CHEMISTRY SMART
ISSN 2830-6198
https://journals.ki-pi.org/index.php/kim-smart/index

ARTICLE

Descriptive Analysis of Learning Outcomes, Misconceptions, and Inhibiting Material on Benzene Material

Sherly Lestia[a], Zonalia Fitriza[b.]

[a]Department Of Chemistry, faculty of Mathematics and Natural Science, Universitas Negeri Padang, Padang, Indonesia.
[b]Department Of Chemistry, faculty of Mathematics and Natural Science, Universitas Negeri Padang, Padang, Indonesia.

*Coresponding email: sherlylestia09@gmai.com zonaliafitriza@gmail.com

ABSTRACT
Based on the results of the questionnaire analysis distributed to 10 teachers in the city of Padang, it is known that the average student learning outcomes in benzene material are categorized as moderate. This is evidenced by the percentage of answers given by the teacher, where 31% -60% of students complete the material. The purpose of this study is to describe learning outcomes, misconceptions, and inhibiting material in benzene material. This study uses the Mixed Method with Convergent Mixed Parallel Design. The research was conducted on 29 students at a high school in the city of Padang. The instrument used is the Structured Essay Diagnostic Test of Chemistry (SEDToC) with a total of 14 questions with 58 sub questions. The results showed that the percentage of completeness of student learning outcomes was 0% where out of 29 students, none of the students had passed the SEDToC test on benzene. This is due to the misconceptions experienced by students. A total of 27 misconceptions were found in students' answers. This misconception is caused by the presence of an inhibiting material in the benzene material, which implements the properties of benzene.

ARTICLE HISTORY
Submission:
Receveid:
Accepted:

Citation:

Keywords: Learning Outcomes, Misconceptions, Blocking Material, Benzene.

1. Introduction

Learning that focuses on students can make students more active, creative and innovative because they are given the flexibility to explore and share the resources they get (Reksoadmojo, 2010). The knowledge possessed and which will be formed after learning is in the form of factual, conceptual, procedural or metacognitive knowledge that can be obtained through student experiences from various learning sources (Wiyanto, 2017). One of the lessons in chemistry that should require a high level of thinking is on benzene and its derivatives.

Based on Permendikbud no. 37 of 2018, the basic competency for benzene and its derivatives is KD 3.10 analyzing the structure, nomenclature, properties and uses of benzene and its derivatives and KD 4.10 Presenting the results of information searches on several dangerous and non-hazardous benzene

Corresponding: Sherly lestia; sherlylestia09@gmail.com

derivatives. According to the results of a questionnaire that was distributed to undergraduate students, 77.5% of the 80 respondents answered that benzene is one of the most difficult materials to learn in chemistry. This difficulty can be due to misconceptions that occur when students build their knowledge from prerequisite material to benzene and its derivatives (Gurel, 2015). As a result, most students experience conceptual errors or misconceptions and of course affect learning outcomes.

Based on the analysis of the questionnaire which was also distributed, it was found that the average student learning outcomes on benzene and its derivatives were categorized as moderate. This is evidenced by the percentage of answers given by the teacher, where 31% -60% of students complete the material.

Therefore, this research is very important to do as a way to find solutions to these problems. Starting from studying the root of the problem, namely to identify learning outcomes, misconceptions, and students' inhibiting material, it is carried out using the Structured Essay Diagnostic Test Of Chemistry (SEDToC) instrument on benzene material and its derivatives which have been developed by Lillah (2021) and have been tested for validity. This instrument was chosen with the consideration that this instrument consists of essay questions with directional answers ranging from simple to complex concepts so that student learning outcomes and misconceptions can be more easily detected. This research is intended so that the description given can not only assist teachers in diagnosing student learning difficulties but also become a reference and correction for teachers to improve the learning process in a better direction.

Based on the description above, the research entitled "Descriptive Analysisi of Learning Outcomes, Misconceptions, and Inhibiting Material, on Benzene Material" is important to do to determine the ability and level of understanding of students on benzene material and its derivatives.

2. Methodology

The type of research used is descriptive research using a mixed method approach (Mixed Method), namely qualitative and quantitative approaches. Mixed Method research design is a procedure for collecting, analyzing, and “mixing” quantitative and qualitative methods in a study or series of studies to understand the research problem (Creswell & Plano Clark, 2011). The population in this study were all class XII students at a high school in Padang City. The sample in this study were 29 students of class XII MIPA 4. The sampling technique used was purposive sampling. The research instruments used were questionnaire analysis and SEDToC.

