



## Identification and Analysis of Senior Secondary School Students' Misconception in Organic Chemistry in Lokoja Education Zone of Kogi State

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### Abstract

This study investigated misconceptions in organic chemistry among senior secondary school students in Lokoja Education Zone, Kogi State. Two research questions were formulated to guide the study. The study employed descriptive survey research design. The population comprised of 1246 SS III chemistry students in Lokoja education zone of Kogi state. The sample size of the study 312 SS III chemistry students from the eight sampled schools. One instrument was used for data collection namely Organic Chemistry Misconception Test (OCMT) was used for data collection, achieving a Cronbach-alpha reliability of 0.840. Frequency and percentage were used to answer research questions. Findings indicated high levels of misconceptions in topics such as hydrocarbons, isomerism, structural formulas, molecular formulas, functional groups, and organic chemistry reactions. Recommendations included implementing regular formative assessments to identify and address misconceptions early and providing professional development for chemistry teachers to enhance their content knowledge and teaching skills.

**Key Words:** Analysis, Identification, Organic chemistry and Students' misconception

### Introduction

Chemistry is the study of the composition, properties, and reactions of matter. Suresh (2021) describes it as the science of matter's building blocks, while Kesharwani (2020) focuses on its composition, structure, and reactions. Chemistry is foundational to modern technology, medicine, engineering, and other sciences (Okeke & Nwandinigwe, 2015). It helps learners understand the world around them (Nnoli, 2014) and involves studying substances' properties, composition, and the energy changes during reactions (ACS, 2014). Chemistry requires abstract thinking and cognitive processing (Nworgu & Ellah, 2019).

The teaching and learning of chemistry, particularly organic chemistry, concern educators and researchers. Much research efforts made by researchers are to identify the difficulties associated with chemistry teaching and learning so as to proffer solutions that could result in better achievement (Omwirhiren & Ubanwa, 2016; Sirhan, 2007; Uce & Ceyhan, 2019). Students often struggle with understanding chemical reactions and processes due to a lack of knowledge in

chemical bonding and molecular structure (Tsaparlis & Byers, 2018), which is crucial in organic chemistry (Miller & Castillo, 2021). Difficulties also arise from the inability to connect abstract concepts to concrete phenomena (Iyamuremye & Mukiza, 2022), particularly in understanding the relationships between molecular structures and chemical reactivity in organic chemistry (Yanarates & Yerlikaya, 2022). These statements highlight how the fundamental concepts learned in chemistry (bonding, reactivity) are essential for understanding the behavior of organic compounds, which are the focus of organic chemistry.

Organic Chemistry is the chemistry of hydrocarbons and their derivatives. According to (Jones & Fleming, 2014), organic chemistry involves the study of the structure, properties, composition, reactions, and synthesis of organic compounds, which are defined as any molecules containing carbon atoms. Although the importance of chemistry is indisputable, organic chemistry has been reported widely by researchers and chemical educators as being difficult (Chang &



Goldsby, 2016, Salame, 2019). Organic chemistry is often considered a difficult subject and this observation has repelled learners from progressing with their studies in chemistry (Salame, 2019; Sibomana, 2021). Many scholars believed that it is hinged on misconception. Furthermore, organic chemistry is often perceived as a difficult and complex area of chemistry, leading to various misconceptions among students (Chang & Goldsby, 2016). For instance, some students also believe that organic chemistry is also about reactions and formulas. However, it involves a lot of critical thinking; problem-solving and analytical skills (Chang & Goldsby, 2016). Addressing these misconceptions can help learner approach organic chemistry with a more open and informed mindset, leading to better learning outcomes.

Misconceptions are personal notions that are created to establish the meaning of an individual understands of the physical world (Gooding & Metz, 2011). Misconceptions refer to knowledge gained by individuals from experiences and events which are educational or informal and do not have the acceptable scientific meaning of a concept (Allen, 2014). Ojose (2015) defines misconceptions as misunderstandings resulting from incorrect interpretations. Students' misconceptions about chemistry have received considerable attention. Alamina (2018) categorized the causes of misconceptions into "deficiency factor" and "misrepresentation factor." The deficiency factor involves learners' lack of baseline knowledge necessary for constructing new knowledge, while the misrepresentation factor involves inappropriate presentation of instructional materials. Halim, Lestari, and Mustafa (2019) identified textbooks, teaching methods, students' preconceptions and wrong intuitions, and teachers' lack of content knowledge as causes of misconceptions. Topal, Oral, and Ozden (2016) found that students often misunderstand aromaticity and struggle to recognize aromatic compounds from condensed structural formulas. Students may have preexisting partial or alternative conceptions about new topics. Research reveals that students harbor various misconceptions in chemistry, particularly regarding covalent and chemical bonding. Suat, Bayram, and Alipasa (2010) showed students struggle with understanding covalent bonding processes and characteristics. Vidyanand and Asmita (2021) found that abstract concepts like valency and chemical bonding lead to misunderstandings. Ozdemir and Oztekin (2018) found pre-service chemistry teachers hold misconceptions about covalent bonds,

including polar and non-polar bonds. Despite chemistry's importance in understanding biological and chemical processes, students' misconceptions hinder their ability to apply chemical knowledge. A significant knowledge gap exists due to scarce research on misconceptions in organic chemistry, necessitating further study to promote accurate understanding of these concepts.

