JPPS (Jurnal Penelitian Pendidikan Sains)
Homepage : https://journal.unesa.ac.id/index.php/jpps
Email : jpps@unesa.ac.id

p-ISSN : 2089-1776 ; e-ISSN : 2549-1597
JPPS, Vol. 11, No. 1, November 2021 : 1-11

Exploring Cause of Misconception on Reaction Rate Using 4TMC Diagnostic Test Instrument

Ilham Pradana Putra Harahap[1], Dian Novita[2], Rezi Ulya Fauziah[3], Chawalluck Sriwarom[4]

[1,2] Universitas Negeri Surabaya, Surabaya, Indonesia
[3] National Taiwan University of Science and Technology, Taipei City, Taiwan
[4] Khon Kaen University, Khon Kaen, Thailand

DOI : https://doi.org/10.26740/jpps.v11n1.p1-11

Sections Info

Article history:
Submitted: March 26, 2021
Accepted: November 20, 2021
Published: November 30, 2021

Keywords:
Diagnostic test
Four-tier multiple choice
Misconception
Reaction rate

ABSTRACT

The research purpose to explore the cause of misconception on the factors affecting reaction rates using the 4TMC diagnostic test instrument which is reported on the students' conceptions profile, students' misconceptions, and the causes of students' misconceptions. This research was conducted at the class XI science three students senior high school. The result showed that (1) the students' conceptions profile on the factors affecting reaction rates is 49.77 % misconceptions, 29.55 % did not understand the concept, and 20.68 % understood the concept, (2) the students' misconceptions profile of each sub-material ie misconception of concentration 24.20 %, temperature 21.00 %, surface area 26.03 % and catalyst 28.77 % and there are 5 student (22.73 %) included in the category of high misconceptions, 13 students (59.09 %) medium misconceptions and 4 students (18.18 %) low misconceptions, (3) students' misconceptions depend on a variety of causes, ie: associative thinking 43.53 %, incomplete reasoning 24.02 %, preconceptions 19.84 %, incorrect intuition 9.96 %, humanistic thinking 2.65 %.

INTRODUCTION

According to Permendikbud Number 20 the year 2016 regarding graduate competency standards, the dimensions of knowledge that must be possessed by SMA/MA/SMALB/Package C students are factual, conceptual, procedural, and metacognitive knowledge at the technical, specific, detailed, and complex levels (Kemendibud, 2016). High school students are required to have the ability of conceptual knowledge dimensions (Ogan-Bekiroglu & Eskin, 2012). One of the sciences related to conceptual knowledge is chemistry (Picon et al., 2020).

Chemistry is a field of science that studies a variety of compositions, structures, properties, changes, and associated energies (Landa et al., 2020) of a material developed by the scientific method and based on scientific attitude (Fernandez-Gonzalez, 2013; Hono et al., 2014). Understanding the concepts in learning chemistry is decisive (Avargil, 2019) since one concept with another concept is tightly connected (Irawati, 2019). In addition, the concept in chemistry has an important role in chemistry as a strong foundation for students to perform the following applicable learning (Wu et al., 2021). This is in line with Jean Piaget's thought in Slavin (2012) which stated that when students build their understanding through the assimilation process, integration of old and new concepts in cognitive structure, students often experience difficulties and even failures (Eymur & Geban, 2017). Consequently, it raises a variety of misunderstandings and the potential to lead to misconceptions (Kiray & Simsek, 2020).

Misconceptions are defined as wrong ideas or views about a concept of someone who has different from the scientific concepts according to the experts right consider (Vamvakoussi & Vosniadou, 2010; Ibrahim, 2012; Kala et al., 2013). The wrong view of students is usually resistant and persistent (Ibrahim, 2012; Jafer, 2020). However, the student's mind is not empty, full of prior knowledge, and has some daily experience related to scientific phenomena before reaching a scientific source (Cetin et al., 2015). Therefore, misconceptions must be detected early on because they can interfere with students' understanding of the following concept they will learn. (Treagust, 2006). Moreover, according to Seel (2012), even if misconceptions existed in their prior knowledge, their current understanding needs to be confronted and included before developing new or more correct ideas.