The SEDToC instrument is used to see or measure students' ability to answer benzene material questions so that learning outcomes, misconceptions and inhibiting material are obtained which make it difficult for students to understand benzene material at school. Then do an analysis of the results of the students' answers. The test results obtained were analyzed using 3 categories of answers, namely not understanding, misconceptions and understanding the concept (Table 1).

Table 1. Concept Understanding Level Category

Kategori	Level Pemahaman	Kriteria Penilaian
Don't understand	No response	1. No answer/blank 2. Answer "I don't know" 3. Answer "I don't understand"
	Don't understand	1. Recopy the questions 2. The answer is not related to the question 3. Answer is not clear
Misconception	Misconception	1. Answers are not in accordance with the literature / not logical 2. Answer contains incorrect information
	Half understand with misconception	1. The answers show that there are concepts that are understood correctly but there are statements that are misconceptions 2. The answers are related to the questions but there is information that is not in accordance with the literature
Understand	Half understanding without misconceptions	1. At least 1 correct answer without misconceptions 2. The answer shows that the concept is understood correctly without any misconceptions
	Understand concept	1. Logical, precise, and correct answers indicate the concept is understood correctly

(Marek, 1986; Renner et al., 1992)

Referring to the results of the analysis of the level of understanding of students, the next step is to determine the percentage of misconceptions per item calculated using the formula:

$P = \frac{f}{n} \times 100\%$

Information:

P = Percentage of observations

f = The number of students in the understanding group, namely understanding, misconceptions, and not understanding

n = Number of students taking the test

If the percentage of misconceptions has been obtained, the next step is to conclude the data based on categories such as;

Tabel 2. Percentage of Misconceptions

Percentage of Misconceptions	Category
0 – 30%	Low
31% - 60%	Currently

61% - 100%	Tall

(Kaltakci & Didic, 2007).

Meanwhile, the analysis of learning outcomes can be determined using the following formula,

$$\textit{Student learning outcomes} = \frac{jumlah\ skor\ siswa}{Jumlah\ soal} \times 100\%$$

3. Results and discussion

Based on research data, learning outcomes, misconceptions, and material inhibitions can be identified using the SEDToC instrument. Then an analysis of the three variables is carried out. The results of the analysis at SMAN Padang are presented in the following description.

Based on data on student learning outcomes in table 8. It was found that the proportion of student completeness in the benzene material and its derivatives was 0% where out of 29 students there were no students at all who were shown to exceed KKM 80, all students scored below KKM. This is not in accordance with national education standards. The proportion of student completeness should be at least 75% (Ministry of Education and Culture, 2014). The highest score on this test was 69 and the lowest score was 17 while the average score of students in that class was 47. This figure is still far from the ideal score of 100. This shows that student learning outcomes in benzene material are still in the low category.

One of the causes of low student learning outcomes is the occurrence of misconceptions (azura & Copriady, 2017) and inhibiting material. Referring to the data that has been obtained, the percentage of students who do not understand the concept is 34%, the percentage of misconceptions is 10%, and the percentage of understanding the concept is 56% respectively. Based on the results of the analysis of SEDToC answers from 29 students in the 57 items of the benzene sub-task, 27 kinds of misconceptions were found. Most of the misconceptions found were in substitution reaction materials, the naming of benzene and chemical polarity. This can happen because the instrument questions used are not in accordance with the GPA taught at the school where the research takes place. The material contained in the SEDToC instrument questions explains starting from the 1st substitution reaction, the 2nd substitution reaction and the 3rd substitution reaction. While students only study up to the 1st substitution reaction. So that the results of student learning are classified as low.

In the material on chemical bonds in the section on understanding polar bonds, 5 types of misconceptions were found with an average percentage of 22.4% on the low criteria. Forms of misconceptions experienced by students can be seen in the following figure:

 ISSN 2830-6198

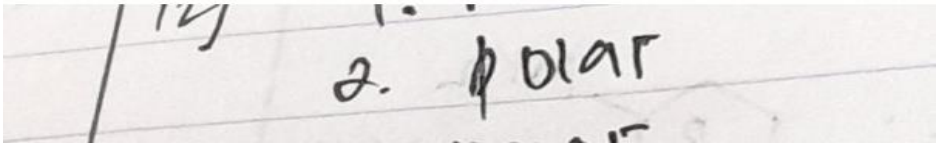


Figure 1. Misconcession answers to question 12 b.

