be useful in restructuring the SSCE curriculum and examination in order to correct problems associated with students misunderstanding of organic chemistry.
iv. Authors of textbooks with useful information in their presentation of the subject matter in a form that would facilitate easier understanding of concepts in chemistry by both students and teachers so as to avoid misconception.
v. Future researchers with information and guide in determination of misconceptions in other aspects of chemistry.

6 Methodology

6.1 Research Design

This study is intended to determine students' misconception in organic chemistry. Survey research design was employed to establish the extent to which misconception in organic chemistry is dependent on; (i) Gender (ii) academic achievement. Survey research is a systematic method for gathering information from (a sample of) entities for the purpose of constructing quantitative description of attributes of the larger population of which the entities are members (Groves *et al,* 2004).

6.2 Area and Population of the study

The population of the study comprised SSIII science students offering chemistry in public and private senior secondary schools, in Zaria Local Government of Kaduna State. This comprised single sex and co-educational schools. There are 16 public and 33 private senior secondary schools in the local government with a total population of 29,808 students. It is from this population that the sample was drawn.

6.3 Sample and sampling techniques

The study was conducted using 120 senior secondary III (SS3) students with an age range of 15-20 years randomly drawn from two single sex public schools and one co-educational private school, in Zaria Local Government of Kaduna State. The schools are shown in the table 1 below.

S/N	Name of school	Type of School	Gender	
			Male	**Female**
1	Science Senior Secondary School, Kufena, Zaria.	Single sex (male only)	40	Nil
1	Government Girls Secondary School (Former WTC), Zaria.	Single sex (Female only)	Nil	40
2	Saint Bartholomew's Secondary School, Wusasa, Zaria.	Co-educational	20	20
	Total		**60**	**60**

6.4 Instrumentation

Two research instruments were used to collect data for the study. One is a set of Organic Chemistry Misconception Test (OCMT) questions designed to obtain and identify students' achievement and misconception in organic chemistry. It contains thirty (30) multiple choice items drawn from chemistry texts and the West African Examination Council (WAEC) past question papers. Each item of the test includes one correct answer and three distracters lettered A to D. Each item requires students to select scientifically complete response. Two different categories which help to classify scientifically accepted and unacceptable explanations were determined. These categories are:

Scientifically Correct (SC): Scientifically complete response and correct explanations take part in this category.

Specific Misconception (SM): Scientifically unacceptable response or explanations take part in this category.

The other is a structured questionnaire which consists of two sections, A and B. Section A contained the demographics of the students while section B contained items on students' interest, awareness, perception and misconception in organic chemistry. The respondents are to tick (√) against their opinions.

6.5 Validity and Reliability of research instrument

This was done by subjecting the questions to content validity to determine whether the test items reflects the concept area of the study, and face validity to determine the degree to which the test items appears to measure what is intended for the purpose of the research. Some items were redesigned while others were completely removed and replaced to suit the study. The reliability coefficient of the instrument (OCMT) was computed by subjecting the scores collected from Saint Bartholomew's School using the Pearson Product Moment correlation Coefficient and the value was r=0.96. This value suggests that the test questions were reliable and as such would test what it was designed to test.

6.6 Method of data collection

The questionnaires and OCMT was administered by the researcher to the students and the data was collected and recorded. The administration and collection of the research instruments was done in second term of the school calendar and took two weeks.

6.7 Method of data analysis

The data that was collected were analyzed using frequency, percentages, mean, standard deviation and t-test statistics to test the hypotheses and research questions that were formulated.

7 Results

Table 2: Rating students' awareness and perception of organic chemistry

Item	Yes	%	No	%
I have heard of organic chemistry before	117	97.5	3	2.5
I have been taught organic chemistry	117	97.5	3	2.5
Do you the period given to chemistry in a week is enough?	75	62.5	29	37.5
Organic chemistry is a very important branch of chemistry	89	74	31	26
Ability to balance chemical equation makes organic chemistry easier	91	76	29	24

Table 3

Started learning organic chemistry in	Frequency	%
SS1	20	16.7
SS2	49	40.8
SS3	51	42.5
Total	**120**	**100**

Table 2 shows that 97.5% of students have heard of organic chemistry and also been taught the branch of chemistry. 74% agree that organic chemistry is a very important branch of chemistry while 76% are of the view that ability to balance chemical equation makes organic chemistry easier.

In table 3, 16.7% students started learning organic chemistry in senior secondary one, 40.8% in senior secondary two and 42.5% in senior secondary three. This shows that more of the students started learning organic chemistry in SS3.

