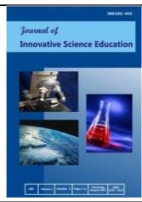
JISE 9 (3) 2020 : 267 – 274

Journal of Innovative Science Education

http://journal.unnes.ac.id/sju/index.php/jise



Analysis of Salt Hydrolysis Misconception with False Statements After Application of Guided Inquiry Assisted by E-Laboratory Instruction

Min Zahrotil Umami✉[1], Rubi'ah Rubi'ah[1], Sri Wardani[2], Cepi Kurniawan[2]

[1] SMA Negeri 1 Jekulo Kudus, Indonesia
[2] Universitas Negeri Semarang, Indonesia

Article Info

Article History :
Received October 2019
Accepted November 2019
Published December 2020

Keywords:
misconception, guided inquiry, e-laboratory instruction

Abstract

Salt hydrolysis is a difficult chemical concept because it is microscopic and abstract. These properties can occur misconceptions. The misconception in this material is quite high and is spread across all concepts. Submission of this material with appropriate learning methods and models is expected to reduce student misconceptions. Therefore, it is necessary to conduct research aimed at studying the results of the analysis of salt hydrolysis misconceptions after the application of guided inquiry assisted by e-laboratory instructions. This research was conducted at Jekulo 1 High School in the 2018/2019 academic year with 104 research subjects. The method used in this research is quantitative description method. The results obtained showed that students' misconceptions of salt hydrolysis material after the application of guided inquiry assisted by e-laboratory instructions were still high. The results of misconception analysis on salt hydrolysis materials were 47.50%. Misconceptions regarding changes in color in a salt solution, ionic equilibrium in a salt solution, experimental experiments to predict the pH of a salt solution, the acidic acidic nature of a salt solution, and the pH of a suitable salt solution were 41.35%; 62.50%; 35.58%; 37.02%; and 61.06%.

✉ correspondence :
Postgraduate Universitas Negeri Semarang
Jalan Kelud Utara III No.37, Kota Semarang, Indonesia 50237
E-mail: min.chemistry33@gmail.com

p-ISSN 2252-6412
e-ISSN 2502-4523

INTRODUCTION

Salt hydrolysis material is one of the difficult chemical concepts (Nuswowati & Purwanti, 2018). Misconceptions on salt hydrolysis material are spread across all concepts (Amelia et al., 2014). Misconceptions that occur in the hydrolysis material spread in each sub-discussion include: (a) the concept of salt hydrolysis (60.00%), (b) the concept of acid and base titration and its relationship to salt hydrolysis (42.00%), (c) the concept The pH of the hydrolyzed salt solution (36.75%), and (d) the concept of the nature of the hydrolyzed salt (36.33%) (Amelia et al., 2014).

Misconceptions that occur in students can be caused by several factors. These factors include abstract chemistry, low scientific language skills of students, books used by students, lack of understanding of teacher concepts, and misconceptions of observations that are passed from one person to the next (Tumay, 2016; Alpaydin, 2017; Haryani et al., 2017; Nyachwaya, 2016; Kusumaningrum et al., 2017; Taufiq et al., 2011). In addition, students' interest and attention during the learning process can also affect student misconceptions.

Learning that is carried out should attract students' interest and attention. Students' interest and attention can be realized in concrete learning. One concrete learning model is inquiry. Chemistry learning should be carried out by inquiry so as to foster the ability to think, work and be scientific and communicate it as an important aspect of life skills (Rustam et al., 2017; Muna et al., 2013). Inquiry learning involves students to observe real phenomena through practicum activities. The experiences gained directly are expected to reduce student misconceptions.

Things to consider in this learning are alternative concepts developed by students. Alternative concepts that are too free and not directed will cause students to experience misconceptions (Redhana et al., 2017). Alternative concepts that may arise in this learning can be directed using guided inquiry.

