CUSTECH INTERNATIONAL JOURNAL OF EDUCATION, VOL.1, NO. 1, JULY, 2024
http://custechijoe.org.ng
ISSN 1595-1839

ANALYSIS OF MISCONCEPTIONS IN ORGANIC CHEMISTRY AMONG SENIOPR SECONDARY SCHOOL STUDENTS IN ADAVI LOCAL GOVERNMENT AREA, KOGI STATE, NIGERIA

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Abstract

The main aim of the study is to analyse the types of misconceptions in Organic Chemistry among senior secondary school students using a survey design and random sampling. Two research questions and one hypothesis were formulated and tested in the study. The population of the study comprised of all SS III Chemistry Students in the sixty-eight (68) Secondary Schools in Adavi Local Government Area of Kogi State. The sample comprises of One hundred (100) Senior Secondary III (SS 3) students from four Government owned and one Private Secondary Schools in Adavi Local Government Area of Kogi State The instrument used was Organic Chemistry Misconception Test (OCMT). The result showed that Chemistry students harbor Misconception in Organic Chemistry with most of their Misconception in the area of Organic Chemical Reactions. The result shows that there is no significant difference in the type of misconception among male and female student in Organic Chemistry. This was confirmed by t-calculated value of 0.489 is lower than the t-critical value of 1.345.Hence it was recommended Chemistry teachers should be sent regularly to seminars and workshops to acquire modem skills in teaching Organic chemistry

Keywords: Misconception, organic chemistry, chemical, reaction, Chemical, bonding

Introduction

The benefit of education in recent years cannot be over emphasized as the society grows stronger with all credit given to scientific researches and discoveries. Science and technology education have been identified as the universal foundation for economic growth and stability and sciences is based on the principle of rationality that can be explained using academic principles (Arunwarakorn & Suthiwartnarueput, 2020). Science concepts are critical elements in explaining and understanding natural phenomena across all science disciplines and particularly science concept provides a practical framework for integrating science disciplines and has a significant impact on the learning process and in the thinking and modeling of natural and technological processes (Soeharto, 2021)

Chemistry as a branch of science has contributes to better health and improved living standards for humanity. This fact is illustrated in areas of provision of healthcare, agriculture, environmental remediation, textile, manufacturing and processing industries. It was as a result of the recognition given to chemistry in the development of individuals and nations that makes it a core subject among the natural sciences and other science-related courses in Nigeria education system. Chemistry is a world filled with predominant events, interesting experimental activities and flourishing knowledge for understanding the natural and man-made worlds, however students faces problems in understanding the subject despite its association with daily life's experiences (Ortiz & Ortiz, 2019). Chemical concepts are very abstract and students find it difficult to explain chemical phenomena by using these concepts Success in studying Chemistry requires students' sound reasoning skills, fundamental scientific knowledge, ability to work with scientific knowledge and excellent problem solving skills (Ortiz & Ortiz, 2019)

Organic chemistry, the subdivision of chemistry that treaties with the structure, properties, and reactions of combinations that contain carbon, and these compounds are known as hydrocarbons since they contain both hydrogen and carbon atoms mainly (Sibomana et al., 2021). Students' strong comprehension of basic chemistry does not guarantee their good understanding of organic chemistry and the most frequently misconceptions of Senior High School students in Nigeria are about the definition of organic chemistry, polymerization, isomer identification, identifying aromatic compound from condensed structures formula, distinguishing substitution and addition reactions, unsaturated hydrocarbon, and applying IUPAC rules in naming an organic compound (Widarti et al., 2017). Generally concepts are ideas forming objects or abstraction, helping an individual to comprehend the scientific world phenomena (Sarimanah et al., 2019) while misconception in scientific context, is an idea or explanation that differs from the accepted scientific concept . In this study, students' conception means students' understanding or belief of what the structures and names of organic molecules should be, which differ significantly from that which is socially agreed by scientific community (i.e. IUPAC system)

(Garnet, Ganet & Hackling 2008). The study analysed the misconceptions in organic chemistry among senior secondary school students *Adavi Local Government Area of Kogi State* with an attempt to know the types of misconceptions among secondary school student, study the variation in misconception that may exist among male and female student and finally improve students' understanding of basic organic concept.

