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Identification of Students' Misconceptions on Hydrocarbon Material Using a Four-Tier Multiple Choice Diagnostic Test

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ABSTRAK

Ilmu kimia sebagai salah satu ilmu yang diangap kompleks dan abstrak bagi sebagian siswa sehingga banyak timbul kesalahan konsep khususnya pada materi Hdrokarbon. Miskonsepsi bisa berakibat fatal apabila tidak dideteksi sejak dini. Penelitian ini bertujuan untuk mengidentifikasi miskonsepsi siswa yang terjadi pada materi hidrokarbon. Jenis penelitian yang digunakan adalah penelitian deskriptif kualitatif. Penelitian deskriptif kuantitatif digunakan untuk mengidentifikasi miskonsepsi pada siswa dengan menggunakan tes diagnostik four-tier multiple choice. Subjek penelitian ini adalah siswa sebanyak 24 orang. Instrumen yang digunakan adalah empat level soal meliputi (1) soal pilihan ganda, (2) tingkat keyakinan pada jawaban (3) alasan dari jawaban, dan (4) tingkat keyakinan dari alasan. Hasil penelitian menunjukkan bahwa pemahaman siswa pada konsep hidrokarbon terdiri dari 24,7% paham konsep, 32,1% tidak paham konsep, dan 43,2% miskonsepsi. Miskonsepsi dengan kategori tinggi terdapat pada sub materi reaksi senyawa hidrokarbon (66,7%), miskonsepsi kategori sedang pada sub materi pengertian senyawa hidrokarbon (31,3%), struktur dan tata nama (56,3%), jenis atom karbon (37,5%), sifat fisik dan kimia (45,8%), isomer (47,9%) dan miskonsepsi kategori rendah pada sub materi kekhasan atom karbon (16,7%). Implikasi dari penelitian ini adalah guru diharapkan dapat mendeteksi bentuk miskonsepsi yang dialami siswa dalam menafsirkan konsep hidrokarbon sehingga terjadinya miskonsepsi dapat diminimalisir.

ABSTRACT

As one of the sciences, some students consider chemistry complex and abstract, so many misconceptions arise. One of the chemistry topics that cause many misconceptions is hydrocarbons. A misconception is an understanding of concepts in students' minds that are contrary to scientific concepts. This research aimed to identify the student's understanding and misconception of hydrocarbon. The study was qualitative descriptive research. Qualitative descriptive research was used to identify student misconceptions using the four-tier test. The sample of the research was 24 students. The instruments used in this research are four test levels which include (1) multiple-choice, (2) confidence rating of the answer beliefs, (3) reason for the answer, and (4) confidence rating of the reasoning. The result shows that 24,7% of students well-understood hydrocarbon concepts, 32,1% do not understand, and 43,2% have misconceptions. Misconceptions in this research are divided into three categories: low, moderate, and high. The students experience misconceptions with high criteria on the concept reaction of hydrocarbon (66,7%), moderate criteria on the concept of determining hydrocarbon compound (31,3%), the nomenclature of hydrocarbon compound (56,3%), types atom carbon (37,5%), Physical and Chemical Properties (45,8%), isomers (47,9%) and low criteria on the concept of characteristics of carbon atoms (16,7%).

1. INTRODUCTION

Chemistry is a branch of science that studies the existence of matter in terms of its structure, properties, and energy changes that accompany these changes (Jespersen, Brady, & Hyslop, 2012; Madiya, 2020). Chemistry is one of the sciences that is close to human life. However, for chemistry students, it is