Table 4 : Rating students' interest in organic chemistry

Item	Yes	%	No	%
Do you have a separate teacher for organic chemistry?	35	29	85	71
Organic chemistry is interesting and easy	80	67	40	33
Organic chemistry is interesting but difficult	65	54	55	46
I enjoy organic chemistry more than other branches of chemistry	77	64	43	36
My chemistry teacher makes organic chemistry interesting and fun	94	78	26	22
My chemistry teacher makes organic chemistry uninteresting and boring	23	19	97	81

Table 4 shows that only 29% of students have a separate teacher for organic chemistry. 67% believe that organic chemistry is interesting and easy while 54% believe that it is interesting but difficult. 64% of students enjoy organic chemistry more than other branches of chemistry. 78% think that their chemistry teacher makes organic chemistry interesting and fun while only 19% are of the view

that their chemistry teacher makes it uninteresting and boring.

Table 6 : Rating students' misconception in organic chemistry

Item	Yes	%	No	%
There are many misconceptions in organic chemistry	81	67.5	39	32.5
I once had misconception of some terms in organic chemistry	85	71	35	29
Reading chemistry textbooks helps me clarify some concepts in organic chemistry	110	92	10	81

Table 6 shows that 67.5% of students believe that organic chemistry has many misconceptions whereas only 32.5% believe otherwise. 71% of students once had misconception in organic chemistry whereas 29% never had. 92% are of the view that reading chemistry textbooks helps them to clarify some concepts in organic chemistry whereas only 8% disagree.

Table 7: Percentage of students' response* to OCMT

Test Item	categories	male	female	Test Item	Categories	male	Female
Item 1	SC	17	57	Item 16	SC	22	12
	SM	83	43		SM	78	88
Item 2	SC	75	87	Item 17	SC	55	58
	SM	25	13		SM	45	48
Item 3	SC	81	80	Item 18	SC	48	25
	SM	19	20		SM	52	75
Item 4	SC	85	47	Item 19	SC	50	60
	SM	15	53		SM	50	40
Item 5	SC	78	57	Item 20	SC	33	48
	SM	22	43		SM	67	52
Item 6	SC	60	60	Item 21	SC	35	48
	SM	40	40		SM	65	52
Item 7	SC	78	67	Item 22	SC	43	47
	SM	22	33		SM	57	53
Item 8	SC	82	75	Item 23	SM	42	52
	SM	18	25		SC	58	48
Item 9	SC	60	82	Item 24	SC	40	35
	SM	40	18		SM	60	65
Item 10	SC	82	93	Item 25	SC	28	37
	SM	18	07		SM	72	63
Item 11	SC	45	25	Item 26	SC	80	58
	SM	55	75		SM	20	42
Item 12	SC	37	50	Item 27	SC	47	53
	SM	63	50		SM	53	47
Item 13	SC	25	38	Item 28	SC	38	33
	SM	75	62		SM	62	67
Item 14	SC	55	48	Item 29	SC	22	38
	SM	45	52		SM	78	62

Item 15	SC SM	33 67	50 50	Item 30	SC SM	32 68	43 57

SC: Scientifically Correct Response; SM: Specific Misconception
* See Appendix 1 for OCMT items.

Table 7 shows that more female students' responses fell into the SC category as shown in 17 items (i.e items 1, 2, 9, 10, 12, 13, 15, 17, 19, 20, 21, 22, 23, 25, 27, 29 and 30) than their male counterparts' responses in 11 items (i.e items 4, 5, 7, 8, 11, 14, 16, 18, 24, 26 and 28 respectively), even though they both have similar responses in items 3 and 6 respectively. Hence, more male responses fell into the SM category than their female counterparts. This means that more male students did not acquire satisfactory understanding of some concepts in organic chemistry and hence have more misconception than the females. This implies that the female students perform better than their male counterparts in organic chemistry. Some of the misconception discovered from the students' response to the OCMT includes; definition of organic chemistry, polymerization, isomers and isomerism, identifying aromatic hydrocarbons from condensed structural formula, substitution and addition reactions, unsaturation in hydrocarbons, numbering of carbon chain when writing the IUPAC nomenclature of organic compounds.