Statement of Problem

Organic chemistry was identified as one of the difficult topics in our Chemistry curriculum which can contribute to poor achievement in chemistry. For instance, chief examiner's report for WASSCE has shown that inability of students to grasp the concept of International Union of Pure and Applied Chemistry (IUPAC) system of nomenclature affects the understanding of molecular structures which will in turn affect students' learning and achievement in organic chemistry (Sibomana et al., 2021). 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. The study therefore tends to make a relevant approach in pointing out the misconceptions among senior secondary school students in Organic chemistry.

Objectives of the Study

The objectives of the study are as follows:

1. To find out the misconceptions in organic chemistry among secondary school chemistry students in Adavi Local Government Area of Kogi State

2. To find out if there are distinctions in the types of misconceptions in organic chemistry among male and female chemistry students in senior secondary schools.

Research Questions

Based on the objectives the following research questions are put forward:

1. What area of Organic Chemistry do students have misconceptions and what percentage of the students have the Misconceptions?

2. Is there any difference in the type of misconception in organic chemistry among male and female students in senior secondary schools?

Research Hypothesis

There is no significant difference in the types of misconceptions in organic chemistry among male and female students in Adavi Local Government Area of Kogi State

Literature Review

Behaviorism paradigm and behaviorist focus on observable behaviors, they believe that the main purpose of education is that learners' behavior is to respond to their past and behavioral modification (Sibomana et al., 2021). Conversely, cognitivist realized the limitations of the behaviorist theory and started focusing on the development of the brain by focusing on the two main functions which are organization and adaptation in learning (Seema Malik, 2021). These two main functions are effective for both organic chemistry educators and students since organization mentions the fact that all reasoning structures are interconnected, and that any new information must be tailored into the current system (Muhajirah, 2020). Therefore, the process of cognitive development is the result of a series of related assimilation and accommodation. Constructivism holds that meaningful learning occurs if a process is associated with new information on relevant concepts contained in a person's cognitive structure, then if no effort is made to assimilate new understanding of relevant concepts that already exist in the cognitive structure, it will rote learning occurs meaningful learning occurs if a process is associated with new information on relevant concepts contained in a person's cognitive structure, then if no effort is made to assimilate new understanding of relevant concepts that already exist in the cognitive structure, it will rote learning occurs (Efgivia et al., 2021). Effective organic chemistry teaching and learning is a product of a well-designed constructivist classroom that offer a diversity of activities to challenge students to accept individual differences and use concrete learning experiences since constructivist lessons are based on the fact that students construct their own implication; new knowledge builds on prior knowledge; a learning that is improved by social interaction and a education to be developed through authentic tasks (Sibomana et al., 2021).

Methodology

The design used in carrying out the study was survey design which attempted to analyze the Misconceptions in Organic Chemistry among Senior Secondary School Students. A Survey design is a means of collecting information though brief interviews and discussions with individuals about a specific topic. Survey design was used because it is an efficient way of gathering information or data to help answer research questions. For this study a Misconception Test was administered to the respondents and the data was collected at the end of the response. The population of the study comprised of all Senior Secondary (SS) III chemistry students in Adavi Local Government Area of Kogi State. The sampling technique that was used for selecting the sample from the population was random sampling.

Five schools out of the secondary schools was randomly selected from the study area. The schools were selected based on the following reasons: they have qualified teachers which are employed by same Government using the same criteria, the schools have the same curriculum which were planned by the Government, the schools have been presenting candidates for West African Examination Council for Senior Secondary Certificate Examination (WASSCE) and National Examination Council for Senior School Certificate Examination (NECO, SSCE). The five randomly selected schools were stratified into one single sexed school (Boys), one single sexed school (Girls) and three co-educational school for the purpose of the study. The research instrument used in the study was Organic Chemistry Misconception Test (OCMT) which is made up of section A and section B. The section A consists of the Demographic data of the e respondents and section B consist thirty (30) Organic Chemistry multiple choice question on Organic Chemistry nomenclature, Organic Bonding and Organic Reactions. These was used to find out the level of misconceptions in Organic Chemistry. The Organic Chemistry Misconception Test (OCMT) was validated to ensure that it is reliable and not beyond the scope of secondary school students. The Instrument (OCMT) was validated by two expert the Department of Science Education and one from Department of Chemistry ABU Zaria before it was administered to the student in other to ensure effectiveness. The data was collected by the researchers through the administration of the OCMT to SS III Chemistry students that were randomly selected from the targeted school. The researchers collected the answered questions immediately after the student's responses on the same day. The students were encouraged to avoid copying from themselves in other to ensure that the questions were answered by each student on their own. This is to aid the researchers to know their level of misconception in Organic Chemistry from the obtained result. The obtained data was use as a tool to test the formulated hypothesis is research questions. The students' response to the test was scored based on the marking scheme. The result from the test was collected using the SPSS statistical tool, this is a computer aided analytical software, the analysis was carried out using Pearson Product Moment Correlation Coefficient (PPMCC) and t-test to the hypothesis on whether to reject or to accept it. This was analyzed at a significance level of $P \leq 0.05$