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considered a difficult subject (Qodriyah, Rokhim, Widarti, & Habiddin, 2020; Rico & Fitriza, 2021). One of them is hydrocarbon material. Hydrocarbon material is difficult for students to understand. It is indicated by the fact that many students still score below the Minimum Completeness Criteria standard. The basic competence that is considered the most difficult by students is to analyze the structure and properties of hydrocarbon compounds based on the characteristics of carbon atoms and their compound groups (Oktavianita, Kurniasih, & Fitriani, 2019). Student's difficulties in learning hydrocarbon material include facts in studying hydrocarbon material that students have to memorize in large and varied numbers, most students are still unfamiliar with several terms related to hydrocarbon material in the form of compound names, and the process of delivering the material requires a long time because the hydrocarbon material is broad (Qodriyah et al., 2020). The material for hydrocarbon compounds consists of several indicators, namely being able to explain the meaning of hydrocarbon compounds, grouping hydrocarbon compounds based on bond saturation and nomenclature, giving names to hydrocarbon compounds (alkanes, alkenes, alkynes), and distinguishing primary and secondary, tertiary, and quaternary C atoms (Susanti, Fatah, & Wahyutami, 2019).

Students experience difficulties in understanding the central concepts of chemistry. Learning that emphasizes abstract concepts and abstract concepts that are difficult to explain with concrete examples. Even though the phenomenon in this concept can be observed visually, for further explanation, a special method is needed to describe the phenomenon in a real and easy-to-understand manner (Munandar & Jofrishal, 2016). It can cause students to make conclusions about a concept that needs to be corrected or follow the actual concept. Concepts that need to follow scientific concepts can last a long time and are difficult to repair because these concepts can explain the problems faced even if they are wrong. This wrong understanding of a scientific concept can be called a misconception (A'yun & Nuswowati, 2018).

One fatal problem in educational practice is a misconception because it is related to student understanding. Therefore, this must be detected early in the learning process (Raharjo, Ramli, & Rinanto, 2019). The level of students' understanding is distinguished, namely Understanding the Concept, Understanding the Concept but Not Confidence, and Not Knowing the Concept (Mustakim et al., 2015). Misconceptions are individual knowledge inconsistent with scientific concepts (Putri & Subekti, 2021). The existence of misconceptions should not be allowed because it can cause students to experience misconceptions about other, more complex concepts (A'yun & Nuswowati, 2018). Misconceptions are known as students' obstacles in learning science. Several topics in science learning always give misconceptions to novice students, and researchers use various diagnostic assessments to identify students' misconceptions about science (Soeharto, Csapó, Sarimanah, Dewi, & Sabri, 2019). Based on the results of observations, students experienced misconceptions about the concept of the uniqueness of carbon atoms 96.4%, the concept of C atomic bonds in carbon chains 85.8%, and the concept of closed chains 78.6%. Misconceptions about hydrocarbon material were also identified using a three-tier diagnostic test on the concept of understanding hydrocarbon compounds by 22.1%, the specificity of carbon atoms by 23.6%, the types of carbon atoms by 22.9%, the structure and nomenclature of hydrocarbon compounds by 24, 8%, physical and chemical properties of hydrocarbon compounds by 31.7%, isomers by 45.1%, and reactions of hydrocarbon compounds by 31.4% (Qodriyah et al., 2020). Misconceptions were found in students in the 1st semester of Chemistry Education who understood the concept 12.25%, had a misconception of 26.72%, and did not understand the concept of 61.03%. The factors that cause the odd-semester students' misconceptions about chemistry education on hydrocarbons are the lack of basic skills, the low interest in studying chemistry, and the influence of other students. Misconceptions in students occur because of experiences or events experienced by students in everyday life, the initial concepts possessed by students, and the teacher's teaching methods (Sundaygara et al., 2021).

One of the instruments used to identify students' misconceptions is a diagnostic test instrument. It can measure students' misunderstandings or misconceptions so that this will be followed up immediately through proper handling (Istiyani, Muchyidin, & Rahardjo, 2018). A good diagnostic test will make it easier for teachers to classify students who have misconceptions or not (Jubaedah, Kaniawati, Suyana, Samsudin, & Suhendi, 2017). Researchers have developed various diagnostic test instruments. One of them is a four-tier test format diagnostic instrument, which is a development of a three-level multiple-choice diagnostic test coupled with students' confidence level in choosing answers and reasons (Sheftyawan, Prihandono, & Lesmono, 2018). The four-tier diagnostic test instrument helps students understand the material.