Guided inquiry in principle still uses an approach where the teacher plays an active role and becomes a middle ground solution between the teacher center and the student center (Koksal & Berberoglu, 2014). Guided inquiry provides opportunities for students to conduct investigations with teacher guidance. Guided inquiry not only requires students to be able to carry out an inquiry process independently, but also requires students to understand the implications of the results of the investigations conducted. The stages of inquiry learning formulate problems, formulate hypotheses, test hypotheses, draw conclusions and apply conclusions and generalizations (Gulo, 2008; Arifin et al., 2015). The teacher's active role in learning can limit alternative concepts that may emerge.

The learning that is carried out also needs to be adjusted to the development of education in the 21st century. The demands of the 21st century are based on technology and information networks. All transaction activities are carried out online as well as in learning activities. Learning in the 21st century is characterized by: (1) the amount of information available anywhere and can be accessed at any time; (2) faster computing; (3) automation that replaces routine jobs; and (4) communication that can be done from anywhere and anywhere (Kemdikbud, 2013). Therefore, learning in the 21st century is also characterized by a variety of technology-based infrastructure.

Guided inquiry assisted by e-laboratory instruction is a technology-based inquiry learning, where this learning combines face-to-face and online meetings. E-laboratory instruction also helps teachers overcome the problem of long time in this learning. Students can design practicum outside the learning hours with the directions contained in this media. Guided inquiry learning assisted by e-laboratory instruction is expected to help students to reduce misconceptions that occur. Therefore, to determine the effect of the use of guided inquiry learning assisted by e-laboratory instruction on students' misconceptions of salt hydrolysis material, research on "Analysis of Salt Hydrolysis Misconception with False Statements after Application of Guided Inquiry Assisted by e-Laboratory Instructions".

METHODS

This study aims to determine the results of students' misconceptions on the analysis of salt hydrolysis after the application of guided inquiry assisted with e-laboratory instruction. The study was conducted in the 2018/2019 school year at SMA 1 Jekulo Kudus. The subjects of this study were class XI IPA 1 with 32 students, XI IPA 2 with 36 students, and XI IPA 3 with 36 students.

The method used in this research is quantitative descriptive. The steps in this research are planning, implementation, and analysis. The planning stage is designing the research instruments needed, such as syllabus, lesson plans, learning media (e-laboratory instruction), and tests of understanding the concept of false statement types. The implementation phase is implementing guided inquiry learning assisted by e-laboratory instruction on salt hydrolysis material with details: 1) students discuss about salt hydrolysis material; 2) students discuss about practicum design in accordance with the directions in e-laboratory instruction; 3) students present the results of practical work; 4) students do practical work; 5) students discuss problems in learning salt hydrolysis; 6) evaluation with false statement tests. The last step is analysis. False statement test results were analyzed in order to obtain a profile of students' understanding of concepts.

Data collection in this study through a false statement test. False statement tests are used to diagnose learners' misconceptions on buffer hydrolysis material after the application of guided inquiry assisted with e-laboratory instruction. Analysis of false statements is calculated using the following formula:

$$\text{True } (\%) = \frac{n}{N} \times 100\%$$

Information :

n : the number of true / false / no idea values

N : Total number of values

The results of the analysis are then categorized as follows:

% true : Number of students who understand the concept

% false : Number of students who are misconceptions

% no idea : Number of students who do not understand

(Alpaydin, 2017)

RESULTS AND DISCUSSION

This research was conducted by analyzing the understanding of student concepts after the application of guided inquiry aided by e-laboratory instruction. Analysis of concept understanding is carried out using a false understanding test. The results of analyzing students' understanding of concepts in salt hydrolysis material using evaluation of false statement types are shown in Figure 1.

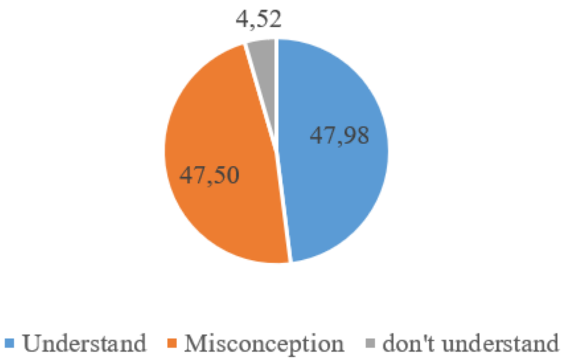


Figure 1. Results of an analysis of the concept understanding of salt hydrolysis with false statements

Based on Figure 1, it is known that students' misconceptions on salt hydrolysis material reached 47.50%. Students' understanding of this material is 47.98%. Students who do not understand as much as 4.52%. The results obtained indicate a high misconception in salt hydrolysis material. Students who understand the concept based on the results of false statements are 47.98%.

