

The Comparison of Students' Misconception on Acid Base Topic After General Chemistry II Course and Chemistry School II Course at Chemistry Education of University of Riau

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Received: 10 September 2018, Accepted: 19 October 2018

Published online: 31 December 2018

Abstract: The comparative study of acid base misconception with Three-Tier Test method at chemistry education of University of Riau has been done. This study aims to determine magnitude of chemical education students' misconception on acid base topic after General Chemistry II course and Chemistry School II course. The research population is all students of chemical education, University of Riau, while the sample is 64 students who have taken school chemistry course and 79 students who have taken general chemistry course selected by purposive random sampling technique. The percentage data of chemical education students' misconceptions on acid base subject has been obtained and processed by Levene test and *t*-test using SPSS 21 program. The results show that the variance of the two groups of the students is the same. The mean difference test is performed with *t*-test and the *t* value is 3.109 ($t_{table} = 1.977$) with significance 0.002. Based on the *t*-test, the alternative hypothesis (H_a) is accepted, meaning that there is a difference in mean percentage of significant misconceptions between groups of students who have taken Chemistry School II courses with students who have taken General Chemistry II courses on acid base topic.

Keywords: Misconception, Three-Tier Test, acid base.

1. Introduction

Chemistry is a natural science that focuses on understanding concepts [1]. The concept is an abstraction that describes the general characteristics of an object or event that can facilitate communication between humans so as to enable humans to think [2]. Concepts in chemistry are arranged in stages, starting from basic concepts to higher-level concepts [3]. Therefore, to understand a higher concept requires understanding the correct basic concepts. For example, the concept of acid base is a basic concept for understanding higher concepts, namely the concept of buffer solution and salt hydrolysis. The general concepts of acid-base topic include the concept of acid-base, acid-base reaction, calculation of acid-base pH, acid-base indicator, and acid-base titration which is an important topic in chemistry. Most of these concepts are abstract, so that students have difficulty understanding them and encourage misconceptions. Acid base material in the chemical education of University of Riau is taught in two main courses, namely General Chemistry II and School Chemistry II course.

General Chemistry II is a subject taught to new students in 2nd semester II which aims to make students know about the basic concepts of chemistry. Whereas School Chemistry II is a subject taught in the 6th semester which aims for students to gain experience to analyze chemical concepts in the standard content of chemistry for 2nd grade high school. In addition, this course also focuses on discussing material that is considered difficult, solving problems, and discussing selected high school chemistry experiments. The presence of this school chemistry course is expected to minimize the

occurrence of students' misconceptions on acid-base topic. Misconception can be identified in several ways; one of them is the Three-Tier Test (TTT) method. TTT is a combination of Two-Tier Test and Certainty of Response Index (CRI) [4]. This method is superior to other methods because it can distinguish students who experience misconceptions with less knowledge and reduce the percentage of students in guessing answers.

Based on the above description, the authors are interested to conduct research entitled "The Comparison of Students' Misconception on Acid Base Topic after General Chemistry II Course and Chemistry School II Course at Chemical Education of University of Riau".

2. Literature Review

The subject of acid and base is full of concepts and requires an integrated understanding of many areas of introductory chemistry [5]. In addition, some of the concepts are abstract, making students difficult to learn and encourage misconceptions in students. Bradley and Mosimege have done comparative study of misconception in acid and bases for student teachers with different chemistry backgrounds using multiple choice and discussion questionnaire [6]. This method has several weaknesses, namely ineffective, difficult to be tested, cannot distinguish students who guess answers and misconceptions.

Another method for detecting misconceptions is the two tier test. According to Akkus and his friends, this method is more effective, easily tested, scoring is more objective, and the results are more accurate for detecting student misconceptions [7]. However, this method also has the disadvantage of not being able to distinguish between students whose misconceptions with students lack knowledge. To overcome this weakness, the two-tier test method can be combined with the Certainty of Response Index (CRI) method developed by Hasan and his friends into the three tier-test method (TTT) [8]. Based on these descriptions, I would like to do a comparative study of acid-base misconceptions using the three tier test.