Result

Research Question One: What area of Organic chemistry do students have misconception and what percentage of the students have the Misconception?

Table 1

Areas of Misconceptions by senior Secondary School Students in Organic Chemistry Nomenclature

S/N	Areas of Misconceptions	No. of male with Misconception	No. of female with Misconception	Total number with Misconception	Total Population	Percentage of student with Misconceptions (%)
1	Composition of the parent chain of organic compound	35	29	64	100	64
2	Homologous series definition	36	28	64	100	64
3	Functional group definition	21	11	32	100	32
4	General Formula identification	25	30	55	100	55
5	Naming of multiple bond	35	39	74	100	74
6	Differences in formula among successive member of homologous series	38	36	74	100	74
7	Naming of members in Homologous series	40	31	71	100	71
8	Organic compound naming from its formula	24	31	55	100	55
9	Identification of functional group	30	25	55	100	55
10	Functional group naming	43	39	82	100	82

Table 1 shows the areas of misconceptions by senior secondary school students in chemistry nomenclature which serves as prerequisite for further study of Organic Chemistry. The analysis result indicates that senior secondary students hold misconception in area 1,2,5,6,7, 10 with percentage of students having misconceptions as follows 64%, 64%, 74%, 74%, 71% and 82% respectively.

Table 2

Areas of Misconceptions by Senior Secondary School Students' in Organic Chemical Bonding

S/N	Areas of Misconceptions	No. of male with Misconception	No. of female with Misconception	Total number with Misconception	Total Population	Percentage of student with Misconceptions (%)
1	Electronic configuration of carbon	28	29	57	100	57
2	Bonding ability of carbon	24	18	42	100	42
3	Definition of catenation	21	11	32	100	32
4	Identification of carbon ground state configuration	30	22	52	100	52
5	Number of orbitals after hybridization	37	41	78	100	78
6	Bond type existing between C-H	22	31	53	100	53
7	Numbers of atom bonded to a hybrid orbital	34	32	66	100	66

8	Hybridization type existing in organic compound	24	31	55	100	55
9	Types of bond interaction in unsaturated hydrocarbons	31	35	66	100	66
10	Counting orbitals involved in hybridization	33	40	73	100	73

Table 2 shows the area of misconceptions by Senior Secondary School Students' in the aspect of chemical bonding of organic compounds. The results indicate that senior secondary school students hold Misconception in areas 1, 5, 7, 9, 10 with percentage of students with Misconceptions as follows 57%, 78%, 66%, 66% and 73% respectively.

Table 3

Areas of Misconceptions by Senior Secondary School Students' in Organic Chemical Bonding

S/N	Areas of Misconceptions	No. of male with Misconception	No. of female with Misconception	Total number with Misconception	Total Population	Percentage of student with Misconceptions (%)
1	Reaction of alkenes with air (oxygen)	31	32	63	100	63
2	Alkane reaction with halogen	24	33	57	100	57
3	Concept of polymerization	40	28	68	100	68
4	Types of reactions saturated compounds can undergo	41	31	72	100	72

5	Conversation of unsaturated compounds to saturated compounds	23	22	45	100	45
6	Reaction in laboratory preparation of ethyne (alkyne)	37	41	78	100	78
7	Qualitative differentiation of saturated hydrocarbons from unsaturated hydrocarbons	28	31	59	100	59
8	Preparation of alkanes	22	29	51	100	51
9	Preparation of alkenes	35	34	69	100	69
10	Reactivity of various unsaturated hydrocarbons	31	31	62	100	62

Table 3 shows the area of misconceptions by Senior Secondary School Students' in the aspect of chemical reaction in Organic compounds. The results indicate that senior secondary school students holds Misconception in type 1, 2, 3, 4, 6, 7,9, 10 with percentage performance of 68%, 57%, 68%, 72%, 78%, 59%, 69% and 62% respectively.