Table 8 : Two sample t-test on the Misconception of male and female students in organic chemistry

Group	**N**	**Mean**	**SD**	**DF**	t.cal	t.cri	Remark
Male	60	14.97	4.66				
				118	0.48	1.96	Not significant
Female	60		14.87	5.84			

Not significant at $p \leq 0.05$

Table 8 was used to test H_O1 which states that *there is no significant difference in the level of misconception between male and female students in organic chemistry***.**

The result shows that the t. calculated value of 0.48 is lower than the t. critical value of 1.96, hence, the null hypothesis which states that there is no significance difference in the level of misconception between male and female students in organic chemistry is accepted while the alternate hypothesis is rejected. The implication of the analysis above is that both male and female students have misconception in the learning of organic chemistry

H_O2: *There is no significant difference between male students' misconception in organic chemistry and their academic performance*.

Table 9 : Two sample t-test on male students' misconception and their Academic Performance in organic chemistry

Group	**N**	**Mean**	**SD**	**DF**	t.cal	t.cri	Remark
Males	60	15.03	4.61				
				118	0.32	1.96	Not Significant
Misconception	60	14.97	4.66				

Not Significant at $p \leq 0.05$

The result in the table 9 reveals that there is no significant difference between male students' misconception and their academic performance in organic chemistry. This, according to the result of the t-test statistics above, it shows that t-test calculated value of 0.32 is lower than the critical value of 1.96. Therefore, the null hypothesis which states that there is no significant difference between male students' misconception in organic chemistry and their academic performance is retained while the alternative hypothesis is rejected.

H_O3: *There is no significant difference between female students' misconception in organic chemistry and their academic performance*.

Table 10 : Two sample t-test on Female students' misconception and their Academic Performance in organic chemistry

Group	N	Mean	SD	DF	t.cal	t.cri	Remark
Female	60	15.13	5.83				
				118	1.13	1.96	Not Significant
Misconception	60	14.87	5.84				

Not Significant at $p \leq 0.05$

The result in the table 10 reveals that there is no significant difference between female students' misconception and their academic performance in organic chemistry. This, according to the result of the t-test statistics above, shows that t-test calculated value of 1.13 is lower than the critical value of 1.96 at 0.05 alpha level of significant. Therefore, the null hypothesis which states that there is no significant difference between female students' misconception in organic chemistry and their academic performance is retained while the alternative hypothesis is rejected.

H_O4: *There is no significant difference between the academic performance of male and female students in organic chemistry.*

Table 11 : Two sample t-test on the Misconception of male and female students in organic chemistry

Group	N	Mean	SD	DF	t.cal	t.cri	Remark
Male	60	15.03	4.61				
				118	0.57	1.96	Not significant
Female	60	15.13	5.83				

Not significant at $p \leq 0.05$

The result in table 11 shows that the t. calculated value of 0.57 is lower than the t. critical value of 1.96, hence, the null hypothesis which states that there is no significance difference between the academic performance of male and female students in organic chemistry is accepted while the alternate hypothesis is rejected. The implication of the analysis above is that both male and female students show significant relationship in their academic performance in organic chemistry as indicated by their mean scores of 15.03 and 15.13 respectively.

8 Discussion

From the analysis and results of this study, it was found that both male and female students have misconception in organic chemistry, and that there is no significant difference in the level of misconception between male and female students in organic chemistry. This was confirmed by t.calculated value of 0.48 is lower than the t.critical value of 1.96. This is in agreement with the findings of Sheppard (2006), Adesoji and Babatunde (2008), Pinarbasi *et al* (2009), who posited that students have misconception in chemistry. It also supports the finding of Sani (2010), that there is no significant difference in the level of misconception between male and female students in inorganic chemistry.

On academic performance, it was found that despite the presence of misconception, there is no significant difference between the academic performance of male and female students in organic chemistry. This was observed from the t.calculated value of 0.57 which is less than the t.critical value of 1.96 and their mean score of 15.03 and 15.13 for male and female students respectively. Thus the finding suggest that gender is not a relevant factor in academic achievement in organic chemistry. This supports the findings of Udousoro (2003) and Muhammed (2014) that gender has no effect on students achievement in science. Yet the finding contradicts those of Bunkuru (2007) whose study revealed that sex is a significant predictor of academic achievement in science with male achieving higher than female. The works of Daluba (2013), Omwirhiren and Anderson (2016), also revealed that male students perform better in chemistry than their female counterparts while Lawal (2009) found that female students were significantly better than their male counterparts. Hence, the debate on gender and academic achievement is yet to be finally resolved.