Several previous studies have shown that a four-tier diagnostic test instrument can be used to analyze the level of misconceptions held by students (Abbas, 2019). Other research shows that the four-tier diagnostic test is valid and appropriate for learning (Roghdah, Zammi, & Mardhiya, 2021; Zaleha, Samsudin, & Nugraha, 2017). Based on the results of previous studies, this diagnostic test is feasible and has been used several times. However, there needs to research on the four-tier diagnostic test used to analyze misconceptions about hydrocarbon matter. Based on this background, this study aims to analyze the

misconceptions about hydrocarbon material at MAN 2 Bantul in class XI IPA 2 samples with multiple choice questions in the form of a four-tier diagnostic test.

2. METHOD

The research method used is quantitative descriptive research to identify students' misconceptions about hydrocarbons. The population in this study were eleventh-grade students at MAN 2 Bantul. The sampling technique was carried out using purposive sampling. The sample was selected based on observations of student scores in odd semesters. The selected sample is class XI IPA 2, totaling 24 students. The instrument used is a four-tier diagnostic test item consisting of 10 items which two material experts have validated. The instrument questions were distributed to students, and then students' answers were analyzed based on their level of understanding. The categorization criteria, according to (Diani et al., 2019) shown in Table 1.

Table 1. Categories Based on Answers, Beliefs about Answers, Reasons, and Beliefs about Reasons

Category	Tier-1	Tier-2	Tier-3	Tier-4
Understand the concept	Correct	Convinced	Correct	Convinced
	Correct	Not convinced	Correct	Not convinced
	Correct	Convinced	Correct	Not convinced
	Correct	Not convinced	Correct	Convinced
	Correct	Not convinced	Wrong	Not convinced
Need help understanding the concept.	Wrong	Not convinced	Correct	Not convinced
	Wrong	Not convinced	Wrong	Not convinced
	Correct	Convinced	Wrong	Not convinced
	Wrong	Not convinced	Correct	Convinced
	Correct	Not convinced	Wrong	Convinced
	Correct	Convinced	Wrong	Convinced
misconception	Wrong	Convinced	Correct	Not convinced
	Wrong	Convinced	Correct	Convinced
	Wrong	Convinced	Wrong	Not convinced
	Wrong	Not convinced	Wrong	Convinced
	Wrong	Convinced	Wrong	Convinced

Based on the results of the categorization analysis above, a calculation is then performed to determine the percentage of understanding of the concept for each question (Beniarti, Prihandono, & Supeno, 2018). The percentage calculation results were analyzed and grouped according to the criteria for the level of misconceptions, namely the low category with a percentage of 0-30%, the moderate category with a percentage of 31-60%, and the high category with a percentage of 61-100%.

3. RESULT AND DISCUSSION

Result

The results of the research that has been carried out show that the average misconception in the hydrocarbon material is 43.2%, with the details of the concepts that can be seen in Table 2. In contrast, the forms of students' misconceptions about each concept contained in the hydrocarbon material are shown in Table 3.

Table 2. Categories of Student Answers for Each Hydrocarbon Concept

No	Concept	Answer Category (%)		
		Understand	Do Not Understand	Misconceptions
1	Hydrocarbon Compounds	60.40	8.30	31.30
2	The peculiarity of the carbon atom	4.20	79.20	16.70
3	Types of Carbon Atoms	37.50	25.00	37.50
4	Structure and Nomenclature	16.70	27.10	56.30
5	Physical and Chemical Properties	29.20	25.00	45.80
6	isomers	8.30	43.80	47.90
7	Reactions of Hydrocarbon Compounds	16.70	16.70	66.70
	Total	172.90	225.00	302.10
	Average	24.70	32.10	43.20

