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Analysis of Students Misconceptions Using Instruments *Three-Tier Diagnostic Test* on Acid-Base Material

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Abstract
This research aims to analyze students' misconceptions using a three-tier diagnostic test on acid-base material. The type of research used in this research is descriptive research. This research was carried out at SMA Negeri 1 Muaragembong on class XI MIPA students. The data collection technique uses a multilevel multiple choice diagnostic test. The first level contains students' answers, the second level contains the reasons for the answers, and finally the level of belief. Data analysis was carried out by looking for the percentage of misconceptions from each concept in the acid-base material, namely the concept of acid-base theory, pH indicators of acid-base solutions, strength of acids and bases, as well as calculating the pH of acid and base solutions. The results of the research show that students' misconceptions about acid and base material using the three-tier diagnostic test instrument are divided into three, namely M1, M2 and M3. Based on the research results, the largest percentage of misconceptions regarding acid-base material is the misconception M_1. Students with misconceptions M_1 has a percentage of 30.96%, then the misconception M_2 has a percentage of 14.63%, and misconceptions M_3 has a percentage of 9.01%. Misconceptions M_1 is a condition where students answer questions incorrectly at the first level and second level, but answer confidently at the third level. The causes of misconceptions that occur among students are due to incomplete reasoning, students' abilities, students' interest in learning and teachers' teaching methods.

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1. INTRODUCTION

Chemistry is a science that studies the composition, properties and changes of matter (Jespersen, et al., 2012:2). Apart from that, chemistry is also known as a science where most of its concepts are abstract. This makes chemistry difficult for students to learn (Wulandari, et al., 2018: 167) and can trigger misconceptions. Misconceptions are concepts that a person has that are different from the actual concept according to experts (Ikenna, 2014: 3259).

Chemistry education has an important role in building students' understanding of complex scientific concepts, including the concept of acids and bases. Acid-base material is one of the fundamental topics in chemistry which is often the basis for understanding other chemical concepts (Chang, 2019). However, various studies show that students often experience misconceptions in understanding this material.

Misconceptions in acid-base material can occur due to various factors, such as the complexity of the concept, errors in presenting the material, and students' wrong

interpretation of chemical phenomena. For example, students often misunderstand the concept of pH, the strength of acids and bases, and the difference between strong acids and concentrated acids (Demircioglu, 2010). Therefore, an effective diagnostic tool is needed to identify and analyze student misconceptions in depth.

One of the topics in chemistry that is difficult to conceptualize is the topic of acids and bases. The concept of acids and bases is an important topic in chemistry which is the basis for understanding advanced materials such as redox reactions, chemical equilibrium, and buffer solutions. However, research shows that acid-base material is often a challenge for students because of the complexity of the concept. Some common misconceptions found among students include wrong understanding about pH calculations, indicators, strength of acids and bases, as well as the difference between concentrated acids and strong acids, so the possibility of misconceptions among students is very large (Sari et al., 2021).

Misconceptions are understandings that are not in accordance with correct scientific concepts, which can hinder further learning (McClary & Bretz, 2012). Factors that contribute to misconceptions include inappropriate teaching methods, students' incorrect interpretation of chemical phenomena, and inconsistent use of terms in textbooks or learning (Taber, 2019). Misconceptions that occur will make it difficult for students to learn the next concept. Because it is impossible for them to learn higher concepts if the basic concepts do not match the experts. Research on identifying misconceptions was carried out by Yulita (2018:64-72) on the concept of the nature of chemistry and stated that research on identifying misconceptions was very important to conduct to find out students' misconceptions. Therefore, it is important to use diagnostic tools that are able to identify misconceptions in depth and accurately. Misconceptions that occur can be identified using various existing methods, including concept maps, multiple choice tests with open reasons (two-tier tests), essay tests. , interviews, discussions, practicums, and questions and answers (Suparno, 2013:129).

The Three-Tier Diagnostic Test instrument is a diagnostic tool that has been proven effective in identifying misconceptions. This instrument consists of three levels of questions: conceptual answers, reasons behind the answers, and students' confidence in the answers (Caleon & Subramaniam, 2010). The advantage of this instrument is its ability to differentiate between students who understand the concept, students who only guess, and students who have misconceptions (Wang et al., 2016). This method is more effective, easy to apply, not subjective, and the results are more valid for finding misconceptions (Akkus, et al., 2011). However, the weakness of this method is that it cannot differentiate between students who do not know the concept and students who guess the answer. Therefore, the two-tier test method is combined with the Certainty of Response Index (CRI) to produce a new method, namely the three tier-test (TTT). TTT consists of 3 levels of questions. The first level is the statement part, and the second part is the choice of reasons for the first statement. Meanwhile, the third level is to distinguish between students who are confident, unsure and hesitant in answering questions. TTT is expected to be able to differentiate students who guess from those who don't know the concept. Irwansyah and colleagues (2018:207) have succeeded in developing a fluid concept TTT instrument that can differentiate students who know the concept from students who experience misconceptions.