Research Question Two: Is there any difference in the type of misconception in organic chemistry among male and female students in senior secondary schools?

Table 4

Performance of Male and Female Senior Secondary School Chemistry students in Chemistry Nomenclature

S/N	Areas of Misconceptions	Male Pass Fail	Female Pass Fail	Total M F
1	Composition of the parent chain of organic compound	15 35 (30) (70)	21 29 (42) (58)	50 50
2	Homologous series definition	14 36 (28) (72)	22 28 (44) (56)	50 50

3	Functional group definition	29 21 (58) (42)	39 11 (78) (22)	50 50
4	General formula identification	25 25 (50) (50)	20 30 (40) (60)	50 50
5	Naming of multiple bond	15 35 (30) (70)	11 39 (22) (78)	50 50
6	Differences in formula among successive member of homologous series	12 38 (24) (76)	14 36 (28) (72)	50 50
7	Naming of members in homologous series	10 40 (20) (80)	19 31 (38) (62)	50 50
8	Organic compound naming from its formula	26 24 (52) (48)	19 31 (38) (62)	50 50
9	Identification of functional group	20 30 (40) (60)	25 25 (50) (50)	50 50
10	Functional group naming	7 43 (14) 86)	11 39 (22) (78)	50 50

Table 4 shows that the general performance of female student is slightly higher than the male students in organic Chemistry Nomenclature.

Table 5
Performance of Male and Female Senior Secondary School Chemistry Students in Organic Chemistry Bonding

S/N	Areas of Misconceptions	Male Pass Fail	Female Pass Fail	Total M F
1	Electronic configuration of carbon	22 28 (44) (56)	21 29 (42) (58)	50 50
2	Bonding ability of carbon	26 24 (52) (48)	32 18 (64) (36)	50 50
3	Definition of catenation	13 37 (26) (74)	8 42 (16) (84)	50 50
4	Identification of Carbon ground state configuration	20 30 (40) (60)	28 22 (56) (44)	50 50
5	Number of orbital after hybridization	13 37 (26) (74)	9 41 (18) (82)	50 50
6	Bond type existing between C-H	28 22 (56) (44)	19 31 (38) (62)	50 50
7	Numbers of atom bonded to a hybrid orbital	17 34 (32) (68)	18 32 (36) (64)	50 50
8	Hybridization type existing in organic compound	26 24 (52) (48)	19 31 (38) (62)	50 50
9	Types of bond interaction in unsaturated hydrocarbons	19 31	15 35	50 50

		(38)	(30)	
		(62)	(70)	
10	Counting orbitals involved in hybridization	17 33 (34) (66)	10 40 (20) (80)	50 50

Table 5 shows that the performance of male students is higher than that of the female students in Chemical bonding of Organic chemistry.

Table 6

Performance of Male and Female Senior Secondary School Chemistry Students in Organic Chemical Reaction

S/N	Areas of Misconceptions	Male Pass Fail	Female Pass Fail	Total M F
1	Reaction of alkenes with air (oxygen)	19 32 (38) (62)	18 32 (36) (64)	50 50
2	Alkane reaction with halogen	26 24 (52) (48)	17 33 (34) (66)	50 50
3	Concept of polymerization	10 40 (20) (80)	22 28 (44) (56)	50 50
4	Types of reactions saturated compounds can undergo	9 41 (18) (82)	19 31 (38) (62)	50 50
5	Conversion of unsaturated compounds to saturated compounds	27 23 (54) (46)	28 22 (56) (44)	50 50
6	Reaction in laboratory preparation of ethyne (alkyne)	13 37 (26) (74)	9 41 (18) (82)	50 50
7	Qualitative differentiation of saturated hydrocarbons	22 28	19 31	50 50

	from unsaturated hydrocarbon	(44) (56)	(38) (62)	
8	Preparation of alkanes	28 22 (52) (44)	21 29 (42) (58)	50 50
9	Preparation on alkenes	15 35 (30) (70)	16 34 (32) (68)	50 50
10	Reactivity of various unsaturated hydrocarbons	19 31 (38) (62)	19 31 (38) (62)	50 50

Table 6 shows that in Organic Chemistry chemical reactions the male student performance and the female student performance has no significant difference.