Table 3. Forms of Students' Misconceptions about Hydrocarbons

No	Concept	Question	Misconception form
1	Hydrocarbon compounds	1 & 2	• Hydrocarbon compounds are compounds that contain the elements C, H, and N • Hydrocarbon compounds are compounds that contain the elements C, H, and O • Hydrocarbon compounds are compounds that contain the elements C, H, O, and N
2	The peculiarity of the carbon atom	3	• A relatively small carbon atom will make it easier to form a stability
3	Type of carbon atom	4	• The Primary C atom is a C atom that binds 1 H atom • Secondary C atoms are C atoms that bind 2 H atoms • Tertiary C atoms are C atoms that bind 3 H atoms
4	Structure and nomenclature	5 6	• Compounds with the formula C3H8; C5H12; C7H16 is an alkene • The double bond is an alkyne • In atomic numbering, always go from left to right
5	Physical and chemical properties	7	• Compounds with the highest boiling point are compounds with many branches
6	isomers	8 9	• Compound 2-3-dimethyl butane is an isomer pair of compound 2-3-dimethylpentane because it has the same molecular formula but a different framework • Compounds with triple bonds have geometric isomers
7	Reactions of hydrocarbon compounds	10	• Elimination reaction is a change in compounds of double bonds into single bonds

The percentage of misconceptions is then classified into three categories, low, medium, and high, shown in Table 4. Misconceptions with a low category are in the concept of the uniqueness of carbon atoms (16.7%), the moderate category is in the concept of hydrocarbon compounds (31.1%), types of carbon atoms (37.5%), structure and nomenclature (56.3%), physical and chemical properties (45.8%), isomers (47.9%) and low category misconceptions in the sub-matter of carbon atom peculiarities (16.7%).

Table 4. Categories of Misconceptions for Each Hydrocarbon Concept

Concept	Number of Questions	Perscentage (%) Average	Category
Hydrocarbon Compounds	2	31.30	Moderate
Features of the Carbon Atom	1	16.70	Low
Types of Carbon Atoms	1	37.50	Moderate
Structure and Nomenclature	2	56.30	Moderate
Physical and Chemical Properties	1	45.80	Moderate
Isomers	2	47.90	Moderate
Reactions of Hydrocarbon Compounds	1	66.70	High
Average	10	43.20	Moderate

Based on the analysis results in Table 4, the average percentage of students misconceptions in MAN 2 Bantul on hydrocarbons is in the medium category. The results follow the research conducted by (Rico & Fitriza, 2021), which states that hydrocarbon compounds are chemical materials that require an in-depth understanding of concepts because they are classified as substances that are difficult for students to understand. Many students experience misconceptions about various concepts in the material of hydrocarbon compounds which are grouped into the concept of hydrocarbon compounds, the specific types of carbon atoms, types of carbon atoms, structural nomenclature, isomers, physical properties, and reactions of hydrocarbon compounds.

Discussion

Based on the study results, it was shown that the percentage of students misconceptions in the low category was 16.7% in question number 3, namely the concept of the uniqueness of the carbon atom. The

indicator for this question explains the peculiarities of carbon atoms in carbon compounds. This study's results align with previous research, which states that there are common misconceptions about the uniqueness of carbon atoms (Rico & Fitriza, 2021; Siswaningsih, Hernani, & Rahmawati, 2014). Students experience misconceptions because they think that only carbon atoms have four valence electrons and that only carbon elements can form covalent bonds. Misconceptions occur when students think that the uniqueness of carbon atoms is related to relatively small carbon atoms, so they easily form stability. It contradicts the actual concept that what is meant by the uniqueness of a carbon atom is related to the ability of a carbon atom to have four valence electrons so that it can form covalent bonds. When viewed from the electron configuration, the carbon atom is relatively small because the carbon atom is located in period 2, which means that this atom has two atomic shells. Hence, the atomic radius is relatively small. It causes the covalent bonds that are formed to be relatively strong so that they can form single covalent bonds, double covalent bonds, and triple covalent bonds, which cause carbon atoms to have unique characteristics.

