Analysis of Students' Conceptual Understanding on The Acid-Base Remedial Program with Multi-Representation Teaching Material

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Abstract. The study aimed to analyze the conceptual understanding profile of students who had not passed the grade in the remedial program. The remedial program which used multi-representation teaching-material. The subject was 40 students of XI MIPA who had not passed the grade in the acid-base topic. The study was a case study which classified as descriptive research. Three-tier multiple-choice test was chosen as the instrument of the study. The data analysis technique was done by classifying students' combination answer. The combination can represent students' conceptual understanding. The N-gain test was also done to investigate the enhancement. The results of the N-gain test 0.3. It is classified as medium criteria. Students' conceptual understanding profile of acid-base topic could be described as follow: 1) students who deeply understood was improved from 49% to 61%, 2) Students who had misconception reduced from 41% to 36%, 3) Students who only guessed reduce from 4% to 1%, 4) Students who slightly understood dropped from 2 % to 1%, 5) Students who didn't understand was dropped from 4% to 1%. Based on the study, we could infer that multi-representation teaching-material in an acid-base topic is able to improve students' conceptual understanding and reduce the misconception.

INTRODUCTION

Competitions in any sector increase during the 21st Century Era and force student's ability improvement [1]. Students have to possess competitiveness by mastering 21st century abilities [2]. One of those abilities is a higher conceptual understanding [3].

Conceptual understanding is an ability to grasp concepts which is shown by the explaining capability. Students learn the acid-base concept in high school. Acid-base is a basic concept for other concepts such as buffer solution, salt hydrolysis, and solubility concept [4]. Therefore, the learning process of acid-base concept should be emphasized to gain a better conceptual understanding.

Nowadays, students' conceptual understanding of the acid-base concept are still low. The statement is shown by the result of a formative test in a high school. The minimum criteria of mastery learning had not been passed by 82 of 131 students. Therefore, the classical mastery level was only 37%. The reason for this low level of conceptual-understanding was abstract and less understandable of the acid-base concept [5]. The remedial program could be a way to afford the difficulties of understanding the acid-base concept [6].

The remedial program is a follow-up action of the regular program to help students afford their learning difficulties. The remedial program is a good way to achieve the expected competency [7]. This program is also effective for students to enhance their learning ability [6]. Moreover, this program could boost students' motivation for achieving the specified competency [8].

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Remedial program implementation is adjusted by the number of not-mastered students. If the not-mastered students are more than 50% of the total, a re-learning remedial program should be carried out [9]. The formative test result in a high school showed classical mastery level was 37%. It means the not-mastered students were more than 50%. Therefore, re-learning by using other instructional media should be held.

Instructional media is a bridge for the teacher to deliver a message over students. A message will stimulate students' minds and motivation if the instructional media is used [10,11]. A teacher should be proficient in choosing the appropriate instructional media and apply it maximally. Those actions are important to achieve the learning objective [10].

Teaching material is the appropriate instructional media for the acid-base remedial program. Unfortunately, the effective teaching material for the remedial program is still rare [7]. According to this situation, the development of effective teaching-material needs to be done. Multi-representation teaching material could help students improving their conceptual understanding and problem-solving of chemistry [12]. Multi-representation teaching material is a group of an arranged subject of many representations. In this article, the multi-representations consist of definitive, macroscopic, submicroscopic, and symbolic representation. Multi-representation teaching material provides the relationship between the seen phenomena and the molecular reaction that happened [13].

Based on the explanation above, the problem statement and aim of this study could be stated as follow: how is the effectiveness of multi-representation teaching material in the acid-base remedial program toward students' conceptual understanding? The aim of this study is to find out the effectiveness of multi-representation teaching material in acid-base remedial programs toward students' conceptual understanding.

METHOD

The study was done on a senior high school in Kudus regency. The subject was 40 XI MIPA students who had not mastered the acid-base concept. The method used was descriptive research. The research aimed to find out the conceptual understanding after instructional media applied to the student. The type of research is a case study. The case was brought from a real problem in a senior high school. The main problem that happened was the absence of the remedial program in the re-learning form, even though the not-mastered student reach >50%. The data was collected by a test method. The instrument used was a three-tier test. The three-tier test is a kind of test that can be used to discover the conceptual understanding. This kind of test was a reasoned-multiple-choice with the confidence level in answering.