One of the chemistry topics contained many concepts, which are interconnected with each other (Susilaningsih et al., 2018) to cause students' and rate of reaction topic could not be an exception (Habiddin & Page, 2021). Based on the pre-research results of 36 students of class XI Science in a state senior high school in Gresik, it was found that as many as 58 % of them considered the reaction rate material to be tough to understand. Besides, as many as 61 % of students consider concentration factors as difficult to understand in terms of factors that influence the rate of reaction. Then what is considered difficult is the catalyst factor, temperature, and surface area with a percentage of 56 %, 47 %, and 33 %, respectively. In addition to students' assumptions that the reaction rate material is difficult, in this case, students also found misconceptions. Students were identified as having a misconception on the concept of a concentration factor of 24.20 %, on a temperature factor of 21.00 %, on a surface area factor of 26.03 %, and a catalyst factor of 28.77 %. In another study by Suyono (2019), the chemistry teacher candidates are still burdened with misconceptions, including the reaction rate concept. The existence of this misconception must certainly be detected so that it can be fixed immediately (Larkin, 2012). Meanwhile, according to an interview result, one of the chemistry teachers at the school explained that the teacher only uses daily tests and oral questions to students to check students' understanding of concepts. Thus, the teacher never used a diagnostic test to detect the misconception.

The diagnostic test can identify misconceptions (Fulmer et al., 2015; Halim et al., 2019). Depdiknas (2007) interpreted the diagnostic test as a test that can be used to determine the weaknesses and strengths of students. Thus, the diagnostic test results can be used as a basis for providing the appropriate treatment and following student weaknesses. The diagnostic tests at the beginning and the end of learning can help teachers identify students' misconceptions about the material studied.

This four-tier diagnostic test instrument is designed depending on four levels of questions (Fariyani et al., 2015). The four-tier test is developed to complete the three-tier test by giving a selection level of logical beliefs (Hermita et al., 2017). The first level is a multiple-choice question, which includes four answer options for students to choose. The second level is student confidence in choosing an answer. The third level is why students answer questions; those reasons consist of four false reasons and one reason for the correct answer. The fourth level is students' confidence in choosing a reason (Caleon & Subramaniam, 2010). The cause of students' misconceptions can be determined by selecting a deceiver with multiple-choice questions that may indicate the cause of the misconceptions (Syahrul & Setyarsih, 2015).

RESEARCH METHOD

Participantss

The subjects in this study were 22 students at class XI science 3 in GIKI 1 Surabaya Senior High School. Students received reaction rate material and with heterogeneous academic ability levels.

Instrument and Procedures

The instrument used in this research is the Four-Tier Multiple-Choice (4TMC) Diagnostic Test. This instrument was developed by Harahap and Novita (2020), has been tested and declared valid and reliable. Students are given diagnostic tests to know the level of conception and misconception they experience. The students' answer is categorized based on Table 1.

Table 1. Interpretation of the results of students' combination of answers using the four-tier multiple choice diagnostic test instrument.

The answer	The confidence level of the answer	The reason	The confidence level of the reason	Criteria
Right	High	Right	High	Understand the concept
Right	Low	Wrong	High	Misconception
Right	High	Wrong	High	
Wrong	High	Right	Low	
Wrong	High	Right	High	
Wrong	High	Wrong	Low	
Wrong	Low	Wrong	High	
Wrong	High	Wrong	High	
Right	Low	Right	Low	Not understand the concept
Right	High	Right	Low	
Right	Low	Right	High	
Right	Low	Wrong	Low	
Wrong	Low	Right	Low	
Wrong	Low	Wrong	Low	
Right	High	Wrong	Low	
Right	Low	Right	High	

(Fariyani et al., 2015)

Data Analysis

The collected data from students' answers of 4TMC were interpreted as misconceptions where concepts are understood, conceptual or conceptual misconceptions.The test results have shown the basis in determining the category of students' level of conception according to Table 1. Determination of the percentage of each of these categories can use the following equation.