3. Methodology

This study aims to measure the level of misconception of acid-base material in two groups of students, namely groups I and II. Group I students are groups of students who have taken General Chemistry II course. While group II students are groups of students who have taken General Chemistry II and School Chemistry II courses at the University of Riau Chemical Education Study Program. The design of the research used is the Design Posttest-Only group as shown in Table 1.

Table 1. Research Design

Groups	Pre test	Treatment	Post test
Group I	0	X_1	T_1
Group II	0	X_1 and X_2	T_2

Description:

Group I : Group I students

Group II : Group II students

X_1 : Have taken general chemistry course

X_2 : Have taken general chemistry and school chemistry courses

T_1 : Result of group I post test

T_2 : Result of group II post test

The population was all students of the University of Riau's chemical education study program who had taken School Chemistry II and General Chemistry II courses and students who had taken General Chemistry II course only. Whereas as a sample taken 4th semester students as group I and 6th semester students as group II. The sampling technique used was purposive random sampling. The instrument used was 15 items of acid-base TTT diagnostic test questions.

Each item consists of three levels, where the first level contains questions or statements that contain knowledge, while the second level contains the reasons for explaining the answers to the first

level questions, and the third level contains the index of students' trust in the answers they give. Before being tested, this problem was first tested for validity by expert validates.

Based on the results of the misconception test, the samples are grouped into four categories, namely students who know the concept, do not know the concept, guess and misconceptions [9] as shown in Table 2.

Table 2. Criteria for grouping student concepts

Tier 1	Tier 2	Tier 3 (CRI)	Decision
Correct	Correct	Sure	Know the concept
Correct	Correct	Not sure	Guessing
Correct	Wrong	Sure	Misconception
Correct	Wrong	Not sure	Guessing
Wrong	Wrong	Sure	Misconception
Wrong	Wrong	Not sure	Don't know the concept
Wrong	Correct	Sure	Misconception
Wrong	Correct	Not sure	Guessing

Furthermore, the existing data group compared the level of misconception. The level of misconception is measured in percentages, namely by comparing the number of questions that misconceptions with the total number of questions multiplied by 100%. For the similarity test, the variance was used by the Levene test and for the different test; two averages were used by the t-test with the help of the SPSS 21.0 for Windows application program. The statistical hypothesis developed in this study is as follows:

1. $H_0 : \mu_1 = \mu_2$: There is no difference in the level of misconception between students who have taken General Chemistry II and School Chemistry II courses with students who have taken General Chemistry II course.
2. $H_a : \mu_1 \neq \mu_2$: There are differences in the level of misconception between students who have taken General Chemistry II and School Chemistry II courses with students who have taken General Chemistry II course.

4. Results and Discussion

4.1. Result

Data of student misconceptions on acid-base material was made in a frequency distribution table based on Sturges' rules. Based on the results of the TTT diagnostic test and the number of student samples, 9 classes with class lengths were 10 as shown in Table 3. Furthermore, the mean and standard deviations of the two groups were calculated using the SPSS 21.0 for Windows application program. The number of students experiencing specific misconceptions on several concepts of acid base based on students' response to TTT diagnostic tests was analyzed and tabulated as shown in Table 4.

4.2. Homogeneity Test

The homogeneity test aims to examine uniformity of variance between all groups in the study. The test was carried out using Levene Test analysis [10]. Test results using the SPSS 21.0 for Windows application program. Test criteria are: If the probability $> \alpha$ (0.05) means that H_0 is accepted, thus indicating that the two population variants are identical. If the probability $< \alpha$ (0.05) means that H_0 is rejected and this shows the two population variants are not identical. Based on the results of the Levene test, the probability value is 0.097. Where the probability value $> \alpha$ (0.05) means that H_0 is accepted.

