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Analysis of Misconception on Solubility and Solubility Product Constant (Ksp) Using Three-Tier Multiple Choice Test

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Abstract

The research aims to: analyze student's misconception on solubility and solubility product constant (Ksp) using the instrument of three-tier multiple choice test, and know the percentage of student's misconception. The research method used a mixed method with sequential explanatory strategy. Data collection technique was collected by diagnostic test using 20 questions of three-tier multiple choice that was completed by reasons and level of confidence, then the result of student's answer was analyzed. The result of the research shows that the diagnostic instrument test of three-tier multiple choice has fulfilled valid and reliable criteria. The implementation diagnostic instrument of three-tier multiple choice shows misconception percentage of solubility material was 5,272%, solubility product constant (Ksp) was 7,339%, the effect of same ions was 2,025%, the effect of pH on solubility was 4,597%, and sub-material of Ksp and the reaction process of sedimentation was 9,870%.

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INTRODUCTION

Concepts are essential for learning chemistry. Learning concepts is the main outcome of education (Dahar, 2011). Conceptual understanding is an understanding of matters relating to concepts, namely the meaning, nature, and description of a concept as well as the ability to explain texts, diagrams, and phenomena involving basic abstract concepts and basic theories of science (Yunita et al ., 2016). The complexity of concepts in chemistry causes the material to be a difficult lesson for students and potentially leads to a misunderstanding, which if consistently can lead to misconceptions. New concepts that do not fit the concept agreed by scientists are called misconceptions (Suparno, 2005). the Misconception is one of the learning problems that students should know in order to determine the appropriate steps to solve the problem. Misconceptions are obtained in two ways, from experience and learning (Nakiboglu, 2003). The Misconception is a learner's understanding of different scientific concepts with scientifically accepted concepts (Kirbulut & Geban, 2014), very strong and held continuously by students (Schmidt, 1995), resistant and difficult to change (Nicoll, 2001). For that reason, misconceptions must be identified and detected early in order for teachers to immediately learn that can change misconceptions into true conceptions.

Solubility and solubility product constant (Ksp) is one of the materials that learn many concepts. The result of Ulfah (2016) study concluded the difficulties of understanding the concepts experienced by the student on solubility and solubility product constant (Ksp) by 95% covering all the concepts tested. The difficulty of understanding the concept of solubility and solubility results has the potential to the misconception in the material.

One way to detect misconceptions in students is by diagnostic testing (Fariyani et al., 2015). A good diagnostic test can provide an accurate representation of the misconceptions experienced by students based on the error information it generates. Good diagnostic questions not only show that students do not only understand a particular piece of material but also can show how students think in answering the questions given even if their answers are incorrect (Law & Treagust, 2010). The three-tier multiple choice diagnostic test is one type of diagnostic test that can be used to identify and measure misconceptions in the learner. Susilaningsih et al. (2016) did research related to this diagnostic test. The result of the research shows the understanding of the basic chemistry concept of prospective teacher students in the final exam of the semester with an improved test instrument using three-tier multiple choice valid and reliable. The three-tier multiple choice diagnostic test instrument can reveal the combination of misconceptions profiles experienced by students in chemicals (Mubarak et al., 2016)

The three-tier multiple choice test consists of three levels of questions. On the first level contains multiple choice questions with answer choices. The second level contains questions about the reasons for the answers to the first level questions, and the third level contains questions about the students' beliefs in answering first and second level questions. Three-tier multiple choice is considered to be more accurate and leads to the misunderstanding of students since this test can detect a lack of knowledge percentage by means of a level of trust (Gurel et al, 2015). The advantages of a three-tier multiple choice test are to distinguish symptoms that arise between students who are less understanding of concepts with students have misconceptions so that three-tier multiple choice tests become more valid and reliable to diagnose misconceptions of students than two-tier multiple choice or conventional multiple-choice (Pesman & Eryilmaz, 2010).

Based on the above description will be analyzed students' misconception of Madrasah Aliyah Riyadlotut Thalabah Sedan, Rembang on solubility and solubility product constant (Ksp) material. Objectives to be achieved in this research to determine: (1) the feasibility of the three-tier diagnostic test instrument developed; and (2) a misconception profile experienced by

detected students using a three-tier diagnostic test instrument on chemical bonding material.

METHODS

The research was conducted at Madrasah Aliyah (MA) Riyadlotut Thalabah Sedan, Rembang. Class XII MIA 1 was a trial class consisting of 38 students. Research subjects for the final field test were 117 MIA class XI students consisting of XI MIA 1, XI MIA 2, and XI MIA 3.

This research used the mixed method with sequential explanatory strategy. The strategy was applied in sequence to the collection and analysis of quantitative data in the first phase followed by the collection and analysis of qualitative data in the second stage built on quantitative early results (Creswell, 2013). The sequential explanatory research design steps are shown in Figure 1.