1) Percentage of conception level categories for all students

$$P = \frac{nx}{ns}\ x\ 100\% \quad (1)$$

Information:

P : percentage of students' answers

nx : number of answers categorized as understanding concepts, not understanding concepts, and misconceptions

ns : total number of answers

2) Percentage of conception level categories for each student

$$P = \frac{nx}{ns} \, x \, 100\% \qquad (2)$$

Description:

P : percentage of students' answers

nx : number of answers categorized as understanding concepts, not understanding concepts, and misconceptions

ns : total number of answers

From the misconceptions percentage calculation, the sample of students was further categorized into 3 levels of misconceptions. The determining the criteria for each of these categories is as follows:

- High misconception level category

$$(X) \geq (Mi + SD) \qquad (3)$$

Information:

X : percentage of misconception (%)

Mi : ideal mean

SD : standard deviation

- Medium misconception level category

$$(Mi - SD) \leq (X) < (Mi + SD) \qquad (4)$$

Information:

X : percentage of misconception (%)

Mi : ideal mean

SD : standard deviation

- Low misconception level category

$$(X) < (Mi - SD) \qquad (5)$$

Information:

X : percentage of misconception (%)

Mi : ideal mean

SD : standard deviation

As for calculating the ideal mean and standard deviation, the equation is used

$$Mi = \frac{1}{2}\,(highest\ score + lowest\ score) \qquad (6)$$

$$SD = \frac{1}{3}\,(highest\ score - lowest\ score) \qquad (7)$$

RESULTS AND DISCUSSION

Student Conception Profile Class XI Science 3

Based on the treatment results, the data shows a combination of answers from each student. The combination of answers consists of 4 components, namely: (1) answers, (2) confidence level of answer, (3) reasons, and (4) confidence level of reason (Fariyani et al., 2015). Furthermore, each combination of answers was interpreted: (1) Understanding Concepts (UC), (2) Misconceptions (MC), and (3) Not Understanding Concepts (NUC). According to the data results on 22 students of class XI Science 3, the profile of students' conception, in general, is shown in Figure 1.

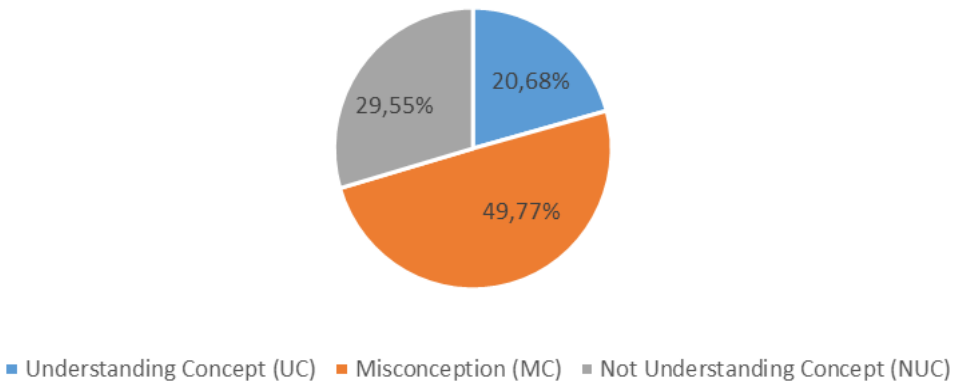

Figure 1. Student conception profile class XI science 3 on the reaction rate concept.