On students' attitude to organic chemistry, 67% of students believe that organic chemistry is interesting and easy while 64% enjoy organic chemistry more than other branches of chemistry. This implies that majority of the science students have positive attitude towards organic chemistry. Perhaps, this reflects the students' awareness to what they chose to study to support their future plan or according to what they can do. Furthermore, the help students may receive from home, teacher or school may contribute to increased students' interest in organic chemistry. These factors can be seen as corresponding directly to yield the increased interest given. For example, an individual who is attracted to the field through positive role models is more likely to consider organic chemistry as a career and thus be further interested in the field. This finding opposes that of Mahdi (2014), who worked on students attitudes towards chemistry. The study revealed that only 36.9% of students thought that chemistry is an interesting subject, which is lower than 63.1% who thought otherwise. Also, Doyle (2006), found out that students entering college no longer perceive physical sciences, such as chemistry to be either desirable or achievable as career aspirations.

On the teaching of organic chemistry in senior secondary schools, it was found out that only 16.7% of students started learning organic chemistry in SS1, 40.8% in SS2 whereas 42.5% in SS3. This indicates that majority of the students started learning organic chemistry very late. This may be a contributing factor to the poor performance of students in organic chemistry, as this will make it extremely difficult to achieve full coverage of its content. Perhaps this is why it is not surprising that a number of misconception found ranging from inability to to identify isomers, aromatic hydrocarbons from condensed structural formula, differentiate between Substitution and addition reactions of hydrocarbons and apply the IUPAC rules to name compounds appropriately among others The finding also shows that only 29% of students have a separate teacher for organic chemistry, 78% are of the thought that their chemistry teacher makes organic chemistry interesting and fun while only 19% believe their chemistry teacher makes it uninteresting and boring. According to Olatoye *et al* (2011), teachers of chemistry should expose the students to cooperative learning method to encourage social interaction, active engagement and self-motivation among learners.

9 Conclusion

The study showed that, students have various misconceptions in organic chemistry and that there is no significant difference in the level of misconception between male and female students. The findings of the study showed that there is no significant difference male and female students' performance in organic chemistry. Finally the researcher found no significance difference between male and female students' misconception in organic chemistry and their academic achievement.

10 Recommendations

In line with the findings of this study, we recommend that:

i. The teaching and learning of organic chemistry in secondary schools should be strengthened to provide a good foundation for students.

ii. Curriculum designers should design the curriculum in order to emphasize the use of models in the teaching and learning process. This will improve students' ideas and understanding.

iii. There should be adequate revision on the writing of chemical symbols, valency, the octet rule, hybridisation, covalent bonding and formation of multiple bonds in carbon by the teachers before naming of hydrocarbon will be taught.

iv. The Ministry of Education, chemistry authors as well as chemistry teachers should design chemistry textbooks using only scientifically accepted definitions and explanation. This will help minimize the source of misconception.

v. Schools, chemistry teachers as well as parents should ensure that student buy and use only recommended chemistry textbooks.

vi. The teaching of organic chemistry should start as early as SS1 so as to allow full coverage of its content and hence familiarize the students with organic chemistry concepts thereby reducing misconception in organic chemistry.

vii. If possible, organic chemistry should be taught by a separate chemistry teacher who is experience enough in the field and have mastery of the subject.

viii. This study should be repeated with other branches science and diversified group of respondent so as to compare the findings.

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Appendix 1

ORGANIC CHEMISTRY MISCONCEPTION TEST CLASS: SS3
Gender: …… *TIME ALLOWED: 1hour*
School:……
INSTRUCTION: **Each question is followed by four options lettered (a) to (d).** ***Circle the correct option for each question.***

1) Organic chemistry is defined as the chemistry of
a) hydrocarbon only (b) hydrocarbon and its derivatives (c) carbon only (d) carbon and its compounds.

2) Catenation is the ability of carbon atoms to
a) combine with one another to form straight chains, branched chains or ring compounds containing many carbon atoms
b) combines with hydrogen, oxygen, nitrogen and halogens
c) form single, double or triple covalent bonds
d) combine with every element.

3) Hydrocarbons are compounds containing
a) carbon and nitrogen only (b) carbon only
c) carbon, hydrogen and oxygen (d) carbon and hydrogen only.

4) The process of linking together small organic molecules to form a chain of repeating unit is referred to as
a) Cracking (b) isomerization (c) polymerization d)aromatization.

5) The breaking of bigger hydrocarbons into smaller hydrocarbons is called
a) cracking (b) reforming (c) dehydrogenation (d) hydrolysis.

6) Carbon has the tendency to form four bonds with itself and other atoms because it is
a) divalent (b) monovalent (c) trivalent (d) tetravalent.

7) A family of organic compounds which follows a regular structural pattern, in which each successive member differs in its molecular formula by a $-CH_2-$ group is known as
a) functional series (b) aromatic hydrocarbons (c) aliphatic hydrocarbons (d) homologous series.