Questions 1 and 2 show a moderate category of misconceptions, namely 31.3% on understanding hydrocarbon compounds. The indicator for this question is that students can classify compounds belonging to the hydrocarbon group. Misconceptions occur because students think that hydrocarbon compounds are compounds that contain the elements hydrogen (H), carbon (C), and oxygen (O). Some students also gave answers on the reasons that hydrocarbon compounds are compounds that contain the elements hydrogen (H), carbon (C), and nitrogen (N), and some also gave answers on the reasons that hydrocarbon compounds are compounds that contain the elements hydrogen (H), carbon. (C), oxygen (O) and nitrogen (N). The correct answer is that hydrocarbon compounds only consist of hydrogen (H) and carbon (C) without other elements. If there are other elements in the compound, such as oxygen (O) and nitrogen (N), these elements are included in carbon compounds. Misconceptions occur because students assume that carbon and hydrocarbon compounds are the same. Errors can occur because students generalize concepts without understanding the essence of the actual theory. It is in line with previous research stating that students answered questions incorrectly because the students' initial concepts were wrong (Diani et al., 2019; Putri & Hasan Subekti, 2021). It is called fixation. Students conclude the same principle directly without considering its meaning and not paying attention to the actual concept. The misconception that occurs is to assume that oxygen and nitrogen are in hydrocarbon compounds.

The percentage of misconceptions about number 4 is included in the medium category, namely 37.5%, which includes the concept of the type of carbon atom. The indicator in question number 4 is in the form of determining the number of primary, secondary, and tertiary carbon atoms. Misconceptions are seen when students interpret primary carbon as carbon that binds one hydrogen atom. It also happens to a secondary and tertiary carbon. The student's understanding is certainly different from the concept of the type of carbon atom, where primary carbon atoms are carbon atoms that bind one other carbon atom.

In contrast, secondary carbon atoms are carbon atoms that bind two other carbon atoms, and tertiary carbon atoms are carbon atoms that bind three carbon atoms. This misconception occurs due to the need for mastery of students' knowledge related to the concept of types of carbon atoms. The results align with research, which states that mastery of knowledge is, of course, students have different levels of understanding (Djarwo, 2019; Qodriyah et al., 2020). The difference in students' understanding of the concept in this problem is the student's mistake in interpreting the meaning of primary, secondary, and tertiary carbon atoms. This error likely occurred because students needed to understand the concept of C atom types in depth and learned by the rote model. Students most likely confused their understanding of C atom types with one another, namely between primary, secondary, tertiary, and quaternary C atoms. Most of the students grouped carbon atoms based on the ability of C atoms to bind to H atoms, not C atoms to bind to other carbon atoms (Pratama & Sukarmin, 2021).

The category of misconceptions about the concept of structure and nomenclature of hydrocarbon compounds is in the moderate category with a percentage of 56.3%. In this concept, there are two questions: question number 5 concerning the grouping of hydrocarbon compounds and question number 6 concerning the nomenclature of hydrocarbon compounds. The indicator in question number 5 is for students to determine groups of unsaturated hydrocarbon compounds based on the molecular formula. Most students who experience misconceptions answer correctly in tier 3, namely unsaturated compounds as compounds with double and triple bonds. Students are wrong in answering questions at tier 1, where students think that the compound with the molecular formula C_3H_8, C_5H_{12}, and C_7H_{16} is classified in the homologous alkene series. The correct answer is C_3H_8; C_5H_{12}; C_7H_{16} is classified in the homologous alkane series. The indicator in question 6 is to determine the structural formula for a hydrocarbon compound named 4-methyl-1-pentuna. Before answering this question, students must understand the steps in numbering hydrocarbon compounds. Students are wrong in determining the structural formula of the compound but are correct in the choice of reasons (tier 3) related to the answer. Indicator question number 6, students assume that compounds with double bonds are included in the alkyne homologous series. Misconceptions in questions