According to Figure 1, the most percentage of students' conceptions of XI Science 3 is Misconception (MC) which is 49.77 %. Next, the percentage order from big to small is Not Understanding Concept (NUC) of 29.55 % and Understanding Concept (UC) of 20.68 %. Most students are categorized in the Misconceptions (MC) on the concept of this reaction rate in which students believe the answers and reasons are wrong. A total of 29.55 % of students do not understand the concept (NUC). They are not sure of the answers and reasons were given. Meanwhile, only a small percentage of students can be included in the Understanding the Concept (UC) category. They had the correct answers and reasons and were confident with the answers and reasons were given. Students do not understand the concept (NUC) possibly because of several possibilities, such as forgetting the concepts that have been learned, they did not listen and pay attention to the teacher, or maybe the conventional teaching methods used by the teacher can cause them to be bored and tired. That made some concepts not conveyed properly to students. students (Jauhariyah et al., 2018).

Profile of Misconceptions for Each Class XI Science 3 Student

Students of XI Science 3 mostly experience misconceptions on the whole sub-material reaction rate, namely concentration, temperature, surface area, and catalyst. The percentage of students' misconceptions per sub material is explained in Figure 2.

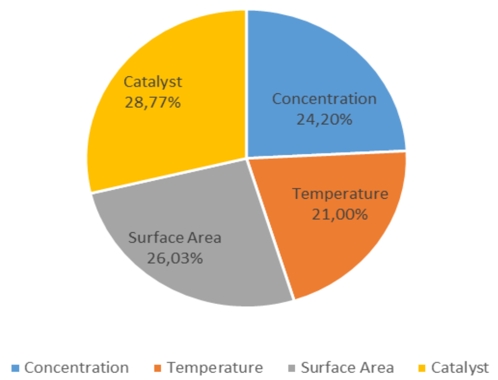

Figure 2. Percentage of students' misconceptions for each sub material.

According to Figure 2, the most percentage of students' misconceptions in XI Science 3 is in the sub-material catalyst of 28.77 %. The smallest percentage of misconception is the sub-material temperature of 21.00 %. While the surface area and concentration sub-material students of class XI Science 3 experienced misconceptions of 26.03 % and 24.20 %. Furthermore, previous research of Yang and Lin (2015) showed that the four-tier diagnostic test could identify students' misconception by the level of answers and reasons. Students' conceptions are categorized based on the percentage of their misconception scores. Starting from high misconceptions, moderate misconceptions, and low misconceptions, as shown in Table 2. Based on the recapitulation of misconception categories, the pie chart is shown in Figure 3.

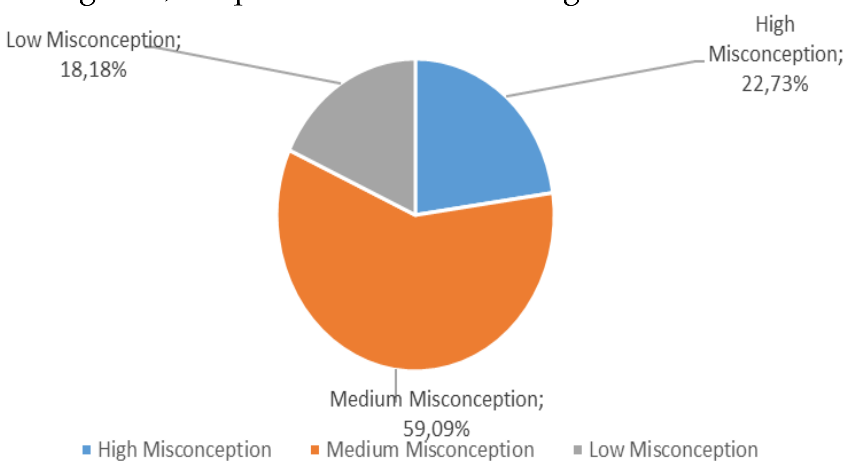

Figure 3. Diagram of percentage of students' misconceptions in class XI science 3.

Table 2. Recapitulation of percentage of conception of students based on sequence of misconceptions and their categories.