Identifying misconceptions is the first step toward correcting them. Teachers can detect misconceptions through open-ended exam questions and other written assessments. Common errors among students indicate widespread misconceptions. Analyzing incorrect answers to these questions can reveal the nature and origin of misconceptions. Concept inventories, which use forced-choice questions with distractors based on common misconceptions, are also useful (Hestenes, Wells & Swackhamer 2017). These inventories can include confidence ratings to detect guessing and two-tier multiple-choice questions with reasons for answers. Lowery (2014) suggested follow-up open-ended questions or discussions to further understand students' thought processes. There is a need to focus on identifying specific misconceptions in organic chemistry, such as reactions, structural formulas, molecular formulas, isomerism, functional groups, and hydrocarbons. Once identified, analyzing the factors contributing to these misconceptions is crucial for improving student learning outcomes.

Analysis is crucial in addressing students' misconceptions. After identifying misconceptions, analysis helps organize and interpret data into useful information for real-world applications. Smith (2020) describes analysis as recognizing meaningful patterns, while Johnson (2021) views it as critical thinking and problem-solving, breaking down complex problems into manageable parts. Green (2022) emphasizes that analysis meticulously examines data to extract insights and understand patterns, aiding decision-making. In educational research, particularly for identifying misconceptions in subjects like organic chemistry, analysis is pivotal. Misconceptions hinder students' learning and ability to apply knowledge. Analyzing these misconceptions helps educators develop targeted interventions for correction and improved comprehension. Assessments often include multiple-choice questions with distractors based on known misconceptions. Two-tiered multiple-choice questions are used, with data scored and statistically analyzed to identify response patterns and trends, involving item



analysis to pinpoint frequently incorrect questions and correlation analysis to link misconceptions.

### Research Questions

The study sought answers to the following questions

1. What misconceptions do students hold in organic chemistry?
2. What are the topics in organic chemistry that students have more misconceptions?

### Methodology

This study adopted a descriptive survey research design, which, according to Nworgu (2015), involves studying a group by collecting and analyzing data from a representative sample. This design was chosen for its efficiency in gathering data from many participants, allowing for broader generalizations about misconceptions in organic chemistry. The study focused on SS III Chemistry students in government

secondary schools in Lokoja Education Zone, Kogi State. The population included 1246 students (676 males and 570 females) from 24 schools. A sample of 312 students was determined using Taro Yamane's formula. The instrument used was the Organic Chemistry Misconception Test (OCMT), a two-tier multiple-choice test with 20 items. The first tier was scored as follows: 3 for sound conception (SC), 2 for partial conception (PC), and 1 for alternative conception (AC). The second tier had no wrong answers but awarded different marks. The OCMT was validated for face and content validity and developed by the researcher. The reliability of the OCMT was measured using Cronbach-alpha, which is suitable for scales that are polytomously scored. The reliability index was 0.840. Data analysis involved using frequency and percentage, with items scoring 50% or above on alternative conception considered high misconception.

### Results

Table 1: Frequency and Percentage of the misconception of students in Organic Chemistry

Item no	SC F(%)	PC F(%)	AC F(%)
1	46(14.7)	107(34.3)	159(51)
2	28(9)	122(39.1)	162(51.9)
3	18(5.8)	118(37.4)	176(56.4)
4	35(11.2)	129(41.3)	148(47.4)
5	44(14.1)	103(33)	165(52.9)
6	38(12.2)	91(29.2)	183(58.7)
7	32(10.3)	91(29.2)	189(60.6)
8	37(11.8)	106(34)	169(54.2)
9	17(5.4)	118(56.7)	177(37.8)
10	46 (14.7)	115(36.9)	151 (48.4)
11	41(13.2)	90 (28.8)	181 (58)
12	36(11.5)	72 (23.1)	204 (65.4)
13	32(10.2)	86(27.6)	194(62.2)
14	29 (9.3)	93(29.8)	190 (60.9)
15	31(9.9)	116(37.2)	165(52.9)
Item no	SC F(%)	PC F(%)	AC F(%)
16	37 (11.9)	98(31.4)	177 (56.7)
17	34(10.9)	115(36.9)	163(52.2)
18	27(8.7)	115(36.9)	170(54.5)
19	40(12.8)	108 (34.6)	164(52.6)
20	39(12.5)	94(30.1)	179(57.4)
<b>Average Frequency and percentage</b>	<b>35(11.2)</b>	<b>104(33.3)</b>	<b>173(55.5)</b>



**KEY:** SC= Sound Conception, PC = Partial Conception, AC = Alternate Conception, f = frequency and % percentage

Result in Table 1 displays the frequency and percentage of the misconception of students in Organic Chemistry. The result indicates that 35(11.2%) of chemistry students have sound conception (SC), 104 (33.3%) of chemistry students have partial conception (PC) and 173(55.5%) of chemistry students have alternative conception (AC). This implies that students with

Alternative conception (misconception) and partial conception are higher since they have the high frequencies. While students with sound conception of organic chemistry are lower since it has the lowest frequency. This suggests that chemistry students have high misconception in organic chemistry.