A trial for the three-tier test was done to get the validity, reliability, difficulty level, and discrimination coefficient. There were 24 of 45 questions that are feasible to be used in this study. The result of the test could be analyzed by Table 1. for qualifying students' conceptual understanding.

TABLE 1. Students' understanding analysis [15]

Tier 1	Tier 2	Tier 3	Decision
True	True	Sure	Understand the Concept
True	False	Sure	Misconception
False	False	Sure	Misconception
False	True	Sure	Misconception
True	False	Not Sure	Guess
False	True	Not Sure	Guess
True	True	Not Sure	Less Understand the Concept
False	False	Not Sure	Not Understand the Concept

The classification of the conceptual understanding enhancement could be calculated by the N-gain test. The data of pretest and posttest results were calculated by N-gain test. The gain obtained from the data on the pretest and posttest values was processed using the following formula:

$$\text{N} - \text{gain} = \frac{posttest\ score - pretest\ score}{\text{maximum score} - pretest\ score} \quad (1)$$

The interpretation of normalized gain is shown in Table 2.

TABLE 2. N-gain criteria grouping [14]

N-gain	Criteria
$G > 0,7$	High
$0,3 \leq G \leq 0,7$	Medium
$G < 0,3$	Low

This study divided into three phases: the preparation phase, implementation phase, and the final phase. The preparation phase consisted of pre-research, test instrument making, and the multi-representation acid-base teaching material. Next, the implementation phase brought by applying the teaching material for the participants of the remedial program. Those participants were also got the pretest and posttest. The final phase of this research was conducted by analyzing students' conceptual understanding based on the test result and calculating the improvement of students' conceptual understanding in the acid-base concept.

RESULT AND DISCUSSION

The subjects were 40 high school students. The analysis of students' conceptual understanding in the acid-base remedial program by multi-representation teaching material was done based on the recapitulation of students' conceptual understanding in each question item. The profile of students' conceptual understanding was classified by a combination that was adapted from Laliyo *et al*. [15]. The profiles were: understand the concept, misconception, guessing, less understand the concept, and not understand the concept. The profile is shown in Figure 1.

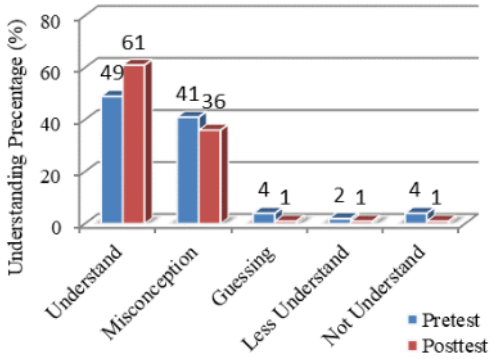

FIGURE 1. Students' conceptual understanding profile

The percentage of students who understand the concept increase from 49% to 61%. The N-gain test based on the pretest and posttest was 0.3. The value of N-gain showed us that multi-representation teaching material is quite effective to boost students' conceptual understanding. The value could be classified as "medium" criteria. This result is matched with Taqwa *et al*. (2020) opinion that said multi-representation learning is effective to increase students' conceptual understanding. The implementation of multi-representation teaching material also can reduce the misconception to 5% [16]. This result is in line with Widarti's statement, that multi-representation based learning could reduce the number of misconception student but the reduction had not reached 0% value [17]. The application of multi-representation teaching material was relatively short so that students did not fully understand the contents. The recapitulation of students' conceptual understanding profile in each item is presented in Table 3.