Initial Student's Name	Conception Percentage (%)			Misconception Category
	UC	MC	NUC	
AA	0	100	0	High
HS	0	100	0	High
MRS	0	100	0	High
LWK	5	95	0	High
SAM	0	95	5	High
RNP	20	80	0	Medium
RK	0	70	30	Medium
RAO	40	60	0	Medium
NJ	10	55	35	Medium
BF	10	50	40	Medium
BAK	10	45	45	Medium
MDS	55	45	0	Medium
SDO	0	45	55	Medium
RA	35	40	25	Medium
FMP	5	25	70	Medium
JAS	75	25	0	Medium
GRA	80	20	0	Medium
NEH	0	20	80	Medium
EMB	85	15	0	Low
BFA	5	5	90	Low
NTA	15	5	80	Low
ANF	5	0	95	Low

Based on Figure 3, 22.73 % or 5 students are categorized as a high misconception, 59.09 % or 13 students are categorized as a moderate misconception, and the remaining 18.18 % or 4 students are classified as a low misconception. The least level of misconceptions a student has is low misconceptions. Students who have good conceptual understanding tend to have misconceptions (Susilaningsih et al., 2020).

Causes of Class XI Science 3 Student Misconceptions

The causes of students' misconceptions vary several factors, such as the teacher, learning media, and the students themselves. The specific causes of students' misconception which originating from themselves can be varied such as: (1) Associative Thinking (AT), (2) Humanistic Thinking (HT), (3) Preconception (P), (4) Incomplete reasoning (R), and (5) Incorrect intuition (I) (Jauhariyah et al., 2018). Overall, the distribution of causes of misconceptions of XI Science 3 students shown in Figure 4.

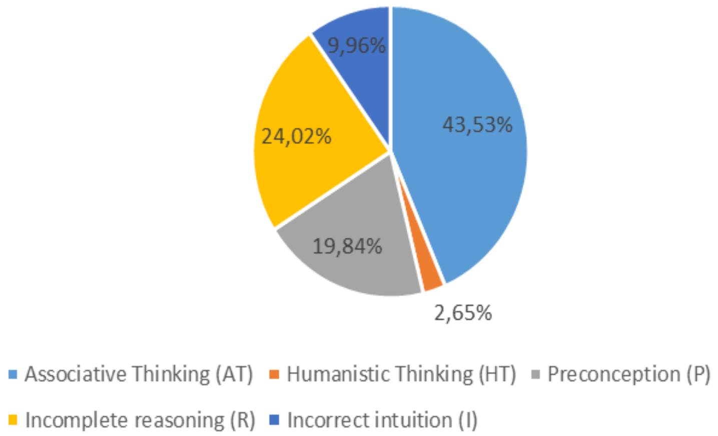

Figure 4. Causes of class XI science 3 students' misconceptions on the concept of reaction rate.

Based on Figure 4, the most cause of misconception among students comes from associative thinking that is equal to 43.53 %. This result cause of misconception is different from Jauhariyah et al. (2018), which states that the highest percentage of causes of misconception is humanistic thinking. Associative thinking is a thought that considers a concept the same as another concept. Students often associate one concept with another concept that gives rise to misconceptions. This way of thinking inevitably happens because of the similarity of terms and errors in understanding the relationship between concepts. Incorrect or incomplete concepts are caused by several reasons, namely students' wrong generalizations as to their experiences result, misinformation from teacher carelessness, teacher misconceptions, and reflection of misleading information in textbooks (Zajkov et al., 2017), this affects students' conceptual learning (Chazbeck & Ayoubi, 2018; Develi & Namdar, 2019).