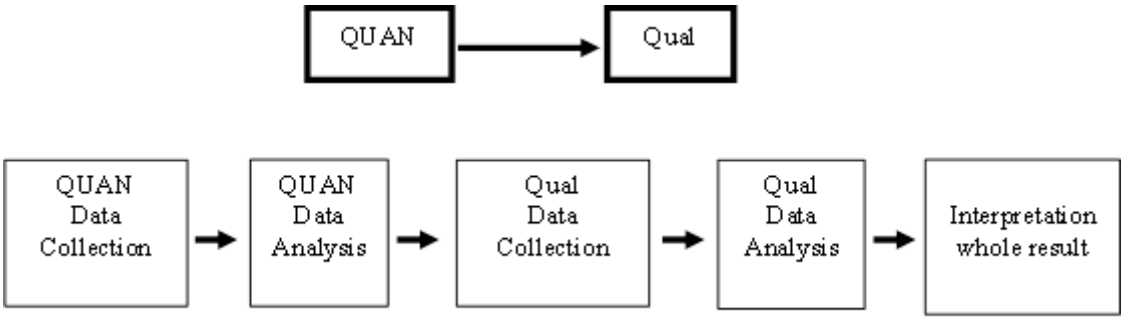

Figure 1. sequential explanatory research design

Based on Figure 1 we can see the quantitative writing of the phases using capital letters "QUAN" which indicates the weight or priority given to data, analysis and quantitative interpretation

Methods of data collection consisted of the test method, interview, and documentation. The test method was performed to obtain quantitative data through the trial test and three-tier multiple choice diagnostic test. Trial test conducted in class XII MIA 1 consisting of 38 students, the students who have received material about solubility and solubility product constant. The result of the trial test was analyzed and the questions that valid, and reliable were used for diagnostic tests with 117 subjects consisting of classes XI MIA 1, XI MIA 2, and XI MIA 3. Interviews were conducted to reinforce the data obtained from the test results and to find out information more accurately and validly related to the conceptual understanding of solubility and solubility product constant (Ksp).

Data analysis performed include validity, reliability, difficulty level, the different power of questions, and misconception analysis of students on solubility and solubility product constant (Ksp). Testing validity consists of two steps, the validity of the content and the validity of each item. Testing content validity was done by two expert lecturers and 1 chemistry teacher, while the validity of each item was calculated using the biserial point correlation technique with the formula:

$$r_{pbis} = \frac{M_p - M_q}{S_t}\sqrt{pq}$$

Information:

r_{pbis} = biserial point correlation coefficient
M_p = number of respondents who answered correctly
M_q = number of respondents who answered incorrectly
St = standard deviation for all items
p = the proportion of respondents who answered correctly
q = the proportion of respondents who answered incorrectly

The result of r_{pbis} calculation then used to find significant ($t_{calculate}$) with the formula (Sudjana, 2005):

$$t_{calculate} = \frac{r_{pbis}\sqrt{n-2}}{\sqrt{1-r_{pbis}^2}}$$

Criteria: Items that have $t_{calculate} \geq t_{table}$ with degrees of freedom (n-2) include valid items. Items containing $t_{calculate} < t_{table}$ include invalid items then need to be revised or not used. To analyze the cause of the difficulties experienced by the students is the misconception, misunderstanding or lack of understanding of solubility and solubility (Ksp) can be done by looking at the results of the three-tier diagnostic test. There are several possible categories of student response patterns based on Arslan et al., (2012) shown in Table 1.

Table 1. Answers Combination Analysis

First Tier	Second Tier	Third Tier	Category
Correct	Correct	Certain	Scientific Knowledge
Correct	Incorrect	Certain	Misconception (false positive)
Incorrect	Correct	Certain	Misconception (false negative)
Incorrect	Incorrect	Certain	Misconception
Correct	Incorrect	Uncertain	Lack of knowledge
Incorrect	Correct	Uncertain	Lack of knowledge
Incorrect	Incorrect	Uncertain	Lack of knowledge
Correct	Correct	Uncertain	Lucky guess

RESULTS AND DISCUSSION

Instrument Preparation

The feasibility test of the three-tier multiple choice diagnostic test instrument used is described in detail as follows:

1. Content Validation

Content validation was done by two expert lecturers and one chemistry teacher. Validation was performed to determine whether the instrument used was feasible and can measure what will be measured, in this study was the misconception of students on the solubility and solubility product constant (Ksp). Recapitulation of results collected by the researchers that the test instrument that has been validated by 3 validators was 0.80 with the valid category. Based on this, the questions worthy to be used for the trial test at MA Riyadlotut Thalabah, Rembang.