Misconceptions that occur in salt hydrolysis material are generally caused by prerequisite material namely acid base (Anwarudin et al., 2019). According to Irawati (2019) as much as 51.5% understanding the concept of acid-base affects the understanding of the concept of salt hydrolysis (Irawati, 2019). This is in line with the findings at the interview. Students admit the difficulty in distinguishing strong acids, strong bases, weak acids, and weak bases. As a result, the misconceptions experienced by students on this material are still high.

Salt hydrolysis material is listed in basic competency (KD) 3.11, which is analyzing the equilibrium of ions in a salt solution and connecting its pH. These basic competencies are translated into 5 indicators summarized in Table 1.

Table 1. Mapping of basic competencies and indicators of achievement of salt hydrolysis material

Basic competencies		Indicator of Achievement	
3.11	Analyzing the equilibrium of ions in a saline solution and connecting the pH	3.11.1	Identifying changes in the color of the red and blue litmus indicators in several saline solutions
		3.11.2	Understand the explanation of ion equilibrium in saline solutions
		3.11.3	Design an experiment to predict the pH of a salt solution using litmus paper / universal indicators / pH meter and report the results.
		3.11.4	Inferring the acid-base properties of a salt solution
		3.11.5	Determine the pH of the salt solution

Based on Table 1, the indicators of achievement of competencies that students must possess are described. There are 5 indicators that must be possessed by students. The results of the analysis of concept understanding of each achievement indicator are shown in Table 2.

Table 2. Analysis of the understanding of the concept of salt hydrolysis of each indicator with false statements

Indicator	Percentage		
	Understand	Misconception	Don't understand
3.11.1	57.21	41.35	1.44
3.11.2	36.54	62.50	0.96
3.11.3	56.73	35.58	7.69
3.11.4	60.58	37.02	2.40
3.11.5	28.85	61.06	10.10

Based on table 2, the highest concept understanding in indicator 3.11.4 is to conclude the acid-base properties of a salt solution. Understanding the concept of height is also obtained on the indicator achievement 3.11.1 identifies the color changes of the red and blue litmus indicators in some salt solutions and 3.11.3 designs an experiment to predict the pH of the salt solution by using litmus paper / universal indicator / pH meter and reporting the results.

The achievement of the concept understanding of each competency achievement indicator is explained as follows:

Identify the change in color of the red and blue litmus indicators in several saline solutions

Misconceptions on indicator 3.11.1 reached 41.35%, while a high concept understanding was obtained on this indicator which was 57.21%. Students have been accustomed to identifying changes in the color of the red litmus and blue litmus indicators during the practicum activities, so that the practicum activities support to understand the concept. Nevertheless, misconceptions on this indicator are still high. The cause of the high misconception on this indicator based on interviews with students is the lack of mastery of acid-base material as a prerequisite. Most students have not been able to distinguish strong acids, strong bases, weak acids, and weak bases.

Understand the explanation of ion balance in a salt solution

Misconception on indicator 3.11.2 was 62.50%, while the conceptual understanding of this indicator was 36.54%. The misconception on this indicator is the highest. The high misconception on this indicator can disrupt students in understanding the concept. Many students have difficulty understanding the explanation of ion equilibrium in salt solutions.

This difficulty can be caused by material about ionic equilibrium in microscopic salt solutions.

Design an experiment to predict the pH of a salt solution using litmus paper / universal indicators / pH meter and report the results

Misconceptions on this indicator reached 35.58%, while understanding students' concepts on this indicator as many as 56.73% of students could understand the concept of predicting the pH of a salt solution by using litmus paper / universal indicator / pH meter and reporting the results. Students can understand the concept because learning is done using inquiry learning models assisted by e-laboratory instruction where they are required to be able to design experiments that support the concept.

