IDENTIFICATION OF DIFFICULT CONCEPTS IN ORGANIC CHEMISTRY AMONG SENIOR SECONDARY SCHOOL STUDENTS AND TEACHERS IN NSUKKA EDUCATION ZONE

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Abstract

The study investigated the common misconceptions encountered by students in organic chemistry in Nsukka Local Government Area of Enugu State. Two research questions guided the study. The study was carried out in Nsukka local Government area of Enugu state. The study adopted descriptive survey research design. The population of the study consisted of 1,087 seniors' secondary school two (SSII) chemistry students in the 30 government secondary schools in Nsukka Local Government Area, Enugu State. A sample size of 292 SS2 chemistry students was selected using multi stage sampling procedure. A structured Organic Chemistry Misconception Test (OCMT) was used for data collection. The instruments were face and content validated by three (3) experts; one from Measurement and Evaluation and two from Chemistry unit, all from the Department of Science Education, University of Nigeria, Nsukka. The reliability of the instrument was established using Kudder Richardson-20 and the reliability coefficient of 0.89 was obtained. The data collected was analyzed using Frequency and percentage 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. The study recommended that school administrators ought to implement a functional supervisory or checking team charged with the mandate of making certain that educational standards are met. They maintain the standards by focusing on state of laboratories. They also ensure monitoring of the performance of students and get to interact with them to identify problems with the purpose of providing solutions. Difficulties faced by students identified by them should be recorded and the Chemistry department led by their teachers working on strategies of how to make the students understand the identified concepts as challenging.

Keywords: Difficult concepts, organic chemistry, teachers, students

Introduction

Chemistry remains one of the most popular subjects among senior secondary school students in Nigeria. Chemistry is the scientific study of elements and compounds made up of atoms, molecules, and ions, as well as their compositions, structures, characteristics, behaviors, and changes they undergo. According to Usselman (2021), Chemistry is the aspect of science that deals with the propertied, composition, and structure of substances (specified as elements and compounds), as well as the changes they go through and the energy emitted or absorbed during these processes. The knowledge of chemistry is crucial to our everyday lives, and has many unforeseen potential benefits for our future. An understanding of Chemistry allows us the opportunity to explain the world around us; and to make informed decisions concerning our actions as individuals. Generally, understanding of Chemistry is necessary for working in almost all the other sciences such as material sciences, engineering, environmental sciences, and medicine.

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Chemistry is a subject with many abstract and complex characteristics, many students still struggle with it or even have misconceptions about it. According to Sibomana, Karegeya, and Sentongo (2020), chemistry students face challenges and misconceptions because of the overwhelming abstract notions that are unrelated to one another. Chemistry as a discipline has five main subdisciplines namely: physical chemistry, organic chemistry, inorganic chemistry, analytical chemistry and biochemistry. Organic Chemistry is the chemistry of hydrocarbons and their derivatives. Organic chemistry encompasses the study of the structure, properties, composition, reactions, and synthesis of organic compounds, which are defined as any molecules containing carbon atoms (Jones & Fleming, 2014). Organic chemistry cover a wide range of topics that require conceptual understanding and knowledge which might be related to students' perception that the course is difficult. Many scholars have acknowledged Organic Chemistry as a difficult subject and many students who wish to pursue a career in Chemistry, engineering and medicine must have a good foundation of Organic Chemistry and possibly a good grade in Organic Chemistry (Salame, 2019, Sana & Adhikary, 2017).

However, many students are discouraged from pursuing this career route due to the challenging nature of the Organic Chemistry materials. Efforts have been made by different researchers to identify the difficulties associated with the teaching and learning of organic chemistry with the sole aim of finding solutions that could improve students' achievement (Omwirhiren & Ubanwa, 2016; Sirhan, 2007; Uce & Ceyhan, 2019). Some of these difficulties include lack of proper knowledge in chemical bonding and molecular structure (Tsaparlis & Byers, 2018) which is essential in the learning of organic chemistry (Miller & Castillo, 2021). According Iyamuremye and Mukiza, (2022), The inability to relate abstract ideas to tangible realities is another source of difficulty in organic chemistry especially when it comes to comprehending the connections between molecular structures and chemical reactivity in organic chemistry (Yanarates & Yerlikaya, 2022). These claims demonstrate how the basic ideas of chemistry bonding and reactivity are crucial to comprehending the behavior of organic compounds, which are the subject of organic chemistry. Many scholars attributed these difficulties to misconception.

