Identification Of Misconceptions In The Materialhydrocarbonsuse *Three-Tier Diagnostic* With Technique*certainty Of Response Index (Cri)*

Ulfah Nurul Mutmainnah[1], Yulia Sukmawardani[2], Ateng Supriatna[3]
[123]Pascasarjana Tadris IPA Universitas Islam Negeri Sunan Gunung Djati Bandung

Abstract

This research aims to identify misconceptions in hydrocarbon materials by applying the Three- Tier Diagnostic method as a diagnostic tool for in-depth exploration. Involving students at a specific educational level, the study develops a three-tier diagnostic instrument that includes questions with varying levels of difficulty. Furthermore, the Certainty of Response Index (CRI) technique is applied to measure students' confidence levels in their answers. Quantitative and qualitative analysis of student responses is expected to provide a deep understanding of commonly occurring misconceptions and factors influencing students' confidence levels in their answers. The results of this research are anticipated to serve as a foundation for improving learning design and developing more effective teaching strategies in the context of hydrocarbon materials. The methodological contribution, particularly the use of the CRI technique, is expected to assist researchers and educators in evaluating not only students' conceptual accuracy but also their confidence levels in understanding the material. Consequently, this research is expected to make a positive contribution to enhancing the quality of chemistry education at the relevant educational level.

***Keywords** : miskonsepsi, hidrokarbon, Three-Tier Diagnostic, Teknik Certainty of Response Index (CRI)*

INTRODUCTION

Chemistry, as a broad discipline, is closely related to everyday life. Within its scope, chemistry examines materials from the atomic level to more complex ones, delving into the structure, properties, and changes of matter, as well as the laws, principles, and concepts that explain the energy changes associated with matter, along with various other topics (Effendy, 2002). Despite its essential nature, some students find chemistry difficult to learn compared to other subjects. This is due to the abundance of material, abstract concepts, calculations, and reactions that require in-depth understanding (Yunita, L., Sofyan, A., & Agung, 2014). In the context of chemistry learning, it is important to create conceptual understanding that is built through student involvement and adaptation, not just through teacher delivery. To student. Learning chemistry should push student to develop critical, creative, and collaborative thinking, as well as the ability to communicate scientific knowledge effectively. Before reaching high school (SMA), students are exposed to basic chemistry concepts through science lessons in junior high school (SMP) and observations of everyday natural phenomena. Understanding concepts is an important indicator of successful chemistry learning, as misconceptions can lead to erroneous understanding, known as misconception (Suparno, 2013).

Misconceptions, as a state of inconsistency of a person's concept with correct scientific understanding, need to be considered in the educational process. Educators have a responsibility to identify and address student misconceptions, as this can negatively impact the success of chemistry learning. This is particularly evident in the material of hydrocarbon compounds, where many students experience difficulties and misconceptions, as reflected in the achievement of scores below the KKM set by the school (Agustina et al., 2013; Agustini & Pramita, 2016; Deska Dewati, 2016; Hardani, 2017; Lathifah et al., 2019; Meilan et al., 2017; Nabila et al., 2017; Nurhayati et al., 2013; Rasyid, 2011; Yunita et al., 2014).

The material of hydrocarbon compounds, which is considered difficult, gives rise to misconceptions in a large number of students, influenced by the broad characteristics of the material and the high level of difficulty. Some obstacles include the abundance of varied terms, unfamiliar to everyday life, as well as concepts involving the properties, structure, nomenclature, isomers, and reactions of hydrocarbon compounds, requiring a considerable amount of time in delivering the material in class. Therefore, this study aims to describe students' conceptual understanding and misconceptions related to the material of hydrocarbon compounds, with the aim of providing information to educators and the public and becoming a reference for further research.

One suitable method for measuring students' understanding is a diagnostic test (Widiyatmoko & Shimizu, 2018). Diagnostic tests are used to identify difficulties students may encounter in a particular topic. The results of these tests provide teachers with information to find appropriate solutions to address student difficulties (Auliyani et al., 2017; Rahmi et al., 2021). The instrument used is a three-tier multiple-choice test, which is a development of the two-tier multiple-choice test. This development lies in increasing the level of confidence of participants in selecting answers and providing reasons (Hidayati et al., 2019).

The three-tier multiple-choice test consists of three levels. First, the answer choices for the questions; second, the reasons for choosing the answer at the first level; and third, the CRI (Certainty of Response Index) (Nurhujaimah et al., 2016; Mellyzar, 2021). The CRI reflects the student's level of confidence in answering the first and second levels. Three-tier diagnostic tests have advantages over two-tier ones because they can identify student misconceptions more deeply, differentiate between conceptual understanding and conceptual ignorance, and help determine which parts of the material need further emphasis during learning. Thus, this method helps plan more effective learning to reduce student misconceptions (Syarifatul et al., 2016). Therefore, the purpose of this study was todeveloping a more holistic and in-depth approach to identifying misconceptions, by combining the advantages of three-tier diagnostic instruments using the CRI (Certainty of Response Index) technique.