CONCLUSION

Students' misconception profiles can be known using instruments that have been developed. The conception profile of students in class XI Science 3 on the concept of reaction rate is 20.68 % understood the concept, 49.77 % misconceptions, and 29.55 % did not understand the concept. Profile of misconceptions of students of XI Science 3 for each sub-material, which are misconceptions on the sub-material concentration of

24.20 %, temperature 21.00 %, surface area 26.03 %, and catalyst 28.77 %. A total of 5 students (22.73 %) were included in the high misconception category, 13 students (59.09 %) were in the medium misconception category and 4 students (18.18 %) were in the low misconception category. And then, the biggest cause of misconception of students is due to associative thinking as 43.53 %. Then incomplete reasoning 24.02 %, preconception 19.84 %. This research implies that the Four-Tier Multiple Choice (4TMC) diagnostic test instrument can be used by teachers to explore the causes of their students' misconceptions. Further research can develop this instrument into the next level, like a five-tier or six-tier diagnostic test.

REFERENCES

Avargil, S. (2019). Learning chemistry: Self-efficacy, chemical understanding, and graphing skills. *Journal of Science Education and Technology*, *28*(4), 285–298. https://doi.org/10.1007/s10956-018-9765-x

Caleon, I.S. and 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. https://doi.org/10.1007/s11165-009-9122-4

Cetin, G., Ertepinar, H., & Geban, O. (2015). Effect of conceptual change text-based instruction on ecology, attitudes toward biology and environment. *Educational Research and Review*, *10*(3), 259- 273. http://dx.doi.org/10.5897/ERR2014.2038

Chazbeck, B., & Ayoubi, Z. (2018). Resources used by lebanese secondary physics teachers' for teaching electricity: Types, objectives and factors affecting their selection. *Journal of Education in Science, Environment and Health (JESEH)*, *4*(2), 118-128. https://doi.org/10.21891/jeseh.409487

Depdiknas. (2007). *Tes diagnostik, direktorat pembinaan sekolah menengah pertama*. Jakarta: Direktorat Jenderal Manajemen Pendidikan Dasar dan Menengah

Develi, F., & Namdar, B. (2019). Defining friction force: A proposed solution to a textbook problem. *Journal of Education in Science, Environment and Health (JESEH)*, *5*(1), 91-101. https://doi.org/10.21891/jeseh.487399

Eymur, E., & Geban, O. (2017). The collaboration of cooperative learning and conceptual change: Enhancing the students' understanding of chemical bonding concepts. *International Journal of Science and Mathematics Education*, *15*(5), 853-871. https://doi.org/10.1007/s10763-016-9716-z

Fariyani, Q., Rusilowati, A., & Sugianto. (2015). Pengembangan four-tier diagnostic test untuk mengungkap miskonsepsi fisika peserta didik SMA Kelas X. *Journal of Innovative Science Education*, *4*(2), 41-49. https://journal.unnes.ac.id/sju/index.php/jise/article/view/9903

Fernandez-Gonzalez, M. (2013). Idealization in chemistry: Pure substance and laboratory product. *Science & Education*, *22*(7), 1723-1740. https://doi.org/10.1007/s11191-011-9428-2

Fulmer, G W., Chu, H E., Treagust D F., & Neumann K. (2015). Is it harder to know or to reason? Analyzing two-tier science assessment items using the rasch measurement model. *Asia-Pacific Science Education*, *1*(1), 1-16. https://doi.org/10.1186/s41029-015-0005-x

Habiddin, H. A., & Page, E M. (2021). Examining students` ability to solve algorithmic and pictorial style questions in chemical kinetics. *International Journal of Science and Mathematics Education*, *19*(1), 65-85. https://doi.org/10.1007/s10763-019-10037-w

Halim, A., Lestari, D., & Mustafa. (2019). Identification of the causes of misconception on the concept of dynamic electricity. *Journal of Physics: Conference Science*, *1280*(5), 052060. https://doi.org/10.1088/1742-6596/1280/5/052060