Problem 12 b in which the problem is given several structures of benzene derivative compounds and students are asked to be able to determine the polarity of each of these compounds. As shown in Figure 16, as many as 13 students stated that the compound was chlorobenzene 

classified as polar compounds. Where these compounds should be classified as non-polar compounds, because non-polar compounds are compounds that are formed as a result of the existence of a bond between electrons in the elements that form it. Chlorobenzene contains a Cl group (Halide). The halide groups are acidic so they can react when reacted in ether because benzene compounds are non-polar and insoluble in polar solvents. This form of misconception also occurs in the compounds $C_6H_6NO_2$, $C_6H_6CH_3$, $C_6H_6OCH_3$, and C_6H_6COH. It can be concluded that students experience misconceptions in determining non-polar compounds, whereas in determining polar compounds students can understand them.

Another misconception that occurs in questions 5 and 7 where the material contained in these numbers is about the substitution reaction of alkane benzene derivatives and their derivatives, along with the forms of these misconceptions.

Another misconception that occurs in questions 5 and 7 where the material contained in these numbers is about the substitution reaction of alkane benzene derivatives and their derivatives, along with the forms of these misconceptions.

For question number 5 there is 1 type of misconception. The reaction that occurs in this problem is a disubstitution reaction, where this disubstitution reaction is a benzene reaction that binds two substituents. The following forms of this misconception:

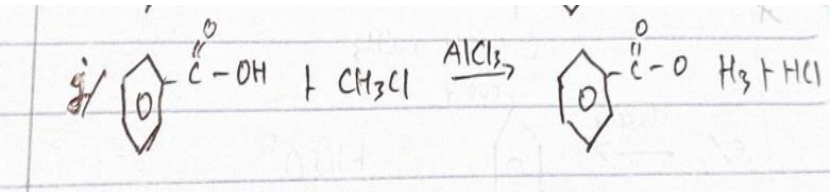


Figure 2. Answers to misconceptions in question 5 i.

The misconception contained in question 5 i was 27.6% as many as 8 students experienced misconceptions in answering the question, it can be seen in Figure 18, where benzoic acid should have reacted with CH_3Cl with the help of $AlCl_3$ catalyst to produce m-methyl benzoic acid. This also happened in question number 5 part e, and g. students make a lot of mistakes in writing and reacting compounds correctly. Furthermore, the misconceptions that occur in question number 7 with an average percentage of 9%, are the following forms of misconceptions that occur:

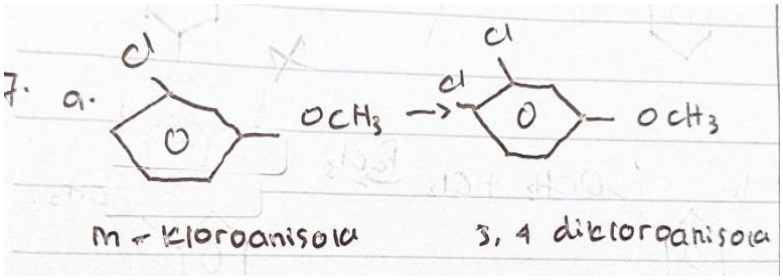


Figure 3. Answers to misconceptions in question 7. a

In question number 7a with a misconception percentage of 20.7%, where the instructions in the question students are given the name of the benzene derivative in the previous question (no. 6), students are required to be able to react it with the specified electrophile/carbocation. This is a polysubstitution reaction. The polysubstitution reaction itself is a reaction that binds 3 or more substituents. If benzene binds to 3 or more substituents, then the position of each substituent is indicated by a number. As seen in Figure 19 there is a student error in writing the name of the compound into the structure. From the problem, it is clearly stated that in part a, o-chloronitrobenzene is reacted with H_2SO_4 with the help of an H_2SO_4 catalyst to produce an acid compound, 3-nitro-4-chlorosulfonic acid. So here you can see the errors that occur in students, where students are not careful in reading and writing questions.