Infer the acid-base properties of a salt solution

Misconceptions obtained on indicator 3.11.4 are 37.02%, while understanding of the concepts on this indicator is 60.58%. The understanding of concepts in this indicator is the highest. Based on interviews conducted, students can distinguish the acid / base properties of a salt solution but cannot explain the concept well. Therefore, students can solve false statement type questions on this indicator well because they only focus on deducing the acid-base properties of a salt solution.

Determine the pH of the salt solution

Misconceptions on indicator 3.11.5 reached 61.06% and understanding of concepts reached only 28.85%. Understanding the concepts of this indicator is the lowest. The high misconceptions on this indicator can interfere with students in understanding the concept, so that students' understanding of the concepts achieved is very low. Many students have difficulty determining the pH of the salt solution. The difficulty is due to the lack of students' mathematical abilities, such as logarithms. In addition, the lack of practice questions also resulted in students not mastering the concepts on this indicator.

False statement tests can be used to detect student misconceptions. The false statement test used consisted of 10 statements. Students are asked to determine the statements given are true, false or do not know. Student misconceptions can be seen from wrong answers, while true answers mean understanding concepts and not knowing means not understanding concepts. The results of the analysis of student responses to each statement are shown in Table 3.

Based on Table 3, the first statement is "hydrolysis is the breakdown of water molecules by cations and salt anions". The answer to this statement is wrong, salt hydrolysis should be a decomposition reaction that occurs between cations and salt anions by water in a solution. Students who chose right answers were 96/104, and students who chose wrong answers were 8/104. Based on these results, it can be seen that students' misconceptions on this statement are still very high.

The second statement is, "the reaction of sodium chloride in water can bleach litmus paper". The answer to this statement is false, sodium chloride should not be hydrolyzed and be neutral so that the color of the red or blue litmus will remain. Students who chose right answers were 48/104 and students who chose wrong answers were 56/104. Based on these results, it can be seen that students' misconceptions on this statement amounted to 46.15%. Some students still experience misconceptions, but there are many students who understand the concept.

The third statement is, "Salts derived from strong acids and weak bases undergo hydrolysis to produce H_3O^+ ions and reduce the concentration of OH^- ions in water so that they are acidic". The statement given is wrong, it should be cations and anions that can undergo hydrolysis reactions are cations and salt anions which are weak electrolytes. The partial hydrolysis of salts from strong acids and weak bases to produce H_3O^+ ions can affect the equilibrium of ions in water but does not reduce the concentration of OH^-. Students who chose wrong answers were 35/104, and those who chose right answers were 64/104. Based on these results, it can be seen that the misconceptions in this statement are still high.

Table 3. Results of analysis of student answers on each statement

Question	True		False		No idea	
	F	%	*F*	%	*f*	%
Hydrolysis is the breakdown of water molecules by cations and salt anions	96	92,31	8	7,69	0	0.00
The reaction of sodium chloride in water can bleach litmus paper	48	46,15	56	53,85	0	0.00
Salts derived from strong acids and weak bases undergo hydrolysis to produce H_3O^+ ions and reduce the concentration of OH^- ions in water so that they are acidic.	64	61,54	35	33,65	5	4,81
Magnesium sulfate solution can change red litmus to blue	38	36,54	63	60,58	3	2,88
Methyl orange can be used to determine the pH of a salt solution	60	57,69	38	36,54	6	5,77
In addition to red litmus and blue litmus, pH meters can be used to identify the pH of compounds NH_4Cl, $MgSO_4$, $FeCl_3$ and $AlBr_3$	80	76,92	14	13,46	10	9,62
The hydrolysis of salts made from strong acids and strong bases does not disturb the equilibrium of H^+ and OH^-ions in water	68	65,38	34	32,69	2	1,92
All salts have a pH = 7 because they can be hydrolyzed in water	13	12,50	91	87,50	0	0.00
Ammonium bicarbonate is a substance used as a substitute for yeast. The pH of 1.58 grams of ammonium bicarbonate (Mr NH_4HCO_3 = 79) in 25 ml of water is less than 5. (Ka $H_2CO_3 = 2.5 \times 10^{-4}$; Kb $NH_3 = 1.8 \times 10^{-5}$)	66	63,46	29	27,88	9	8.65
The pH of 0.66 grams of ammonium sulfate in 0.5 liters of water is 5. (Kb = 1.8 x 10-5; Ar N = 14; Ar H = 1; Ar O = 16; Ar S = 32)	61	58,65	31	29,81	12	11.54