Profile of Students' Understanding with Classification as Understand the Concepts

Students are classified as "understand" the concept if students correctly answer the questions in the first and second tier. Moreover, students should be sure of their chosen answer. Students "understand" the most in the 16th item. Students who understand the concept of the item at pretest were 37/40 and increased in the posttest became 38/40

students. The indicator of the 16th item is asked students to estimate the pH of a solution based on the pH range of some indicators. The analysis of the 16th item showed that students have understood the acid-base indicators concept. The acids-base indicators presented in the 16th item were alizarin yellow and phenolphthalein (PP). Teaching material applications influenced students' understanding of the acid-base indicators concept. The multi-representation teaching material explained acid-base indicators concept in detail and contained practical activities. The acid-base concept, especially phenolphthalein indicators, in definitive, macroscopic, submicroscopic, and symbolic representation is presented in Figure 2. The definitive representation told about the definition of PP solution, which is a weak acid used as an acid-base indicator. The macroscopic representation shows the PP color change from colorless to purplish-red in a pH range of 8.3-10.0. The submicroscopic representation explained the cause of the discoloration of PP in the tested solution. The molecular structure causes color changes. The PP solution molecular structure of H_2 in contains a closed ring, while in the In^{2-} consists of an open ring. PP solution forms an equilibrium. Equilibrium shifts to the left after excess H^+ ions from the acid added. It turns the indicator colorless. The addition of OH^- ions removes H^+ ions and leads right shifting so that the indicator becomes purplish red. The symbolic representation figured by the chemical formulas and equilibrium reactions.

TABLE 3. Students' conceptual understanding profile recapitulation in question item

Students' Understanding	Question Number	
	Highest	Lowest
Understand the Concept	16	8 and 18
Misconception	8 and 18	17
Guessing	20	1, 2, 4, 5, 6, 8, 12, 13, 17
Less Understand the Concept	9	1, 2, 4, 7, 8, 10, 11, 12, 13, 14, 15, 16, 18, 21, 23, and 24.
Not Understand the Concept	15	1, 2, 4, 10, 11, 14, 16, 18, 20, and 22.

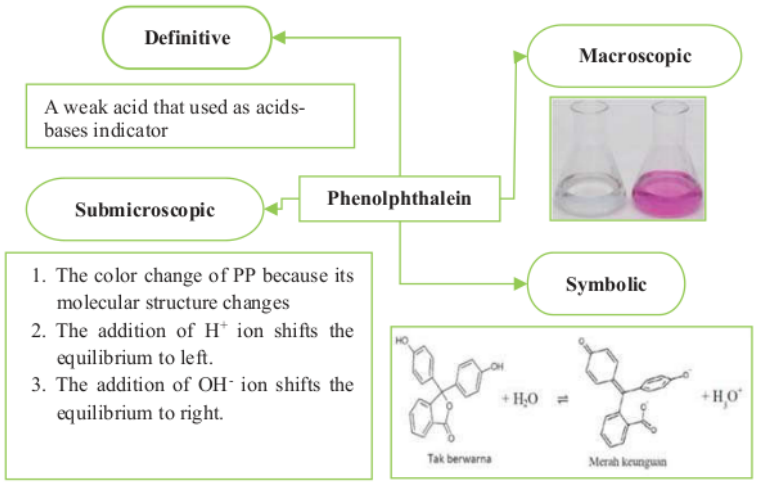

FIGURE 2. The presentation of multi-representation on the phenolphthalein indicator concept in remedial teaching material

Students "understand" the least in the 8th and 18th item. In the 8th item, the pretest score showed 0/40 students "understand" while in the posttest 3/40 students "understand". The 8th item indicator is pH calculation of a solution. The analysis shows students still had low understanding. Strong and weak acids are difficult to distinguish by most of the students. Students who "understand" the concept of 18th item are 2/40 students at the pretest and 6/40 students at the posttest. Students are not able to determine the correlation between ionization degree, concentration of solution, and equilibrium constant of bases. Students' weakness in pH calculation is in line with Nurpialawati's research [4] that stated students' conceptual understanding related to the pH algorithm categorized in the low criteria.

Profile of Students' Understanding with Classification as Misconception

The misconception is a misinterpretation, concept application error, and concept connecting error [18]. Students were classified as "misconceptions" when they sure of their answers while the answer was wrong either in the first or second tier. Students have the misconception the most in the 8th and 18th item. In the 8th item, the were 36/40 "misconception" students in the pretest, while 34/40 students in the posttest. The 8th item indicator is pH calculation of a solution. The misconception happened because they were assuming strong acid as weak acid and vice versa. The decrease of "misconception" students in the 8th item was supported by the contents of the remedial teaching material used. There is a very clear multi-representation view of strong and weak acid concepts, so students are able to distinguish two of them. The presentation of the strong-acid and weak-acid concept in a multi-representation could be seen in Figure 3 and 4 respectively.