Harahap, I. P. P., & Novita, D. (2020). Validitas dan reliabilitas instrumen tes diagnostik four-tier multiple choice (4TMC) pada konsep laju reaksi. *Unesa Journal of Chemical Education*, *9*(2), 222-227. https://ejournal.unesa.ac.id/index.php/journal-of-chemical-education/article/view/32994

Hermita, N., Suhandi, A., Syaodih, E., Samsudin, A., Isjoni., Johan, H., Rosa, F., Setyaningsih, R., Sapriadil, & Safitri, D. (2017). Constructing and implementing a four tier test about static electricity to diagnose pre-service elementary school teacher misconceptions. *Journal of Physics: Conference Science*, *895*, 012167. https://doi.org/10.1088/1742-6596/895/1/012167

Hono, A. S., Yuanita, L., & Suyono. (2014). Penerapan model *learning Cycle 7E* untuk memprevensi terjadinya miskonsepsi siswa pada konsep reaksi redoks. *Jurnal Penelitian Pendidikan Sains*, *3*(2), 354-360. https://doi.org/10.26740/jpps.v3n2.p354-360.

Ibrahim, M. (2012). *Seri pembelajaran inovatif: Konsep, miskonsepsi dan cara pembelajarannya.* Surabaya: Unesa University Press

Irawati, R. K. (2019). Pengaruh pemahaman konsep asam basa terhadap konsep hidrolisis garam mata pelajaran kimia SMA Kelas XI. *Thabiea: Journal of Natural Science Teaching*, *2*(1), 1-6. https://doi.org/10.21043/thabiea.v2i1.4090

Jafer, Y. J. (2020). Assessing kuwaiti pre-service science teachers greenhouse effect perceptions and misconceptions. *International Journal of Science and Mathematics Education*, *18*(4), 657-667. https://doi.org/10.1007/s10763-019-09992-1

Jauhariyah, M. N. R., Suprapto, N., Suliyanah., Admoko, S., Setyarsih W., Harizah, Z., & Zulfa, I. (2018). The students' misconceptions profile on chapter gas kinetic theory. *Journal of Physics: Conference Science*, *997*, 012031. https://doi.org/10.1088/1742-6596/997/1/012031

Kala, N., Yaman, F., & Ayas, A. (2013). The effectiveness of predict–observe–explain technique in probing students' understanding about acid–base chemistry: A case for the concepts of pH, pOH, and strength. *International Journal of Science and Mathematics Education*, *11*(3), 555-574. https://doi.org/10.1007/s10763-012-9354-z

Kemendikbud. (2016). Permendikbud No 20 Tahun 2016 tentang standar kompetensi lulusan pendidikan dasar dan menengah. Jakarta: Kementerian Pendidikan dan Kebudayaan RI.

Kiray, S. A., & Simsek, S. (2020). Determination and evaluation of the science teacher candidates' misconceptions about density by using four-tier diagnostic test. *International Journal of Science and Mathematics Education, 19*(11), 935-955. https://doi.org/10.1007/s10763-020-10087-5

Landa, I., Westbroek H., Janssen, F., & van Muijlwijk, J. (2020). Scientific perspectivism in secondary-school chemistry education: Integrating concepts and skills in chemical thinking. *Science & Education*, *29*(1), 1361-1388. https://doi.org/10.1007/s11191-020-00145-3

Larkin, D. (2012). Misconceptions about "misconceptions": Preservice secondary science teachers' views on the value and role of student ideas. *Science Education*, *96*(5), 927–959. https://doi.org/10.1002/sce.21022

Ogan-Bekiroglu, F., & Eskin, H. (2012). Examination of the relationship between engagement in scientific argumentation and conceptual knowledge. *International Journal of Science and Mathematics Education,* *10*(6), 1415-1443. https://doi.org/10.1007/s10763-012-9346-z

Picon, R. O., Sevian, H., & Mortimer, E F. (2020). Conceptual profile of substance: representing heterogeneity of thinking in chemistry classrooms. *Science & Education*, *29*(5), 1317-1360. https://doi.org/0.1007/s11191-020-00152-4

Seel, N. M. (Ed). (2012). *Encyclopedia of the science of learning*. New York: Springer Science.