The fourth statement is, "Magnesium sulfate solution can change red litmus to blue". The statement given is wrong, magnesium sulfate should be broken down in water into Mg^{2+} and SO_4^{2-}. The decomposed Mg^{2+} ion reacts with water molecules to produce H^+ so that the H^+ concentration is greater than the OH^- concentration and is alkaline. Students who chose wrong answers were 63/104, and those who chose right answers were 38/104. Based on these results, the misconceptions in this statement are still high, but the understanding of concepts achieved is 60.58%.

The fifth statement is, "Methyl orange can be used to find out the pH of the salt solution". The statement given is wrong, the methyl orange indicator should not be used to determine the pH of the salt solution because the pH methyl orange route is between 3.1-4.4. Students who chose wrong answers were 38/104, and those who chose right answers were 60/104. Based on these results, the misconceptions in this statement are still high. Students do not recognize many types of acid-base indicators, as well as the pH routes of these indicators.

The sixth statement is, "In addition to red litmus and blue litmus, a pH meter can be used to identify the pH of compounds NH_4Cl, $MgSO_4$, $FeCl_3$ and $AlBr_3$". The statement is true. Litmus indicators, universal indicators and pH meters can be used to identify salt pH. Students who chose right answers were 80/104, and those who chose wrong answers were 14/104. Based on these results, the misconception in this statement is quite low compared to other statements.

The seventh statement is, "The hydrolysis of salts made from strong acids and strong bases does not disturb the equilibrium of H^+ and OH^- ions in water". The statement is true. Cations and anions that can undergo hydrolysis reactions are cations and salt anions which are weak electrolytes. Whereas salt cations and anions from strong acids and strong bases include strong electrolytes which are not hydrolyzed and do not affect the shift of the equilibrium of H^+ and OH^- ions. Students who chose the correct answer were 68/104, and those who chose the correct answer were 34/104. Based on these results, the misconception in this statement is quite high.

The eighth statement is, "All salts have a pH = 7 because they can be hydrolyzed in water". That statement is wrong, salt from strong acids and strong bases has a pH = 7, salt from strong acids and weak bases has a pH <7, and salt from weak acids and strong bases has a pH> 7. Students who chose the wrong answer were 91/104, and those who chose the right answer were 13/104. Based on these results, the misconception in this statement is the lowest compared to other statements.

The ninth statement is, "Ammonium bicarbonate is a substance used as a substitute for yeast. The pH of 1.58 grams of ammonium bicarbonate (Mr NH_4HCO_3 = 79) in 25 ml of water is less than 5. (Ka H_2CO_3 = 2.5 x 10-4; Kb NH_3 = 1.8 x 10-5) ". The statement is wrong, the pH of ammonium bicarbonate should be 6.42 or more than 5. Students who choose wrong answers are 29/104, and those who choose right answers are 66/104. Based on these results, the misconceptions in this statement are still high.

The last statement is, "pH 0.66 gram of ammonium sulfate in 0.5 liters of water is 5. (Kb = 1.8 x 10-5; Ar N = 14; Ar H = 1; Ar O = 16; Ar S = 32) ". That statement is wrong, the pH of ammonium sulfate should be 5.447. Students who chose wrong answers were 31/104, and those who chose right answers were 61/104. Based on these results, the misconceptions in this statement are still high.

CONCLUSION

The misconception of students about salt hydrolysis after the application of guided inquiry assisted by e-laboratory instruction is still high. The result of misconception analysis on salt hydrolysis material is 47.50%. Misconceptions on the identification of indicator color changes in some salt solutions, ionic equilibrium in salt solutions, designing experiments to predict the pH of salt solutions, acidic acidity characteristics of salt solutions, and pH of salt solutions respectively 41.35%; 62.50%; 35.58%; 37.02%; and 61.06%.

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