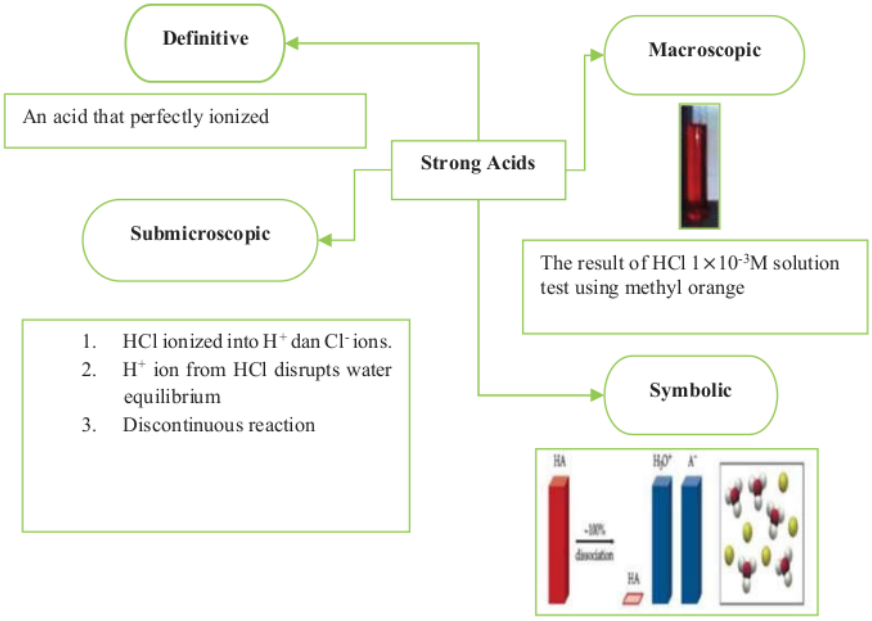

FIGURE 3. Multi-representation on the strong acid concept in remedial teaching material

Definitively, strong acids are perfectly ionized acids, for example, hydrochloric acid (HCl) solution. The macroscopic representation is presented by the color change of 1×10^{-3} M HCl solution after being added by methyl orange indicator. The submicroscopic representation explained that HCl perfectly ionized into H^+ and Cl^- ions in water. The H^+ ion of HCl disrupts water equilibrium and shifts water equilibrium to the left. This causes $[H^+]$ and $[OH^-]$ in water to decrease ($<10^{-7}$ M). The $[H^+]$ of water is ignored because the amount is too small if being compared to $[H^+]$ in the acid. The ionization of strong acid is a discontinuous reaction so it has no Ka. Concentration and valence of acid are the only things that are needed to determine the $[H^+]$ of strong acid. The symbolic representation of strong-acid concept is the chemical equations and strong acid ionization figure.

Weak acid is an acid which slightly ionized in the solution (partially ionized), for example, acetic acid (CH_3COOH). The macroscopic representation presented an orange color appearance after CH_3COOH 1×10^{-3} M solution tested using methyl orange. The submicroscopic representation described CH_3COOH in the water is partially ionized and produce CH_3COO^- and H^+ ions. The H^+ ion of CH_3COOH changes the water equilibrium and shifts it to the left. This causes $[H^+]$ and $[OH^-]$ from water to decrease ($<10^{-7}$ M). The $[H^+]$ of water is very small compared to $[H^+]$ of acid, then $[H^+]$ from water is ignored. The ionization reaction of a weak acid is an equilibrium reaction so that a weak acid has a Ka. The $[H^+]$ of weak acid determined by looking at the concentration and degree of ionization of the acid. The $[H^+]$ could also be determined from Ka because it has a relation with acid concentration and ionization

degree. The symbolic representation of the concept of a weak acid is a chemical equation and an image of weak acid ionization.