RESEARCH METHOD

This study adopted a descriptive approach, a type of research that aims to evaluate the value of independent variables, either one or more variables, without comparing them with other variables (Sugiyono, 2016; Ibrahim, 2018). The research subjects consisted of 63 students from grades XI MIPA 1 and XI MIPA-2 at SMA Negeri 1 Majalaya, Bandung Regency. The research process involved several stages, starting with the preliminary stage which included initial studies and the preparation of a three-tier multiple-choice test instrument which then went through a validation process. The next stage was the implementation of the research, where the test was administered to the research subjects. Meanwhile, the data analysis stage involved processing and analyzing students' answers to determine conceptual understanding, misconceptions, or lack of conceptual understanding, by referring to the Certainty of Response Index (CIR), and concluding the findings from the analysis.

Table 1. CRI Answer Criteria

Answer Criteria	Low CRI (<2.5)	High CRI (>2.5)
Correct Answer	Correct answer but low CRI means don't know the concept	Correct answer and high CRI mean good mastery of the concept
Wrong Answer	Wrong answer and low CRI means don't know draft	Wrong answer but high CRI means it happened misconception

Source: (Hasan et al, 1999)

Table 2. Interpretation of Answers on the Diagnostic Test*Three Tier Multiple Choice*

1. Category	2. Answer Type Level One	Level Two	Level Three
Understand the concept well	Correct	Correct	CRI > 2,5
Understand the concept but lack	Correct	Correct	CRI < 2,5

confidence			
Misconceptions	Correct	Wrong	CRI > 2,5
Don't know the concept	Correct	Wrong	CRI < 2,5
Misconceptions	Wrong	Correct	CRI > 2,5
Don't know the concept	Wrong	Correct	CRI < 2,5
Misconceptions	Wrong	Wrong	CRI > 2,5
Don't Know the Concept	Wrong	Wrong	CRI < 2,5

Source: (Jauhariyah et al, 2018)

RESULTS AND DISCUSSION

The instrument used in this study was a three-level multiple-choice test consisting of 10 items. The test questions were designed according to the indicators of hydrocarbon material. The questions were given to 63 students in grades XI MIPA 1 and XI MIPA 2 of SMA Negeri 1 Majalaya. Based on the results of data analysis, it was found that the level of student understanding of hydrocarbon material was 39% in the concept understanding category, 50% in the misconception category, and 50% in the concept not understanding category.11%. Based on the results of this study, student misconceptions often occur in concepts that are submicroscopic and symbolic representations.

Table 3. Interpretation of *Three-Tier Diagnostic* Results

No	**Question Indicator**	**Representation**	**Answer Category in %**		
			PK	**M**	**TPK**
1	Identifying elements in hydrocarbon compounds	Macroscopic	38,09	36,51	25,40
2	Grouping compounds that are classified as hydrocarbons	Symbolic	47,9	42,95	9,1
3	Determining the groups and periods of carbon atoms	Macroscopic	49,6	36,95	13,4
4	Distinguish between primary, secondary, tertiary and tertiary carbon atoms quaternary	Submicroscopic	46,03	39,68	14,29
5	Distinguishing primary carbon atoms, secondary, tertiary and quaternary	Submicroscopic	33,33	38,40	28,57
6	Grouping hydrocarbon compounds based on bond saturation	Symbolic	26,98	41,27	31,75

7	Determining the properties of hydrocarbon compounds	Macroscopic	39,68	46,03	14,29
8	Summarize the results of the combustion of compounds carbon	Submicroscopic	34,92	31,75	33,33
9	Determining compounds which can have geometric isomers	Macroscopic	58,7	32,4	8,9
10	Analyze the reactions that occur in hydrocarbon compounds	Symbolic	31,74	44,45	33,33
Amount			406,97	390,39	202,84
Rate - Rate			40,69%	39,03%	20,28%

From Table 3, it can be seen that the highest category of conceptual understanding (PK) is found in indicator question number 3, determining the group and period of carbon atoms, while the lowest category of conceptual understanding (PK) is found in indicator question number 10, analyzing reactions that occur in hydrocarbon compounds. The highest category of misconception (M) is found in indicator 7, determining the properties of hydrocarbon compounds, while the lowest category of misconception (M) is found in indicator 8, determining the properties of hydrocarbon compounds.

(M) The lowest is found in indicator 8, namely concluding the results of burning carbon compounds.

The indicator for question 8 is that students are asked to determine the compound with the highest boiling point based on the hydrocarbon compounds presented. In the students' answers, there are several errors that generally appear in option c, namely 2,2-dimethylpropane, as the compound with the highest boiling point. At the misconception level, students tend to associate option c with the explanation that the more C atoms will increase the boiling point, which is actually incorrect. They incorrectly assumed that 2,2-dimethylpropane has the highest boiling point because it has the most carbon atoms. However, if you look closely, other options such as n-heptane and 2-methylpentane in the question have more carbon atoms than 2,2-dimethylpropane. This error is likely caused by the students' assumption that the complexity of a compound can be measured by the number of branches, when in fact it should be seen from the actual molecular structure. This error indicates an incorrect conclusion regarding the relationship between the number of carbon atoms and the boiling point of a compound.