Table 2: Frequency and Percentage for the Analysis of the topics in organic chemistry that students have more misconceptions

Item no	SC F(%)	PC F(%)	AC F(%)	Topic	Level of Misconception
1	46(14.7)	107(34.3)	159(51.0)	Hydrocarbon	High
2	28(9)	122(39.1)	162(51.9)		High
3	18(5.8)	118(37.4)	176(56.4)		High
4	35(11.2)	129(41.3)	148(47.4)	Isomerism	Low
5	44(14.1)	103(33)	165(52.9)		High
6	38(12.2)	91(29.2)	183(58.7)		High
7	32(10.3)	91(29.2)	189(60.6)		High
8	37(11.8)	106(34)	169(54.2)		High
9	17(5.4)	118(37.8)	177(56.7)	Structural formula	High
10	46 (14.7)	115(36.9)	151 (48.4)		Low
11	41(13.2)	90 (28.8)	181 (58)	Molecular formula	High
12	36(11.5)	72 (23.1)	204 (65.4)		High
13	32(10.2)	86(27.6)	194(62.2)		High
14	29 (9.3)	93(29.8)	190 (60.9)	Functional Groups	High
15	31(9.9)	116(37.2)	165(52.9)		High

Item no	SC F(%)	PC F(%)	AC F(%)	Topic	Level of Misconception
16	37 (11.9)	98(31.4)	177(56.7)	Organic chemistry reaction	High
17	34(10.9)	115(36.9)	163(52.2)		High
18	27(8.7)	115(36.9)	170(54.5)		High
19	40(12.8)	108 (34.6)	164(52.6)		High
20	39(12.5)	94(30.1)	179(57.4)		High
<b>Average</b>	<b>35(11.2)</b>	<b>104(33.3)</b>	<b>173(55.5)</b>		<b>High</b>

**Frequency and percentage**

**KEY:** SC= Sound Conception, PC = Partial Conception, AC = Alternate Conception, f = frequency and % percentage

Result in Table 2 displays Frequency and Percentage for the Analysis of the topics in organic chemistry that students have more misconceptions. The result reveals that all the 20 items spread across six organic chemistry

topics have Alternative Conception (misconception) percentages of more than 50% (high) except item 4 and 10 which is less than 50%. This indicates that chemistry students have high or more misconceptions in all items



except item 4 and 10 even though only 14% of them have sound conception. However, the average response indicates that the average percentage of the chemistry students' misconception in organic chemistry is 55.5% which is high or more misconception. Therefore, chemistry students have more misconception in the following organic chemistry topics: Hydrocarbon, Isomerism, Structural formula, Molecular formula, Functional groups and organic chemistry reactions.

### Discussion

One of the results of this study revealed that chemistry students have high misconception in organic chemistry. This indicate that a significant portion of chemistry students exhibit alternative conceptions (AC) or partial conceptions (PC) rather than sound conceptions (SC) in organic chemistry. The complexity of organic chemistry, with its intricate structures, reactions, and mechanisms, and ineffective teaching methods contribute to these misconceptions.

This finding aligns with Ardiansyah, Jahro, and Darmana (2021), who reported high misconceptions in chemical bonding, and Unal, Coştu, and Ayas (2010), who found misconceptions in covalent bonding. Similarly, Khandagale and Shinde (2021) noted misconceptions in abstract chemistry concepts like valency and bonding.

Another result of this study revealed that chemistry students have more misconception in the following organic chemistry topics: Hydrocarbon, Isomerism, Structural formula, molecular formula, Functional groups and organic chemistry reactions. The abstract nature of organic chemistry and inadequate instructional methods contribute significantly to these misconceptions. This is consistent with findings by Topal, Oral, and Ozden (2007) on aromaticity misconceptions among Turkish students and by Hayuni, Siti, and Retnosari (2019) on intermolecular forces.

### Conclusion

The study concludes that senior secondary school students in Lokoja Education Zone of Kogi State exhibit high misconceptions in organic chemistry. These misconceptions are particularly prevalent in topics such as hydrocarbons, isomerism, functional groups, structural formula, molecular formula and organic chemistry reactions. This misconception could be resolved Incorporate active learning techniques such as problem-based learning, group discussions, and hands-on experiments to make abstract concepts more

tangible. Use visual aids, including molecular models, diagrams, and animations, to help students better understand complex structures and reactions.

### Recommendations

Based on the findings of this study the following recommendations are emphasized.

1. School administrators should implement regular formative assessments to identify and address misconceptions early on, allowing for timely intervention and clarification.
2. Federal and state ministry should also provide professional development opportunities for chemistry teachers to enhance their content knowledge and pedagogical skills in organic chemistry instruction.
3. 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.

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