8)…… is an atom, a radical or a bond common to a homologous series, and which determines the chemical properties of the series.
a) functional group (b) functional series (c) reaction series (d) group

9) The existence of two or more compound with the same molecular formula but different structural formula is termed
a) isotopy (b) polymerism (c) molecularism (d) isomerism.

10) Hydrocarbons can be classified into;
a) aliphatic hydrocarbons only (b)aliphatic and aromatic hydrocarbons (c) aromatic hydrocarbons only (d) cyclic hydrocarbons only.

11) Which of the following is an aromatic hydrocarbon?
a) $C_6H_5CH_3$ (b) $CH_3(CH_2)_4CH_3$ (c) $CH_2CH{=}CHCH_3$ (d) $CH_3CH_2CH_3$

12) The general molecular formula of alkenes is
a) C_nH_n (b) C_nH_{2n+2} (c) C_nH_{2n-1} (d) $C_nH_{2n.}$

13) The main chemical property that differentiates methane from ethene is
a) hydrogenation (b) combustion reaction (c) substitution reaction (d) addition reaction.

14) The process involved in converting ethyne to ethane is known as
a) hydrogenation (b) dehydrogenation (c) hydration
d) isomerization.

15) The unsaturated nature of ethyne is due to the presence of
a) two carbon atoms (b) single bonds (c) double bond (d) triple bond.

16) The reaction between ethene and bromine is called
a) substitution (b) esterification (c) oxidation (d) addition

17) Which of the following statements is **not** true about hydrocarbons?
a) They are all saturated compounds (b) They are organic compounds
c) They contain carbon and hydrogen
d) They could be gases, liquids or solids

18) Which of the following statements is **wrong**?
Isomers of the same compound will
a) contain the same types of atoms
b) contain the same number of atoms
c) not necessarily have the same physical or chemical properties.
d) have the same physical and chemical properties.

19) The two main types of Isomerism are
a) structural and non-structural (b) structural and geometric
c) cis and trans (d) geometric and non-geometric

20) Which of the following pair of compounds are isomers?
a) $CH_3C(CH_3)_2CH_3$ and $CH_3CH_2CH_2CH_2CH_3$
b) $CH_3CH_2CH_2CH_3$ and $CH_3CH_2(CH_2)_2CH_3$
c) $CH_3CH=CH_2$ and $CH_3C\equiv CH$
d) $CH_2CH(CH_3)CH_3$ and $CH_3CH(CH_3)_2CH_3$

21) The IUPAC name of the organic compound $CH_3CH_2CHClCH_3$ is
a) 3-chlorobutane (b) butan-3-chlorine (c) 1-chlorobutane
d) 2-chlorobutane

22) The IUPAC name of $(CH_3)_3CCH_2(CH_2)_3CH_3$ is
a) 1,1-dimethylheptane (b) 3-methylheptane (c) 2,2-dimethylheptane
d) pentane

23) The IUPAC name of $CH_3CH_2CH=CH_2$ is
a) but-1-ene (b) but-3-ene (c) but-4-ene (d) butene

24) The structural formula of 2,4-dimethylpent-2-ene is
a) $CH_3C(CH_3)CH_2C(CH_3)=CH_2$ (b) $(CH_3)_3CCH=CHCH_3$
c) $CH_3CH=CHCH_2CH_3$ (d) $CH_3C(CH_3)CH=C(CH_3)CH_3$

25) The structure of 4-methylhex-1-yne is
a) $CH_3CH_2CH_3CH(CH_3)C\equiv CH$ (b) $HC\equiv CCH_2CH(CH_3)CH_3$
c) $CH_3CH_3CH(CH_3)CH_2C=CH$ (d) $CH_3CH_2CH(CH_3)CH_2C\equiv CH$

26) Ethene molecules can be added to one another to form a long chain compound called a
a) polymer (b) dimer (c) monomer (d) trimer.

27) Unsaturation in hydrocarbons is found in
a) ethane (b) 2-methylpropane (c) 2,2,4-trimethylpentane (d) benzene

28) When ethanol is heated with excess concentrated tetraoxosulphate(VI)acid, the organic product formed is
a) ethane (b) ethene (c) ethyne (d) butyne

29) The following are hydrocarbons **except**
a) methylpropanol (b) methylbenzene (c) benzene (d) cyclohexane.

30) Which of the following properties of hexane indicates that it is a **saturated** compound?
a) It burns in air to produce steam and carbon(IV)oxide
b) It exhibits structural isomerism
c) It exists as a liquid at room temperature
d) It has no effect on bromine water.