Table 7

Shows t-test Analysis to Determine the Difference between the type of Misconceptions in Organic Chemistry among Male and Female Students

Sex	No.	Mean	SD	SE	t-cal	t-cri	Df	Sig(P)	Remark
Male	50	11.24	5.13	2.55	0.49	1.35	98	0.63	No significant
Female	50	11.68	3.77						

From Table 7 shows t-test analysis to determine the differences between the type of misconception held by male and female students in organic chemistry. The table shows a significance (alpha) value of 0.63 which is greater than 0.05 level of tolerance and calculated t-value of 0.49 is less than the critical t-value of 1.35.

Discussion

What area of Organic Chemistry do students have misconceptions and what percentage of the students have the Misconceptions? Generally, From the ten (10) Organic Chemistry Misconception Test (OCMT) items in Table 2, students performed moderately in Organic Chemistry nomenclature holding misconceptions in item 1.2,3,6.7,10. The students were found to have misconception on the element (i.e. carbon) which makes up the parent chain, the common of features of the member of a homologous series and differences in the name of hydro carbons with single bond, double bonds and triple bonds. Misconceptions were also found to exist in naming of functional group and identifying the differences in the chemical

formula of each homolog member. These area of misconception in organic chemistry nomenclature are the foundations in the naming of any organic compound irrespective of its source, method of synthesis or composition. Generally, there is average misconception in Organic Chemistry Nomenclature (Barke & Büchter, 2023)

From Table 2 out of the ten (10) OCMT items students holds misconceptions in item 1,5,7,9, 10. The senior secondary students were found to have Misconceptions in: the number of valence electrons of carbon, number of carbon orbitals available for bonding after hybridization, numbers of atom bonded to very type of hybrid orbital, the types of bonding interaction in unsaturated hydrocarbons and counting orbitals involved in hybridization. Acquiring accurate knowledge on the bonding in hydrocarbon without any misconception held by students serves as a good beginning for senior secondary school student to comprehend advance courses in organic chemistry related courses. This is an indication that students averagely holds misconceptions in Organic Chemistry chemical bonding which is in agreement with the findings of Ortiz which states that "students had functional misconception of Chemical bonding" (Ortiz, 2019)

From Table 3 students performed poorly in the 10-item set in the OCMT. Holding misconceptions in item 1.2,3,4,6,7,9,10 which is an indication that student have high misconceptions in Chemical Reaction which in agreement with Sibomana et al, (Sibomana et al., 2020). The senior secondary students were found to have Misconceptions in following areas: combustion reaction of alkenes with oxygen, reaction of Alkane with halogen (halogenation of alkane), Concept of polymerization reaction in ethane, the types of reactions saturated compounds can undergo and the reasons for it restriction to other reaction, the reaction involve in laboratory preparation of ethyne (alkyne), the qualitative analysis for the differentiation of saturated hydrocarbons from unsaturated hydrocarbons, equation preparation of alkenes and the reactivity of various unsaturated hydro carbons. The synthesis of many organic related compounds has it root from simple organic reaction, these reactions when misconceived will be a hindrance for advance study in Organic Chemistry.

Table 7, the result shows that there is no difference between the type of misconception among male and female Senior Secondary students in Organic chemistry. This is because the significance (alpha) value calculated is 0.63 which is greater than 0.05 level of tolerance and calculated t-value of 0.49 is less than the critical t-value of 1.35 showing that there is no difference between the type of misconceptions among male and female students. Therefore, the null hypothesis which states that there is no significant difference in the type of misconceptions is thereby accepted and retained.

Conclusion

The result of the study shows that misconceptions in organic chemistry are held by both male and female senior secondary student and there is no gender difference in the type of misconceptions held by male and female students in Organic Chemistry.

Recommendations

Based on the findings; the following recommendations are made:

1. The high level of misconceptions in organic chemistry indicates that the teaching and learning process is faulty and implies that Organic chemistry concepts are not properly thought in senior secondary schools. Therefore, chemistry teachers should use varieties of teaching methods and instructional materials to facilitate the teaching and learning process.

2. Chemistry teachers should be sent regularly to seminars and workshops to acquire modem skills in teaching Organic chemistry

3. It was observed that chemical reaction in organic chemistry is an abstract concept, therefore teachers should endeavor to introduce the concepts using concrete illustrations that are familiar to the students.

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