Table 3. Frequency distribution of the level of misconception of acid-base topic

Percentage of misconceptions (%)	Frequency of students who misconceptions	
	Group II	Group I
11-20	1	1
21-30	2	0
31-40	8	3
41-50	5	3
51-60	21	18
61-70	9	11
71-80	12	35
81-90	3	5
91-100	3	3
Number of class data	64	79
Amount of all data	143	

Table 4. Percentage of student misconceptions on several concepts

Student misconception	Number of students			
	Group I (79)		Group II (64)	
	f	%	f	%
Acid base reactions must involve H ⁺ and OH ⁻ ions	11	14	9	14
Ionization reaction to water is not an acid base reaction	9	11	4	6
Salt is neutral so it can react with acids or bases	12	15	10	16
A chemical formula containing H indicates the compound is acidic	1	1	12	19
Ionized NaH in water produces Na ⁻ and H ⁺ so it is acidic	10	13	2	3
PH3 produces H + in water	1	1	2	3
The pH of the neutral solution is always = 7	77	97	56	88
At pH = 7, [H ⁺] is always the same as [OH ⁻]	32	41	37	58
The saturated solution of NaOH (NaOH = 10M) has a pH = 15	62	78	38	59
It is impossible to make a solution with pH > 14	21	27	13	20
There is no pH = 0	27	34	13	20
At pH = 0, there are no H + and OH ⁻	17	22	14	22
At pH = 0, [H ⁺] = 0 and [OH ⁻] = 1x10 ⁻¹⁴	16	20	18	28
HCl solution 1x10 ⁻⁸ M, has a pH = 8	50	63	36	56
It is impossible to make 1x10 ⁻⁸ M HCl solution	22	28	23	36
pH interval is only 0-14	66	84	36	56
The neutralization reaction always produces a neutral solution	57	72	35	55
The autoionization constant water value (K _w) is always 1x10 ⁻¹⁴ .	77	97	54	84
Polyprotic acid is ionized in one reaction step	56	71	37	58
pH at equivalent point always equal 7	18	23	30	47
The acid base indicator can accelerate the reaction	13	16	7	11

4.3 Hypothesis testing

Homogeneity testing shows that the two classes have the same variant. Then the *t*-test is used to determine the difference in two class averages which is obtained *t* value of 3.109 with degrees of freedom (df) = 141 and a significance level of 0.002. The value of *t* table for the same degree of freedom at the 5% level of confidence is 1.977. Based on the values of *t* count and *t* table, then H₀ is rejected and H_a is accepted, which means that there are differences in the level of misconception between students who have taken General Chemistry II and School Chemistry II courses with students who have taken General Chemistry II course.

4.4. Discussion

Based on the results of diagnostic tests for acid base TTT carried out in both groups of students, the average percentage of group I misconceptions was 68.20%, while group II was 59.86%. Different test results mean that the level of misconception between two groups of students using *t*-test found that the value of *t*-count (3.109) was greater than the value of *t*-table (1.977), which means that there were significant differences in the average of two groups. This shows that the level of misconception of the group of students who have studied General Chemistry II is higher than the group of students who have studied General Chemistry II and School Chemistry II.

Group II students get a lower percentage of misconceptions than group I students can be caused by the influence of School Chemistry II course. School Chemistry II subject is a course that aims to make students gain experience to analyze chemical concepts in the standard content of chemistry for 2nd grade high school. In addition, this course also focuses on discussion of material and questions that are considered difficult, solving problems, misconceptions, and discussing selected high school chemistry experiments.

Although group II students had a lower level of misconception compared to group I students, for some concepts, the percentage of group II students was higher than group I. This shows that school chemistry learning II was not effective in reducing the level of misconception in some concepts, such as concepts. equivalence point, neutral pH, and acid-base ionization reaction.

5. Conclusion

Based on the results of the research and analysis that has been done, the following conclusions are obtained: 1) There are differences in the level of misconception between groups of students who have studied General Chemistry II and School Chemistry II with groups of students who have studied General Chemistry II on acid-base topic 2) School Chemistry II subject can reduce the level of student misconception on acid-base topic. 3) School Chemistry II subject ineffective in reducing the level of misconception on several concepts, namely the concept of equivalence point, neutral pH, acid base ionization reaction. It is expected that there will be further research on the causes of misconceptions experienced by students on the topic of acid base.

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