In organic chemistry, misconceptions are students' enduring and incorrect ideas about particular ideas, reactions, or structures in the field. These false beliefs have the potential to impair learning, inhibit conceptual comprehension, and result in improper approaches to problem-solving. To improve the efficacy of teaching organic chemistry, it is imperative to recognize and correct these fallacies. various researchers have various ideas of what misconceptions are. According to Khandagale and Shinde (2021), misconceptions are incorrect beliefs or perspectives about a person's concept that diverge from the scientific ideas developed by professionals in their field. Misconceptions, according to Kulgemeyer and Wittwer (2023), are preconceived notions or opinions that students hold about the real world. These misunderstandings could or might not be consistent with scientific theories. Since ethanol (C2H5OH), acetic acid (CH3COOH), glucose (C6H12O6), and amino acids (building blocks of proteins) are all organic compounds that are essential to daily life and biological processes, many students mistakenly believe that chemistry, especially organic chemistry, is a challenging subject that only involves working with corrosive, toxic, and harmful substances. Alamina (2018) categorized the reasons for misconceptions into "misrepresentation factor" and "deficiency factor." While the misrepresentation factor involves the improper presentation of educational materials, the deficiency factor concerns learners' lack of foundational information required to develop new knowledge. According to Halim, Lestari, and

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Mustafa (2019), misconceptions can be caused by a variety of factors, including textbooks, instructional strategies, students' erroneous assumptions and preconceptions, and teachers' ignorance of the subject matter. According to Tetzlaff (2017), students who excel at rote memory frequently struggle with application-based tasks, revealing gaps in their knowledge. Personal experiences, peer relationships, media, language, textbooks, and social variables are some of the many origins of misconceptions (Widiyatmoko and Shimizu, 2018; Diah and Afadil, 2018). These elements produce contradictory frames that result in a disjointed comprehension of scientific ideas. Because they serve as the foundation for more intricate ideas, misconceptions about basic concepts like acid/base chemistry are especially problematic in organic chemistry (Greenwood, 2017). According to Vidyanand and Asmita (2021), misunderstandings arise from abstract ideas like valency and chemical bonding. Pre-service chemistry teachers have misconceptions about covalent bonds, particularly polar and non-polar bonds, according to research by Ozdemir and Oztekin (2018).

Previous studies have established that students often struggle with understanding core concepts in chemistry, particularly in organic chemistry. For instance, Bhattacharyya and Bodner (2005) revealed that students relied on superficial reasoning when proposing organic mechanisms, while Sirhan (2007) highlighted general learning difficulties in chemistry across levels. Similarly, Özmen (2011) documented widespread misconceptions in chemistry and emphasized the need for conceptual change strategies. More recent studies, such as Anim-Eduful (2020) and Nartey, Koranteng, Oppong, and Hanson (2024), demonstrated that misconceptions persist in specific areas like qualitative analysis and reaction mechanisms, even at higher levels of study. Ogundiji (2025) further found that senior secondary school students in Ibadan still faced challenges in IUPAC nomenclature, including isomerism and functional groups. However, despite these valuable insights, little is known about the specific difficult concepts confronting senior secondary school students in Nsukka Local Government Area. Therefore, the identification of areas of difficulty and difficult concepts in chemistry is very imperative. The study seeks to identify difficult concepts in chemistry that senior secondary school students in Nsukka local government area of Enugu state are faced with.

Purpose of the Study

The general purpose of the study is to identify difficult concepts in chemistry that senior secondary school students in Nsukka Local Government Area are faced with. Specifically, the study sought to:

1. Identify difficult concepts in senior secondary school chemistry faced by students.
2. Identify difficult topics in organic chemistry that students have more misconceptions.