In the 18th item, 36/40 students get misconceptions in pretest while 35/40 students at the posttest. The students suffered the misconception because they fail to catch the correlation between ionization degree, the concentration of solution, and equilibrium constant. Meanwhile, students got misconceptions the least in the 17th item. There only 2/40 students who had a misconception. The indicator of the 17th item is acid-base theory.

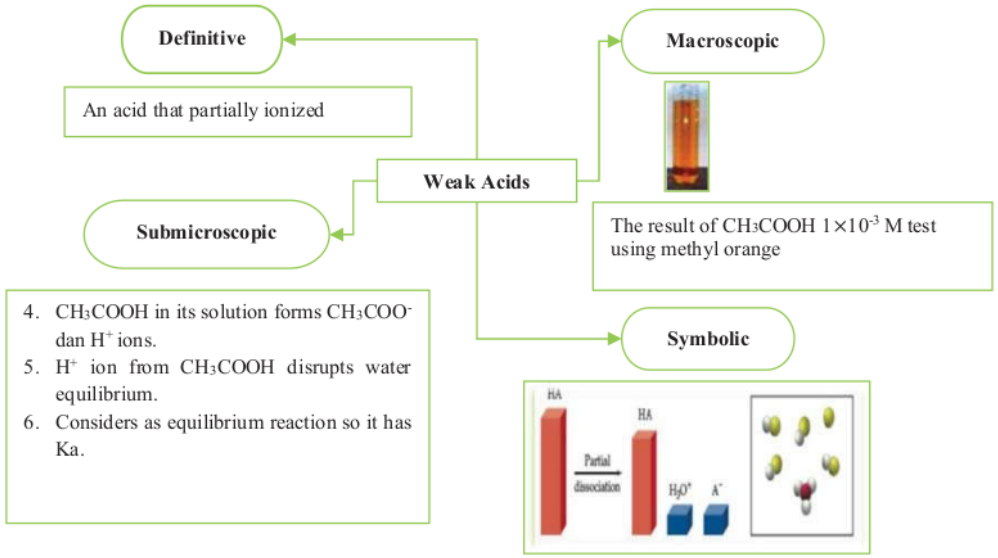

FIGURE 4. Multi-representation on weak acids concept in remedial teaching material

Profile of Students' Understanding with Classification as Guess

Students consider as "guess" if they sure of their answers while the answer was correct either in the first or second tier. Students "guess" the most in the 20th item. There were 8/40 students guessed on the pretest and 2/40 on the posttest. The indicator of the 20th item is about the determination of the neutralization reaction. Students guessed because they have not understood the neutralization reaction concept. In addition, the second-tier answer choice was too long and made them confused. The multi-representation teaching material decreased the number of students who guessed. The concept of neutralization reactions presented in many examples to help students understand the concept. Students did not guess at all on the 1st, 2nd, 4th, 5th, 6th, 8th, 12th, 13th, and 17th item. The indicators are acid-base indicators concept, the acid-base solutions properties, calculation of pH, acid-base theory, and acid-base strength.

Profile of Students' Understanding with Classification as Less Understand the Concept

Students consider as "less understand" if the answer is correct in the first and second tiers and them sure about it. The "less understand" profile shows the most in the 9th item. Students who "less understand" are 4/40 at the pretest and 1/40 at the posttest. The learning indicator on the 9th item is acid-base theory. The students had difficulty in determining acid and base through Bronsted-Lowry theory and made them hesitant about their answers. The decreased number of students who "less understand" the concept was supported by the content of teaching material which gave examples of acid-base reactions according to the Bronsted-Lowry theory. The example contains the occurring molecular reactions. The lowest less conceptual understanding profile was shown in 1st, 2nd, 4th, 7th, 8th, 10th, 11th, 12th, 13th, 14th, 15th, 16th, 18th, 21st, 23rd, 24th item. The "less understand" profile is related to students' beliefs about the concepts that they have already known. The presentation of multi-representation-based concepts can increase students' confidence in answering questions [19].