Furthermore, there is a misconception that occurs in the material nomenclature for benzene, in question numbers 6 and 8, the following is a form of misconception that occurs:

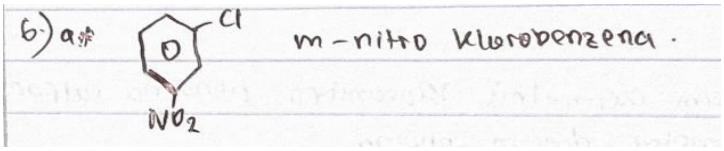
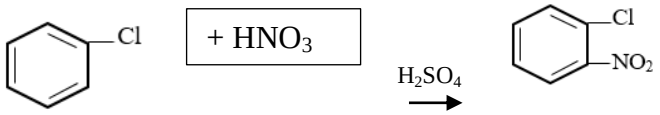


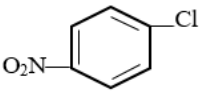
Figure 4. Answers to misconceptions in question 6 a

The misconceptions contained in question number 6 are 11 forms of misconceptions with an average percentage of 55.6%, this is included in the medium category, where in question 6a there are 24 students who are wrong in answering the question. This error can be seen on average from the order or position of students in writing the name of a compound. like problem 6a, the Cl substituent directing the ortho and para positions. In answer number 5a there are 2 versions of the answer namely:



Jawaban 1

Jawaban 2



Whereas if the NO2 substituent directs the meta e answers, students make m-nitrochlorobenzene where the position in the IUPAC name should be in alphabetical order (Fessenden, 1982). It can be seen from all the students' answers that they did not make them according to the order of writing, this happened for other sections such as 6b, 6d, 6f, 6g, 6h, 6i, 6j. Likewise for number 8. The following is a form of misconception that occurs:

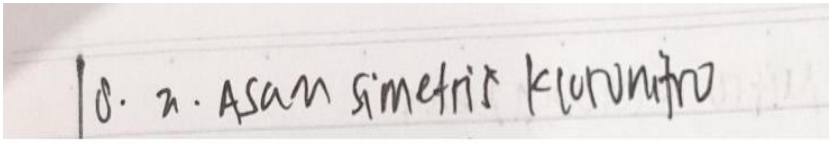


Figure 5. Answers to misconceptions in question 8a.

The misconceptions contained in question number 8 are 7 forms of misconception with an average percentage of 44.8% in the medium category, one of which is shown in Figure 21 above, which is part of question a. Where in this question students are required to be able to write down or determine the nomenclature of each compound in the previous product. The answer for question 8a should be, 3-nitro-4-chlorosulfonic acid, while the students answered symmetrical chloronitro acid. It can be seen here that students are still confused in determining the name of a compound, so that it has an impact on answering question number 8 for all sections, namely 8a, 8b, 8c, 8d, and 8e.

Furthermore, questions that experience misconceptions are question number 13 along with the forms of misconceptions:

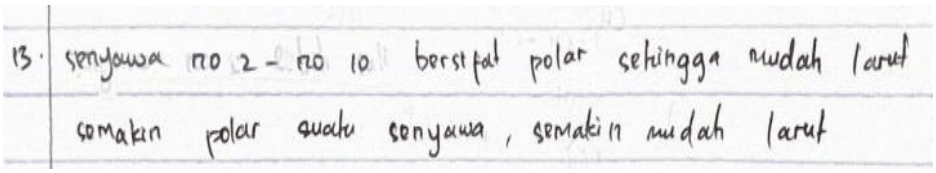


Figure 6. Answers to misconceptions in question 13.

In question number 13, students are asked to be able to determine the solubility of each compound, along with the reasons. In figure 22, it can be seen that the students' answers for number 13 are compounds no. 2- no. 10 which are polar in nature so they dissolve easily, the more polar a compound is, the more easily it dissolves. Whereas compounds 1, 2, 3, 5, 8 and 9 will dissolve in non-polar solvents, compounds 4, 6, 7 and 10 will dissolve in polar solvents. Compounds that can dissolve in non-polar solvents are classified as non-polar compounds and vice versa.

One important factor that affects the solubility of a substance is the polarity of each substance. The polarity is affected by the dipole moment of the compound. If the dipole moment of a compound is non-zero then the molecule is polar, and if it is zero then the compound is non-polar. The value of the dipole moment is influenced by the electronegativity of the elements forming a compound. If the electronegativity difference is large, then the compound has a large dipole moment and is polar. The solubility of a compound in a solvent is basically based on the principle "like dissolves like". The similarity of the polarity of the solute to the solvent used determines the dissolution results.