Research Questions

The following research questions guided the study.

1. What are the students’ misconception in Organic Chemistry?
2. What are the topics in organic chemistry that students have more misconceptions?

Methods

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 II Chemistry students in government secondary schools in Nsukka Local Government Area. The population of the study consisted of 1087

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Senior Secondary School chemistry students in the 30 government secondary schools. A sample of 292 students was determined using Taro Yamane's formula. The instrument used was the Organic Chemistry Miresconception Test (OCMT), a multiple-choice test with 15 items. The items on the instrument were rated as follows: 3 for sound conception (SC), 2 for partial conception (PC), and 1 for alternative conception (AC). 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 0.89. 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 score of students' misconception in organic chemistry

	SC		**PC**		**AC**	
Items	**F**	**%**	**F**	**%**	**F**	**%**
1	20	6.8	98	33.6	174	59.6
2	24	8.2	131	44.9	137	46.9
3	24	8.2	40	13.7	228	78.1
4	9	3.1	68	23.3	215	73.6
5	10	3.4	133	45.5	149	51.0
6	18	6.2	84	28.8	190	65.1
7	14	4.8	86	29.5	192	65.8
8	5	1.7	87	29.8	200	68.5
9	9	3.1	93	31.8	190	65.1
10	20	6.8	89	30.5	183	62.7
11	9	3.1	32	11.0	251	86.0
12	8	2.7	120	41.1	164	56.2
13	34	11.6	86	29.5	172	58.9
14	25	8.6	74	25.3	193	66.1
15	19	6.5	126	43.2	147	50.3
Grand mean F	17	5.66	90	30.75	186	63.59

KEY: SC= Sound Conception, PC= Partial Conception, AC= Alternative Conception and F= Frequency

NB: The grand frequency in each level of misconception is obtained by the summation of each frequency level of misconception divided by the number of items (i.e 15)

Result in Table 1 shows the frequencies and percentage score of students' misconception in organic chemistry. The result indicates that 17(5.66%) of chemistry students have sound conception, 90(30.75%) of chemistry students have partial conception and 186(63.59%) of chemistry students have alternative conception. This implies that students with Alternative

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

Table 2: Frequency and percentage score of the topics in organic chemistry that students have more misconceptions

	SC		PC		AC		Topic	Level of misconception
Items	**F**	**%**	**F**	**%**	**F**	**%**		
1	20	6.8	98	33.6	174	59.6	Hydrocarbon	High
2	24	8.2	131	44.9	137	46.9		Low
3	24	8.2	40	13.7	228	78.1		High
4	9	3.1	68	23.3	215	73.6	Isomerism	High
5	10	3.4	133	45.5	149	51.0		High
6	18	6.2	84	28.8	190	65.1		High
7	14	4.8	86	29.5	192	65.8	Structural formular	High
8	5	1.7	87	29.8	200	68.5	Molecular formular	High
9	9	3.1	93	31.8	190	65.1		High
10	20	6.8	89	30.5	183	62.7	Functional groups	High
11	9	3.1	32	11.0	251	86.0		High
12	8	2.7	120	41.1	164	56.2		High
13	34	11.6	86	29.5	172	58.9	Organic chemistry reaction	High
14	25	8.6	74	25.3	193	66.1		High
15	19	6.5	126	43.2	147	50.3		High
Grand mean F	**17**	**5.66**	**90**	**30.75**	**186**	**63.59**		**High**

KEY: SC= Sound Conception, PC= Partial Conception, AC= Alternative Conception and F= Frequency

NB: The grand frequency in each level of misconception is obtained by the summation of each frequency level of misconception divided by the number of items (i.e 15)

Result in Table 2 displays Frequency and Percentage for the topics in organic chemistry that students have more misconceptions. The result reveals that all the 15 items spread across six organic chemistry topics have Alternative Conception (misconception) percentages of more than 50% (high) except item 2 which is less than 50%. This indicates that chemistry students have high or more misconceptions in all items except item 2 even though only 5.66% of them have sound conception. However, the average response indicates that the average percentage of the chemistry students' misconception in organic chemistry is 63.59 % 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.