2. METHOD

The type of research used is descriptive research. This research can describe the location of students' misconceptions regarding acid-base material. This research was carried out in

class XII MIPA SMAN 1 Muaragembong on 22-23 November 2023 in the Odd Semester of the 2023/2024 Academic Year. The subjects of this research were class XII MIPA 1 and 2 of SMAN 1 Muaragembong MIPA SMA Negeri 1 Mamuju, totaling 74 people.

The research was carried out by giving tests via Google Form using instruments *three-tier diagnostic test* to students to obtain information regarding students' misconceptions about Acids and Bases material. The test instrument consists of 12 questions. After carrying out the test using the instrument *Three-Tier Multiple Choice Diagnostic*, then analysis of student answer patterns was carried out based on Table 1.

The percentage of students is grouped into categories of understanding the concept, not understanding the concept and misconceptions which is calculated using the formula:

$$P = \frac{F}{N} \times 100\%$$

P = percentage of students who have misconceptions.
F = many students have misconceptions.
N = total number of test participants

Table 1. Misconceptions Grouping Categories

***Tier* 1**	***Tier* 2**	***Tier* 3**	**Category**	**Code/Symbol**
Correct	Correct	Certain	Understand the concept (*Scientific knowledge*)	SK
Correct	Correct	Not sure	Don't understand the concept (*Lack of knowledge*)	LK
Correct	Wrong	Certain	False positive or misconception	M2
Correct	Wrong	Not sure	Don't understand the concept (*Lack of knowledge*)	LK
Wrong	Correct	Certain	False negative	M3
Wrong	Correct	Not sure	Don't understand the concept (*Lack of knowledge*)	LK
Wrong	Wrong	Certain	Misconceptions	M1
Wrong	Wrong	Not sure	Don't understand the concept (*Lack of knowledge*)	LK

3. RESULTS AND DISCUSSION

Analysis results using instruments *three tier diagnostic test* It was found that students included in the category *scientific knowledge* (SK)/understand the concept as much as 11.86%, category *misconception* or misconceptions as much as 54.60% and for categories *lack of knowledge* (LK) or do not understand the concept of 24.55%. The large number of students who experience misconceptions compared to students who understand the concept shows that Acid and Base material is difficult material because this material contains complex, interconnected material, calculations and requires a gradual and in-depth understanding of the concept to understand it. This is in line with research conducted by Utami, et al (2020) which states that 61.06% of students think that Acid and Base material is difficult material.

Students' misconceptions about acid and base material using instruments in a three-tier *diagnostic test* divided into three, namely M1, M2 and M3. Based on results research, the

largest percentage of misconceptions in acid-base material is the misconception M_1. Students with misconceptions M_1 has a percentage of 30.96%, then the misconception M_2 has a percentage of 14.63%, and misconceptions M_3 has a percentage of 9.01%. Misconceptions M_1 is a condition where students answer questions incorrectly at the first level and second level, but answer confidently at the third level. This indicates that students believe that the concepts they understand are correct.

The questions that have the largest percentage are based on the misconception category M_1 is question number 4 at 56.75% which can be seen in Table 2. The indicator for question number 4 is about the condition of the soil when acid rain occurs. The reason is that students are unable to determine what methods can be used to restore the condition of the soil so that plants can grow well.

Category M condition2 (*false positive)* is that students answer correctly at the first level, wrong at the second level and confident at the third level. This condition can be interpreted as meaning that students do not understand (*deficiency understanding*) with a concept, the lack of understanding of students which indicates the occurrence of misconceptions in this condition is very difficult to eliminate or cannot be eliminated at all. Based on the results of the analysis of the items that have the largest percentage based on the misconception category M_2 is item number 11 amounting to 27.02% which can be seen in Table 2 while the conditions are category M_3 (*false negative)* is that students answer wrong at the first level, correct at the second level and confident at the third level. This condition can be interpreted that students have little information (*less information*), misconceptions in this condition are considered not problematic because they are caused by students' carelessness in providing answers (Istiyani, et al. 2018). Based on the results of the analysis of the items that have the largest percentage based on the misconception category M_3 is item number 2 amounting to 20.27% which can be seen in Table 3.