In a solution system there are interactions between the solvent and the solvent, the solvent and the solute, and the solute and the solute. If the interaction force between the solute and the solvent is large, the solute will dissolve more easily, and vice versa. Interaction forces can be ionic bonds, hydrogen bonds, and bonds from Van der Waals forces depending on the molecular structure of the solute and the solvent.

Based on the description above, there are 27 kinds of misconceptions that were obtained from the results of the analysis of student answers. In addition to the misconceptions, many students also did not understand the concept of benzene itself, as can be seen in table 7. Where students gave more blank answers, copied the questions and answer unclearly or the answer is not related to the question asked. This is also the reason why student learning outcomes are low.

Students who experience misconceptions are caused by the presence of inhibiting material. Inhibiting material is material that causes students to experience difficulties in understanding certain material (Fitriza, et al., 2020). Based on data on the level of understanding of students, it is known that as much as 48% of the sub-material implements the properties of benzene, that is the material that becomes a barrier

for students in answering questions. Based on these data, it can be concluded that the inhibiting material in this benzene material lies in implementing the properties of benzene.

4. Conclusion

The percentage of completeness of SMAN Padang students' learning outcomes is 0% where out of 29 students, not a single student has passed the SEDToC test on benzene and its derivatives. This is because there are answers that students cannot answer so they just repeat the question again, or give blank answers and also misconceptions that students experience in understanding the concept of benzene. As many as 27 types of misconceptions were found in the answers of SMAN 3 Padang students and the GPA on the research instrument was not the same as the GPA at school so that students had difficulty understanding and answering these questions. Meanwhile, this misconception is due to the presence of inhibitory materials in benzene and its derivatives. The inhibiting material for SMAN 3 Padang students is implementing the properties of benzene.

Acknowledgements

The author would like to thank Zonalia Fitriza, M.Pd as the research supervisor, Dra. Suryelita, M.Si and Eka Yusmaita, M.Pd as examiners so that this research is summarized..

References

[1] Azura, S., & Copriady, J. (2017). Identifikasi Miskonsepsi Materi Ikatan Kimia Menggunakan Tes Diagnostik Pilihan Ganda Tiga Tingkat (Three Tier) pada Peserta Didik Kelas X MIA SMA Negeri 8 Pekanbaru. *Jurnal Online Mahasiswa*, *4*(3), 1–13.

[2] Creswell, J.,& Plano Clark, V. (2011). *Designing and conducting Mixed Methods Research. 2nd Edition.* Sage Publications, Los Angeles.

[3] Fessenden. (1982). *Kimia Organik Edisi Ketiga*. Jakarta: Erlangga.

[4] Fitriza, Z., Aini, F. Q., Handayani, P., & Munira, I. (2020). Development of structured essay diagnostic test of chemistry (SEDToC) to investigate senior high school student's conception of buffer solution. *AIP Conference Proceedings*, *2229*. https://doi.org/10.1063/5.0003289

[5] Gurel. (2015). A Review and Comparison of Diagnostic Instruments to Identify Students' Misconceptions in Science. *Eurasia Journal of Mathematics, Science & Technology Education, 11(5),989-*.

[6] Kaltakci, D., & Didic, N. (2007). Identification OF Pre Service Teachers' Misconceptions On Gravity Concept: A Study With a 3 Tier Misconception Test. AIP Conference Proceedings, 899, 499-500.

[7] Kemendikbud. (2014). *konsep dan implementasi kurikulum 2013*. jakarta: kementrian pendidikan dan kebudayaan.

[8] Lillah Fitri. (2021). *Pengembangan Structured Essay Diagnostic Test of Chemistry (SEDToC) Materi Benzena dan Turunannya.*

[9] Marek, E. (1986). Understanding and Misunderstanding of Biology Concepts. American Biology Teacher, 48(1), 37-40.

[10] Reksoadmojo. (2010). *pengembangan kurikulum pendidikan teknologi dan kejuruan*. bandung: refika aditama.

[11] Wiyanto. (2017). Pendekatan saintifik pada perkuliahan dengan sistem learning. *INTEGRALISTIK, XXVIII*(No.2).