Slavin, R. E. (2012). *Educational psychology: Theory and practice tenth edition.* New York: Pearson Education.

Susilaningsih, E., Wulandari, C., Supartono, Kasmui, & Alighiri D. (2018). The use of multi representative learning materials: Definitive, macroscopic, microscopic, symbolic, and practice in analyzing students' concept understanding. *Journal of Physics: Conference Science*, *983*(1), 012165. https://doi.org/10.1088/1742-6596/983/1/012165

Susilaningsih, E., Nuswowati, M., & Natasukma, M. M. (2020). Profile of misconception in particulate level of acid basic subjects. *IOP Conference Series: Materials Science and Engineering*, *830*(4), 042082. https://doi.org/10.1088/1757-899X/830/4/042082

Suyono. (2019). The map of post-5th semester pre-service chemistry teachers' conceptions at universitas negeri surabaya. *Journal of Physics: Conference Science*, *1317*(1), 012148. https://doi.org/10.1088/1742-6596/1317/1/012148.

Syahrul, D. A., & Setyarsih, W. (2015). Identifikasi miskonsepsi dan penyebab miskonsepsi siswa dengan three-tier diagnostic test pada materi dinamika rotasi. *Jurnal Inovasi Pendidikan Fisika, 4*(3), 67-70.

Treagust, D. F. (2006). "Diagnostic Assessment in Science as a Means to Improving Teaching, Learning, and Retention". In UniServe Science Assessment Symposium, Sep 28, 2006, UniServe Science, The University of Sydney.

Vamvakoussi, X., & Vosniadou, S. (2010). How many decimals are there between two fractions? aspects of secondary school students' understanding about rational numbers and their notation. *Cognition and Instruction*, *28*(2), 181–209. https://doi.org/10.1080/07370001003676603

Wu, S-H., Lai C-L., Hwang, G-J., & Tsai, C-C. (2021). Research trends in technology-enhanced chemistry learning: a review of comparative research from 2010 to 2019. *Journal of Science Education and Technology*, *30*(4), 496-510. https://doi.org/10.1007/s10956-020-09894-w

Yang, D. C., & Lin, Y. C. (2015). Assessing 10- to 11-year-old children's performance and misconceptions in number sense using a four-tier diagnostic test. *Educational Research*, *57*(4), 368-388. https://doi.org/10.1080/00131881.2015.1085235

Zajkov, O., Gegovska-Zajkova, S., & Mitrevski, B. (2017). Textbook-caused misconceptions, inconsistencies, and experimental safety risks of a grade 8 physics textbook. *International Journal of Science and Mathematics Education*, *15*(5), 837-852. https://doi.org/10.1007/s10763-016-9715-0

***Ilham Pradana Putra Harahap (Corresponding Author)**
Science Education, Postgraduate School,
State University of Surabaya
Jl. Lidah Wetan, Surabaya, East Java, 60213, Indonesia
Email: ilham.21014@mhs.unesa.ac.id

Dian Novita, M.Sc.
Chemistry Department, Faculty of Mathematics and Natural Science,
State University of Surabaya
Jl. Ketintang, Surabaya, East Java, 60231, Indonesia
Email: diannovita@unesa.ac.id

Rezi Ulya Fauziah
Graduate Institute of Digital Learning and Education,
National Taiwan University of Science and Technology
No.43, Keelung Road., Sec.4, Da'an Dist., Taipei City, 106335, Taiwan (R.O.C.)
Email: M10911815@mail.ntust.edu.tw

Chawalluck Sriwarom
TESOL Program, Faculty of Education,
Khon Kaen University
No. 123 Mitrapsarb Road, Muang District, Khon Kaen, 40002, Thailand
Email: aqua.namnam@gmail.com