2. Validity of Questions

the Validity of test items was calculated using biserial point correlation technique. The test results from 40 items obtained 21 valid questions. A total of 21 questions that valid criteria were divided into 5 sub-chapters on solubility and solubility product constant (Ksp), they were 5 questions for the solubility sub-chapter, 4 questions for the sub-chapter of solubility product constant (Ksp), 1 question for the effect of same ions, 4 questions for the effect of pH on solubility, and 7 questions for Ksp and the reaction process of sedimentation.

3. Difficulty Questions Levels

The difficulty questions level was calculated by comparing the number of students who answered correctly and the number of students who answered incorrectly. The Questions with valid criteria have varying degrees of difficulty. The calculation result of difficulty questions levels was presented in Figure2.

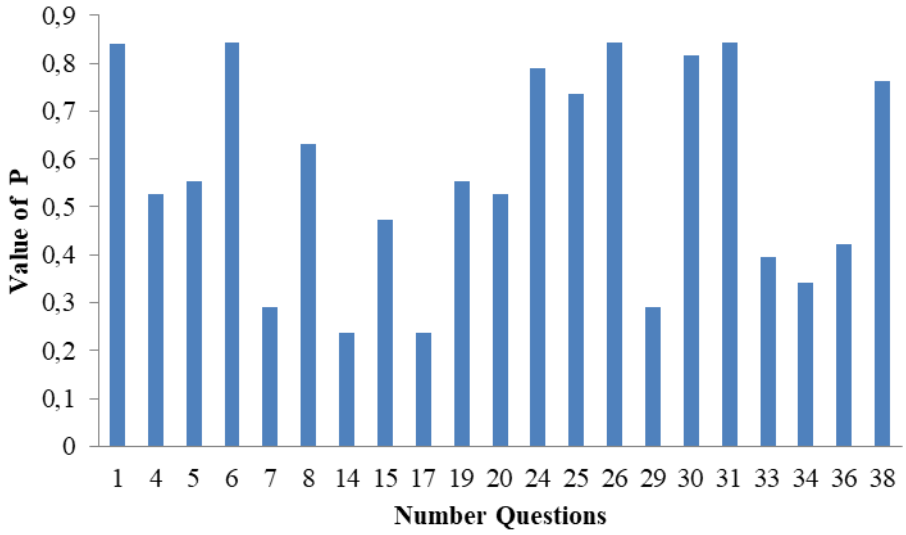

Figure 2. Difficulty Questions Levels

Based on Figure 2, 3 questions are classified as difficult with the P value <0.30; 10 questions were moderate with P values between 0.20-0.70; and 8 questions are easily classified with P> 0.71. Most questions with valid categories have a moderate degree of difficulty. The level of difficulty is needed so that students who are less clever is not too difficult in doing the problem and smart students are not too easy in doing on the questions. Selection of questions with moderate difficulty is also in accordance with the research Wahyuningsih et al. (2013) using a problem with a median average difficulty level for diagnostic tests.

4. Different Power of Questions

Determination of different power of question was done by dividing 38 students into 19 upper group students and 19 lower group students then done the calculation of value D. The D value of 40 questions is presented in Figure3.

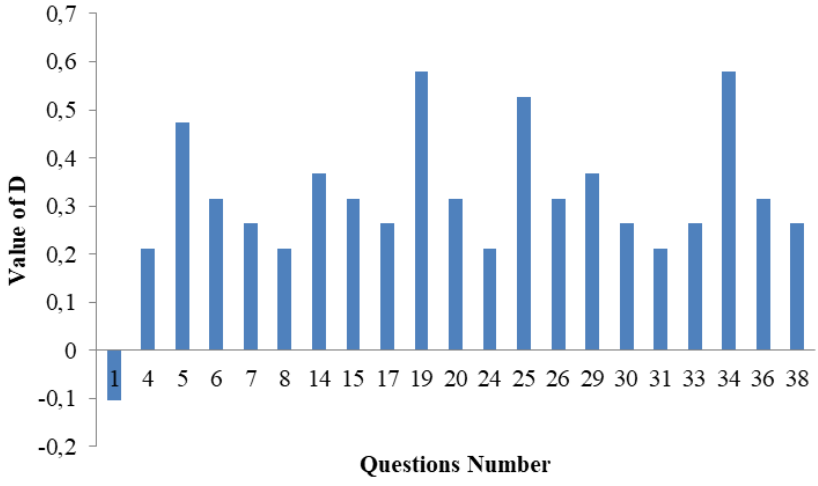

Figure 3. Different Power of Questions

According to Figure 3, the 21 questions that had valid criteria, there is 1 questions that the power is very bad (-0.105), then the decision to be taken is not using question number 1 for

the diagnostic test step. Questions with good different power can distinguish clever students and students less clever. This is in accordance with the opinion of Nugraeni et al. (2013) which states that good test items should be able to distinguish the students who actually master the material from those who do not. Problem tests with bad distinguishing features could not be used. This is because if the test questions could not distinguish clever students and students less clever then the purpose of the test will not be achieved. So for the next step, the diagnostic test question was 20 questions.