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

Indicator	Representation	Question no	SK	M			Total M	LK
				M1	M2	M3		
Students can understand the concept of acids and bases according to the Bronsted-Lowry theory	Macroscopic	1	36,15	13,51	6,75	2,70	22,96	13,51
Students can determine ionic equilibrium in acid and base solutions	Microscopic	2	4,62	33,78	13,51	20,27	67,56	24,32
Students can calculate the mass of a substance in making soap	Symbolic	3	0,77	32,43	21,62	13,51	67,56	31,08
Students can find out what can be done to restore the condition of the soil when acid rain occurs	Macroscopic	4	7,69	56,75	5,40	5,40	67,55	18,91
Students can find out the content of weak bases found in stomach medicine	Symbolic	5	24,62	22,97	16,21	1,35	40,53	16,21

Students can determine the strength of acid-base, calculate pH, α and the equilibrium constant of acid-base solutions	Microscopic	6	11,54	31,08	5,40	12,16	48,64	31,08
Students can identify the borax content in food using natural indicators	Macroscopic	7	26,92	27,02	1,35	4,05	32,42	20,27
Students can identify acids and bases in solutions using natural indicators	Macroscopic	8	12,31	31,08	9,45	14,86	55,39	22,97
Students can determine ionic equilibrium in acid and base solutions.	Microscopic	9	2,31	31,08	17,56	13,51	62,15	33,78
Students can determine an acid-based solution based on acid-base theory and its role in everyday life	Microscopic	10	3,08	28,37	25,67	6,75	60,79	33,78
Students can determine the strength of acid-base, calculate pH, α and the equilibrium constant of acid-base solutions	Microscopic	11	3,08	33,78	27,02	5,40	66,20	28,37
Students can determine an acid-based solution based on acid-base theory and its role in daily life	Macroscopic	12	9,23	29,72	25,67	8,10	63,49	20,27
Rate - rate			11,86	30,96	14,63	9,01	54,60	24,55

The highest misconception is in the concept of acid rain with a percentage of 56.75% in question number 4. Based on the explanation above, the misconception that occurs among students in question number 4 is because students do not understand the concept of acid rain theory, so students cannot choose the right reasons regarding the right way to restore the condition of the soil when acid rain occurs. The cause of misconceptions regarding acid-base material based on research results is because *reasoning is incomplete*, students' abilities, students' interest in learning and teachers' teaching methods. Indicator *reasoning* Incomplete means that the information that students have regarding a material is incomplete, resulting in incorrect conclusions being drawn and causing misconceptions.

Next is an indicator of students' abilities, namely students who are less talented will find it difficult to understand a concept that is conveyed correctly so that misconceptions can occur during the learning process. Each student certainly has different abilities in understanding concepts and developing the concepts they already have. According to Istiyani et al. (2018), each concept does not stand alone, but each concept is related to other concepts, so each concept can be connected to many other concepts. Often students only memorize concept definitions without paying attention to the relationship of one concept to

other concepts. Students' mistakes in understanding the relationship between concepts often give rise to misconceptions.

When linked to the results of direct observation, the learning process provided by teachers still uses the lecture method, even though many innovative learning methods have been discovered, many of our teaching staff still use the lecture method. It is said to be a lecture method because only the teacher is active during the learning process and students are less active during the learning process. This is in accordance with research conducted by Prihatini, et al (2017) which states that one of the causes of misconceptions is learning methods using conventional learning models, which makes students less active in the chemistry learning process in class. Moreover, each student has different cognitive abilities, so not all students have the same learning suitability in implementing a learning model proposed by the teacher and ultimately of course this influences students' understanding of concepts so it can be concluded that the indicators of teaching methods and teachers are the cause. misconceptions regarding the acid-base material in this research.

The final indicator is students' interest in learning. This indicator can cause misconceptions because students who have an interest in learning in certain subject areas will tend to cause fewer misconceptions than other areas that are not of interest (Suparno, 2013). A person's interest in a lesson can be seen from the tendency to pay greater attention to its lessons. If someone has a great interest in a subject such as chemistry, their learning value tends to change for the better and this means that misconceptions no longer occur.

Based on the causes of misconceptions revealed by Suparno (2013), misconceptions can be overcome by asking teachers to pay more attention to conveying the concepts being taught so that students do not develop wrong conceptions and do not express concepts based on their own opinions. Teachers should choose and design appropriate learning methods so that errors in understanding concepts do not occur to students and students become interested in participating in learning.