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Discussion

Result on table 1 shows that chemistry students have high misconception in organic chemistry. The finding that chemistry students have high misconceptions in organic chemistry suggests that learners struggle to correctly understand and interpret key concepts in this branch of chemistry. Misconceptions may arise from the abstract and symbolic nature of organic chemistry, the multiple representations used (structural formulas, reaction mechanisms, nomenclature), or the cognitive demand of linking microscopic, macroscopic, and symbolic levels of understanding. This indicates that despite formal instruction, many students may develop flawed mental models or hold onto alternative conceptions that interfere with accurate problem-solving and application of knowledge in organic chemistry. Such misconceptions can hinder students' overall achievement in chemistry and limit their readiness for advanced studies in science-related fields.

This finding aligns with the study of Akinbobola and Afolabi (2019), who reported that secondary school students in Nigeria held significant misconceptions in organic chemistry, particularly in areas such as functional groups and reaction mechanisms. Similarly, Tümay (2016) found that university students struggled with multiple representations in organic chemistry, leading to persistent misconceptions about molecular structures and reactions. However, this result contrasts with the findings of Schmidt-McCormack et al. (2019), who observed that with the use of targeted instructional strategies, such as active learning and mechanistic approaches, students demonstrated fewer misconceptions and better conceptual understanding in organic chemistry.

Result on table 2 shows 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 finding that chemistry students have more misconceptions in hydrocarbons, isomerism, structural and molecular formulas, functional groups, and organic reactions suggests that these areas are especially challenging due to their abstract and symbolic nature. Students often confuse molecular and structural representations, struggle to visualize isomers, and find it difficult to recognize functional groups and predict organic reaction mechanisms. Such misconceptions indicate that rote memorization may be replacing conceptual understanding, limiting students' ability to connect ideas and apply them to solve problems in organic chemistry. Consequently, these challenges can hinder students' mastery of organic chemistry, since the identified topics serve as foundations for advanced concepts.

This result is consistent with the findings of Anim-Eduful (2020), who reported that students exhibited poor understanding of functional groups, compound naming, and distinctions between related organic compounds. Similarly, Nartey, Koranteng, Oppong, and Hanson (2024) found that undergraduate students frequently made errors in representing organic substitution mechanisms, such as confusing SN1 and SN2 pathways and misusing electron-pushing arrows. However, the finding differs from Ogundiji (2025), who, while noting students' misconceptions in IUPAC nomenclature, reported that some students demonstrated moderate accuracy in distinguishing between structural and molecular formulas and in applying naming conventions.

Conclusion

It can be concluded that many chemistry students still struggle with understanding organic chemistry, especially in key areas like hydrocarbons, isomerism, molecular and structural formulas, functional groups, and organic reactions. These struggles show that students are not just facing challenges with abstract ideas but are also finding it difficult to connect

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what they learn in class with meaningful understanding. The persistence of these misconceptions suggests that the way organic chemistry is taught may not always meet students where they are, making it harder for them to fully grasp the concepts. This calls for teaching methods that break down complex ideas into simpler, relatable forms and give students opportunities to engage actively with the subject so that learning becomes clearer and more lasting.

Recommendations

From the findings of the study, the following recommendations were made:

1. Teachers should move beyond rote memorization and emphasize conceptual understanding by using models, simulations, and real-life examples to help students connect abstract organic chemistry concepts with practical applications.
2. Instruction should include molecular models, structural diagrams, animations, and symbolic representations side by side to help students make connections between microscopic, macroscopic, and symbolic levels of chemistry.
3. Since specific topics such as isomerism, functional groups, and organic reactions were identified as areas of difficulty, teachers should organize focused remedial lessons and practice exercises to address these misconceptions directly.
4. Engaging students in peer tutoring, group discussions, and problem-solving tasks can help them explain concepts to one another, confront misconceptions, and develop deeper understanding through interaction.
5. Workshops and training programs should be organized to equip chemistry teachers with innovative strategies and tools, such as inquiry-based learning and ICT resources, that make abstract organic chemistry concepts more accessible to students.

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