no. 5 and 6 can occur to students because students need more depth in studying the concept of structure and nomenclature of compounds so that there is an exchange of understanding between homologous hydrocarbon series. In indicator number 6, student misconceptions can occur due to student errors in sorting atomic numbers. Students assume that in sorting atomic numbers, it is always from left to right, even though the correct one is that the C atom number 1 is the C atom at the end close to the double bond. In line with previous research, students still needed help understanding the concept of the nomenclature of hydrocarbons and other organic compounds (Purwanto, 2021). The learning difficulties were caused by students not understanding the nomenclature rules and finding it difficult to memorize the names of alkyl groups.

In question number 7, the misconception is in the moderate category, with a percentage of 45.8% on the concept of physical and chemical properties of hydrocarbon compounds. The indicator for this question is that students answer the questions with the reason that the compound with the highest boiling point is a compound with many branches because it has stronger intermolecular bonds. This misconception can occur to students due to students' initial preconceptions that they think that compounds with many branches will have complex bonds and are increasingly difficult to remove. The energy needed to break the bond is greater, causing the boiling point to be higher. The correct answer is that the boiling point will be higher in the presence of straight and long-chain alkanes. It is due to van der Waals attractions between molecules that occur in alkanes with chains that are getting longer and straighter. Compounds with many branches will have weaker intermolecular bonds, so their boiling points will be lower.

Regarding the physical and chemical properties of hydrocarbon compounds, the teacher can explain the material by relating it to everyday life. It is in line with the results of previous research, which states that if the teacher does not explain and associate the material with everyday life, students misperceive, which causes misconceptions (Abbas, 2019; Sitepu & Yakob, 2019). Learning currently experiences many obstacles because students find it difficult to understand the lesson or material delivered by the teacher.

The category of misconceptions in questions number 8 and 9 is in the moderate category, with a percentage of 47.9% in the isomer concept. The indicator for question number 8 is to determine the isomer pairs of a compound, while the indicator for question number 9 shows compounds with geometric isomers. Students are said to understand the concept if they can determine isomer pairs and show compounds with geometric isomers for the right reasons. The indicator for question number 8 is that students can determine isomer pairs in 2,3-dimethyl butane compounds. The misconception identified here is that students answered correctly on the choice of reasons but answered incorrectly on tier 1. It can be caused by a lack of mastery of students' knowledge related to the concept of isomers. Students assume that the meaning of the same molecular formula is because they have the same number and methyl writing equation, namely 2,3-dimethyl. Supposedly, the meaning of the same molecular formula is the same number of C and H atoms, namely C_6H_{14}. Indicator question number 9, students can determine compounds that have geometric isomers. Most students who experience misconceptions answer that compounds with triple bonds have geometric isomers. Other studies have shown that students were fooled by the structure's shape in the analysis, so students answered that the isomer between the two compounds is a geometric isomer.

The correct isomer between the two compounds is a positional isomer (Barasbanyu, Enawaty, & Hadi, 2021). Based on the interviews, information was obtained that students thought that there were double bonds or that the compounds described were alkenes, so the isomers that occurred were geometric. The correct answer is that compounds with triple bonds only have positional isomers and no geometric isomers. Geometric isomers are formed when the carbon atom involved in the double bond binds to two different groups of atoms. This misconception can occur because students experience problems describing the structure of compounds, so misconceptions occur in the isomer sub-matter.