4. CONCLUSION

Based on the results of the research that has been carried out, it can be concluded:

The highest percentage of students' misconception category in acid-base material uses instruments three-*tier diagnostic test* is category M_1. In this category, students answered incorrectly at the first and second levels but were sure that the answers at both levels were correct. Percentage obtained with category M_1 based on research results is 30.96%.

The highest student misconceptions in the Acid and Base material occurred in the concept of acid rain with a percentage of 56.75% occurring in question item number 4 which is a macroscopic representation. The causes of misconceptions that occur in students are due to *reason* incompleteness, students' abilities, teachers' teaching methods, and students' learning interests.

5. SUGGESTION

This research can be continued by developing innovative learning strategies, such as interactive media or inquiry methods, to overcome the misconceptions found. Apart from that, it is necessary to conduct a more in-depth exploration of the causes of misconceptions through interviews or questionnaires to obtain more comprehensive data. Possible obstacles influence The research results are limited in population coverage, so further research can involve more schools or regions for more representative results. Another limitation is the

instrument used, so it needs further development to ensure its validity and reliability. Further research can also be focused on developing teaching materials or learning media based on these findings, so that they can be directly applied in learning.

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7. BIBLIOGRAPHY

Caleon, I., & Subramaniam, R. (2010). Do students know what they know and what they don't know? Using a four-tier diagnostic test to assess the nature of students' alternative conceptions. *Research in Science Education, 40*(3), 313-337.

Chang, R. (2019). *Chemistry*. New York: McGraw-Hill Education.

Demircioglu, G. (2010). Conceptual understanding of chemical equilibrium by using conceptual change text. *Chemistry Education Research and Practice, 11*(4), 267-276.

Ikenna, I.A. (2014). Remedying Students' Misconception in Learning Chemical Bonding and Spontaneity through Intervension Discussion Learning Model (IDLM). International Scholarly and Scientific Research & Innovation, 8(10):3259-3262.

Irwansyah, Sukarmin & Harjana. (2018). Development of Three-Tier Diagnostic Instruments on Students Misconception tes in fluid concept. Jurnal Ilmiah Pendidikan Fisika Al-BiRuNi, 07(2):207-217.

Istiyani, R., Muchyidin, A., & Rahardjo, H. (2018). Analisis Miskonsepsi Siswa pada Konsep Geometri menggunakan Three Tier Diagnostic Test. Jurnal Cakrawala Pendidikan, 223-236.

Jespersen, N.D., Brady, J.E. & Hyslop Alison. (2012). Chemistry: the molecular nature of matter (6 th ed). USA : John Wiley & Sons.

McClary, L., & Bretz, S. L. (2012). Development and assessment of a diagnostic tool to identify organic chemistry students' alternative conceptions related to acid strength. *International Journal of Science Education, 34*(2), 231-252.

Prihatini, E. (2017). Pengaruh Metode Pembelajaran dan Minat Belajar terhadap Hasil Belajar IPA. Jurnal Formatif. 7(2), 171-179.

Sari, M. W., Husna, A., & Rusyda, H. D. (2021). Diagnosing students' misconceptions about acids and bases using a three-tier diagnostic test. *Jurnal Pendidikan Kimia Indonesia, 5*(1), 22-30.

Suparno, P. (2013). Miskonsepsi dan Perubahan Konsep Dalam Pendidikan Fisika. Jakarta: PT. Grasindo.

Taber, K. S. (2019). Experimental methods for probing alternative conceptions in chemistry education: A review. *Chemical Education Research and Practice, 20*(1), 115-127.

Wang, Y., Chang, Y., & Liou, J. (2016). Using three-tier diagnostic tests to evaluate conceptual understanding and identify misconceptions in acid-base chemistry. *Journal of Research in Science Teaching, 53*(4), 463-487.

Wulandari, C., Susilaningsih, E., & Kasmui. (2018). Estimasi Validitas dan Respon Siswa Terhadap Bahan Ajar Multi Representasi : Definitif, Makroskopis, Simbolik pada

Materi Asam Basa. Jurnal Phenomenon, 8(2):165-167.

Yulita, I., (2018). Analisis Prekonsepsi Siswa TerhadapKemampuan Menghubungkan Konteks Air Laut Dengan Konten Hakikat Ilmu Kimia Kelas X SMA. Jurnal Pendidikan Sains (JPS), 6(1):64-72.