At the conceptual level, students tend to associate option c in the first tier with the reasons for options c and d. They assume that 2,2-dimethylpropane has the highest boiling point because it has many branches or a small molar mass. Students appear to use this assumption to identify cause and effect and predict the outcome of a process. They assume that compounds with more branches have more complex and difficult-to-break bonds, thus requiring more energy to break the bonds, which in turn increases the boiling point. In fact, the boiling point of alkane compounds with straight and long chains should be higher because of the van der Waals attraction between longer and straighter molecules. Conversely, compounds with branches tend to have weaker intermolecular bonds, resulting in lower boiling points. This error reflects students' lack of understanding of basic concepts involving intermolecular interactions and the molecular structure of compounds. This problem, in dimension C3, namely applying, in Bloom's Taxonomy is included in lower-level thinking skills.

The next indicator with a high level of misconception occurs in question number 10, which is analyzing reactions that occur in hydrocarbon compounds. The indicator in this question is that students are asked to determine the reaction equation that includes elimination reactions from several given hydrocarbon reactions. A common error made by students in this question is when they assume that an elimination reaction is a reaction that converts compounds with double bonds into compounds that do not have double bonds. This error may arise because students tend to assume relationships with similar characteristics, namely elimination is interpreted as reduction or removal, so they may assume that reduction in this context means reducing bonds. Students apply the principle of elimination without understanding the meaning of the elimination reaction itself. They apply principles, strategies, and interpretations directly without considering the meaning. In fact, in an elimination reaction, a molecule loses atoms or ions from its structure. Therefore, what is meant by elimination is not only the loss of double bonds, but also the loss of atoms in the reaction process. This question is included in the C2 dimension in the realm of understanding, and in the revised Bloom's taxonomy, it includes lower-order thinking skills.

The research results show that the Three Tier Test is effective in identifying students' conceptual understanding by dividing them into levels. From these results, we can trace students' alternative concepts from the dominant answer choices in the test that do not align with the concept.

Students often experience difficulties when faced with problems involving compound structures. This difficulty may be due to the abstract nature of the submicroscopic and symbolic representations of compound structures, which are often inaccessible to students in their everyday lives. Abstract and difficult-to-understand concepts can lead to varying understandings, differing from the intended goal. Therefore, problems related to compound structures can lead to misunderstandings and confusion in answering them.

CONCLUSION

Based on the research results and discussions obtained from diagnostic tests *Thee Tier* with the CRI technique, it can be concluded that:

1. Misconceptions were identified in each sub-concept of the Hydrocarbon concept with an average of 39%.
2. The sub-concept of hydrocarbons with the highest misconception is the sub-concept of determining the properties of hydrocarbon compounds, while the lowest percentage is the sub-concept of determining the combustion results of hydrocarbon compounds.

BIBLIOGRAPHY

Abraham, Michael R. dan Eillen B. Grybowsky. Understanding and Misunderstanding of Eight Grader of Five Chemistry Concepts Found in Textbooks, *Journal of Research in Science Teaching*. Vol.29, 1992.

Bayrak, Beyza Karadeniz. Using Two Tier Test to Identify Primary Student’s Conceptual Undersatnding and Alternative Conception in Acid Base. Mevlana International Journal of Education. Vol.3, 2013.

Chandrasegaran, A.L., David F. Treagust dan Mauro Mocerino. The Developmet of a Two Tier Multiple Choice Diagnostic Instrumen for Evaluating Secondary School Student’s Ability to Describe and Explain Chemical Reaction Using Multiple Levels of Representation. Chemistry Education Research and Practice.8, 2007.

Dahar, Ratna Willis. Teori-teori Belajar dan Pembelajaran. Jakarta: Erlangga, 2011. DEPDIKNAS. Tes Diagnostik. Dirjen Manajemen

Pendidikan Dasar dan Menengah

Direktorat Pembinaan Sekolah Menengah Pertama, 2007.

Fessenden, Ralf J dan Joan S. Fessenden. Kimia Organik Edisi Ketiga. Jakarta: Erlangga, 1986.

Linuwih, Suharto. Konsepsi alternatif Mahasiswa Calon Guru Fisika tentang Gaya-gaya yang Bekerja pada Balok. Jurnal Pengajaran MIPA. Vol.18, 2013.

Longman, Addison Wesley. Kerangka Landasan untuk Pembelajaran, Pengajaran, dan Assesmen: Revisi Taksonomi Pendidikan Bloom. Yogyakarta: Pustaka Belajar, 2010.

Marsita, Resti Ana, Sigit Priatmoko, dan Ersanghono Kusuma. Analisis Kesulitan Belajar Kimia Siswa SMA dalam Memahami Materi Larutan Penyangga

Talanquer, Vicente. Commonsense Chemistry: A Model for Understanding Student's Altenative Conception, Journal of Chemical Education, Vol.83, 2006.

Treagust, David F. Development and Use of Diagnostic Test to Evaluate Student's Misconception in Science. Journal Science Education. 10, 1988.