The high category misconception is shown in the concept of carbon compound reactions in problem number 10, with a percentage of 66.7%. The indicator of the problem is that it can determine the elimination reaction equation and several other hydrocarbon reactions. The misconception in this problem is that students think that elimination reactions are reactions that change compounds that initially have double bonds into single bonds. In addition, students have an initial concept of the notion of elimination in the form of omission, resulting in a misconception that the elimination reaction is a reduction reaction from double to single. This study's results align with previous studies that state that students experience errors interpreting what is meant by elimination reactions (Liza, Fitriza, & Iryani, 2021). The correct answer to this problem is that an elimination reaction is a molecule that has lost an atom or an ion from its structure.

The causes of misconceptions are four: students, teachers, teaching materials or literature, context, and teaching methods. It is hoped that by knowing the types and causes of students' misconceptions about understanding science, it will be easier for teachers to find solutions in teaching science concepts (Suprapto, 2020). Misconceptions must be detected from the beginning of the learning process because they are related

to students' understanding which can be fatal in the world of education (Raharjo et al., 2019). Misconceptions can be minimized by recognizing the initial conceptions that exist in students before learning begins, namely by giving pretests about Newton's laws and their application. Teachers who teach must have the right strategy, and the methods used in learning do not confuse students (Shalihah, Mulhayatiah, & Alatas, 2016).

Diagnostic tests are an appropriate way for teachers to carry out evaluations. Diagnostic tests can be used to determine which elements are still weak. A good diagnostic test can accurately show students' misconceptions based on the error information made. A good diagnostic question will show students' way of thinking in answering questions in the form of right or wrong answers. In addition, it also shows that students need help understanding certain parts of the material (Diani et al., 2019). The four-tier diagnostic test is a type of test which consists of 4 parts. This four-tier test format consists of tier-1, which are questions and answer choices, tier-2 which is the level of confidence for tier-1 answers, tier-3 which is the reason for tier-1 answers; and tier-4, which is the level of confidence from tier-1 reasons -3 (Zulfikar, Samsudin, & Saepuzaman, 2017). According to Ritonga & Yasthophi (2019), The advantages possessed by the four-tier diagnostic test are that the teacher can: (1) dig deeper into the level of student's understanding of concepts by differentiating the level of confidence in the answers and the level of confidence in the reasons students choose, (2) diagnosing the misconceptions experienced students more deeply, (3) determine parts of the material that require more emphasis, (4) plan better learning to help reduce student misconceptions. This four-tier test format instrument is used to diagnose students' level of conception of a chemical concept, but this instrument is rarely used. In addition, the four-tier diagnostic test is the best current test instrument for measuring misconceptions because it can measure respondents' misconceptions accurately so that conclusions drawn are free from errors and lack of knowledge (Maison, Kurniawan, & Widowati, 2021).

The advantages of this four-tier diagnostic test are time efficiency and can identify misconceptions free from errors and misunderstandings (Soeharto et al., 2019). The choice of instrument type is because the four-tier multiple choice diagnostic test is the most effective instrument for identifying misconceptions. After all, it includes all the advantages of the previous instrument (Ismail, Samsudin, Suhendi, & Kaniawati, 2015), including time efficiency and the ability to identify misconceptions free from errors and misunderstandings (Soeharto et al., 2019). The choice of instrument type is because the four-tier multiple choice diagnostic test is the most effective instrument for identifying misconceptions. After all, it includes all the advantages of the previous instrument (Ismail et al., 2015). In the future, the teacher can conduct student diagnostic test activities first to determine each student's weaknesses or deficiencies.

4. CONCLUSION

Based on the research on identifying misconceptions about hydrocarbon material using a four-tier diagnostic test, it can be concluded that there are students' misconceptions about hydrocarbon material in the medium category at class XI IPA 2 MAN 2 Bantul. The misconceptions are divided into three categories: high-category misconceptions in the compound reaction sub-material. Hydrocarbons, moderate category misconceptions on the sub-material understanding of hydrocarbon compounds, structure and nomenclature, types of carbon atoms, physical and chemical properties, isomers, and low category misconceptions on the uniqueness of carbon atoms.

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