Reliability

In this research, the reliability test used the Kuder-Richardson equation (KR-20) with the formula:

$$r_{11} = \left[\frac{n}{n-1}\right]\left[\frac{M(n-M)}{n\,S_t{}^2}\right]$$

Information:

r_{11} : instrument reliability

n : number of items

M : average score

St^2 : total variance

The test reliability test criterion was the value of r_{11} consulted with r_{table} price. If $r_{calculate} > r_{table}$ then tested test items are reliable (Arikunto, 2013). The reliability calculation result of three-tier diagnostic test instrument was 0.643 with good reliability criteria.

Misconception Analysis

Based on the results of the interpretation of the answers combination obtained profile data results of student answers in accordance with the criteria in Table 1. The data in the form of the percentage of student answers criteria presented inFigure4.

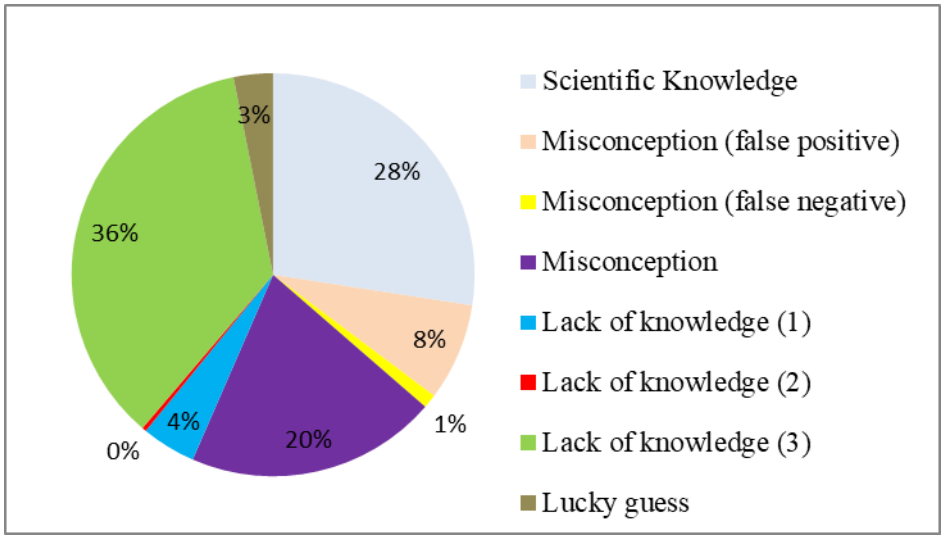

Figure 4. Percentage of Student Answers Criteria

Based on Figure 4, it was known that the type 3 misconception most experienced by the student with the percentage of 20% of the total misconception percentage of 29%. Students within the category of misconception type 3 were when the students answer the wrong question, then give the wrong reasons too, but they were sure to answer. Furthermore, misconception analysis was performed to determine the percentage of misconceptions on the sub-subject of solubility and solubility product constant (Ksp) expressed in Table 2.

Table 2. The Percentages of Misconception

No	Sub Subject	(%)
1	solubilitiy	5.272
2	solubility product constant (Ksp)	7.339
3	the effect of same ions	2.025
4	the effect of pH on solubility	4.597
5	Ksp and the reaction process of sedimentation	9.870
	Total	29.103

Based on Table 2, it could be seen that Ksp and the reaction process of sedimentation had the largest percentage of misconception (9.870%), while the effect of same ions had the smallest misconception percentage. The results were supported by the interviews of students. Interviews indicate that students have difficulty predicting compounds that settle based on Ksp prices. students still have difficulty to ionize the compound so that it affects the determination of the solubility formula of the compound. In addition, errors also occur in many students because directly compare the price of Ksp data is known. Students assume the greater the price of Ksp then the greater the solubility, but this did not apply if the number of ions was different. If the compound was different, then the compound should be ionized first, then determined Ksp formula so that later can be derived into the solubility formula of the compound. Based on the findings of misconception and the analysis of the causes, it was necessary to learning model with the more in-depth explanation to reduce the misconception that occurs in students.

CONCLUSION

Based on the results of research and discussion, it can be concluded that that the diagnostic instrument test of three-tier multiple choice has fulfilled valid and reliable criteria. The implementation of this instrument shows misconception percentage of solubility material was 5,272%, solubility product constant (Ksp) was 7,339%, the effect of same ions was 2,025%, the effect of pH on solubility was 4,597%, and sub-material of Ksp and the reaction process of sedimentation was 9,870%.

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