Profile of Students' Understanding with Classification Not Understand the Concepts

Students classified as "not understand" if the answer for both tiers are wrong and they not sure about it. Students "not understand" the most in the 15th item. Students who did not understand the concept at the pretest on the item were 10/40 students and decrease when the posttest became 1/40 students. The learning indicator on the 15th item was pH calculation of a solution. Students did not understand the pH calculation of polyprotic acid. Students still hesitant about the acid equilibrium constant (Ka) that should be used in the calculation. The decreased number of "not understand" students is influenced by the multi-representation teaching material used. Theasy *et al*. [19] stated that the use of multi-representation learning can improve students' conceptual understanding and beliefs in the truth of the studied concept. The lowest profile of not understand the concept shown in item number 1, 2, 4, 10, 11, 14, 16, 18, 20, and 22, namely 0/40 students.

CONCLUSION

Based on research, multi-representation teaching material of acid-base concepts can improve students' conceptual understanding. Students' conceptual understanding increased in these percentage as follows: students who understood the concept increased from 49% to 61%, students who had misconceptions decreased from 41% to 36%, students who guessed decreased from 4% to 1%, students who less understand decreased from 2% to 1%, and students who did not understand the concept decreased from 4% to 1%.

REFERENCES

1. T. Koparan, Malays. Online J. Educ. Technol. **5**, 8-28 (2017).
2. P. Turiman, O. Jizah, M. D. Adzliana, and O. Kamisah, Procedia Soc Behav Sci. **59**, 110-116 (2012).
3. C. C. Morroco, C. M. Aguilar, and C. J. Bershad, *Supported Literacy for Adolescents: Transforming Teaching and Content Learning for the 21 st Century*, (Jossey-Bass, Education Development Center in Newton, 2008).
4. I. Nurpialawati, *Analisis Miskonsepsi Materi Asam Basa Siswa SMA dengan Menggunakan Instrumen Tes Diagnostik Two-Tier di Wilayah Kota Tangerang Selatan*, (Universitas Islam Negeri Syarif Hidayatullah, Jakarta, 2017).
5. Suyanti, *Strategi Pembelajaran Kimia*, (Graha Ilmu, Yogyakarta, 2010).
6. P. Selvarajan, and V. Thiyagarajah, Int. J. Soc. Sci. Interdiscip. Res. **1**, 49-58 (2012).
7. A. Kumar, Adv. Res. J. Multidiscip. Discov. **7**, 36-38 (2016).
8. M. C. Cheng, J. Mod. Educ. Rev. **4**, 859-877 (2014).
9. Depdiknas, *Panduan Pengembangan Bahan Ajar*, (Direktorat Jenderal Manajemen Pendidikan Dasar dan Menengah, Jakarta, 2008).
10. Y. D. Puspitarini, and M. Hanif, Anatol. J. Educ. **4**, 53-60 (2019).
11. F. Leow, and M. Neo, Turkish Online J. Educ. Technol. **13**, 99-110 (2014).
12. C. Citra, I. W. Distrik, and K. Herlina, J. Phys. Conf. Ser. **1467**, 012029 (2020).
13. B. Bucat, and M. Mocerino, *Learning at the Sub-micro Level: Structural Representations*, (Springer, Dordrecht, 2009). pp. 11-29.
14. W. Wiana, M. S. Barliana, and A. A. Riyanto, Int. J. Emerg. Technol. Learn. **13**, 4-20 (2018).
15. L. A. R. Laliyo, S. Hamdi, M. Pikoli, R. Abdullah, and C. Panigoro, Eur. J. Educ. Res. **10**, 825-840 (2021).
16. M. R. A. Taqwa, A. Zainuddin, and C. Riantoni, J. Phys. Conf. Ser. **1567**, 032090 (2020).
17. H. R. Widarti, P. Anna, and M. Sri, Int. J. Educ. **9**, 105-112 (2017).
18. Soeharto, B. Csapo, E. Sarimanah, F. I. Dewi, and T. Sabri, J. Pendidik. IPA Indones. **8**, 247-266 (2019).
19. Y. Theasy, Wiyanto, and Sujarwata, J. Phys. Conf. Ser. **983**, 012005 (2018).

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