

Development of Structured Essay Diagnostic Test of Chemistry (SEDToC) on Acid-Base As an Instrument For Analysis Of Student Learning Outcomes

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Abstract—The misconceptions experienced by students towards a material will have an impact on learning difficulties in other materials. This study aims to produce a Structured Essay Diagnostic Test of Chemistry (SEDToC) test instrument that can identify misconceptions, inhibiting materials and analyze student learning outcomes on Acid-Base that meet good criteria in terms of validity, reliability, difficulty index and distinguishing power. The research procedure consists of three stages, namely the stage of determining the content, the stage of obtaining information about the misconceptions experienced by students and the stage of developing the SEDToC test instrument. The test instrument was validated by 5 chemists. The test instrument was tested on 20 students of class 11th grade at SMAN 12 Padang. The results showed that the Structured Essay Diagnostic Test of Chemistry (SEDToC) test instrument on Acid-Base for senior high school students developed was content valid, having a very high reliability of 0.94. Analysis of the difficulty index of the SEDToC test instrument showed that there were 36 questions in the easy category, 13 questions in the medium category and 10 questions in the difficult category. The analysis in terms of differentiating power of the questions obtained as many as 18 questions in the bad category, 18 questions in the sufficient category, 20 questions in the good category and 3 questions in the very good category. Based on the results of the study using the Structured Essay Diagnostic Test of Chemistry (SEDToC) test instrument on the Acid-Base, it was proven that the SEDToC test instrument could identify misconceptions, inhibiting materials and analyze student learning outcomes.

Keywords—misconceptions, inhibitory materials, learning outcomes, acid-base, SEDToC

I. INTRODUCTION

One of the studied chemistry topics in 11th grade is acid-base material. Acid-base material consists of the concept of acid-base, acid-base indicator, and pH of strong acids, strong bases, weak acids, and weak bases (Kemendikbud, 2017). The concept in acid-base material must be mastered correctly and appropriately by the student, if the student in studying acid-base material has a misconception, then students will experience obstacles in learning the next chemical concept that is closely related to the concept of acid-base and affect the learning outcome. Previous research has reported that misconceptions occurly happened in acid-base materials. Students' difficulties in acid-base materials are thought to stem from many misconceptions of acid-base material prerequisites such as chemical reactions, chemical equilibrium, stoichiometry, and chemical bonds (Harizal, 2012); (Nugroho et al., 2019); (Gazali & Yusmaita, 2018); (Dewi et al., 2018); (Sadhu et al., 2015); (Sadhu et al., 2017); (Hadinugrahaningsih et al., 2018); (Demircioglu et al., 2005); (Fajri, A. Y., Agung, S., & Saridewi, 2020); (Sugiyarto, & Al, 2013)

Sutrisno (1995) explained that remedial program could be done in order to overcome student misconceptions (Sutrisno, 1995). Remedial programs serve to correct misconceptions that occur in students (Suparno, 2005). In fact the implementation of remedial programs conducted only in the form of retests with the same questions to students who have not completion achieved without making improvements to the learning process based on the results of analysis of learning difficulties in students. Learning difficulties in students need to be analyzed to know the obstacles in learning to lead the achievement of learning objectives. In remedial programs so that misconceptions can be detected, analysis of learning difficulties in students is an important thing to implement (Direktorat Pembinaan SMA, 2010); (Direktorat Pembinaan SMA, 2017). Analysis of learning difficulties in students can be done by identifying misconceptions.

Identification of misconceptions in students can be done with diagnostic tests such as interview, open ended test, multiple choice and multiple-tier. the advantage of Interview activities are reaching in-depth and flexible information when identifying misconceptions in students but it takes a long time and can only diagnose a limited number of misconceptions, open ended test gives students the freedom to answer questions so the students get a lot of time to think and write down their own ideas, however, learners in general are to lazy to write their answers in full sentences and require more time and effort for teachers to evaluate results because students can answer questions broadly (Gurel et al., 2015). Multiple choice and multiple-tier diagnostic tests help teachers to get quick information in identifying misconceptions in learners but these tests provide a great opportunity for students to guess answers, so tests with multiple choice and multiple-tier can reduce test reliability, in addition students are forced to choose available answers (Gurel et al., 2015).

To solve problems in existing diagnostic tests it needs a diagnostic tests that can detect student misconceptions but do not take a long time, easy to evaluate by teachers and do not give students the opportunity to guess answers so that the reliability of the test is not reduced. Structured Essay Diagnostic Test of Chemistry-SEDToC is a diagnostic test form essay developed by Zonalia Fitrizia from previous research by David Treagust that aims to know the extent of students' understanding concepts in science, especially in chemistry subjects. Structured Essay Diagnostic Test of Chemistry is one of the instruments that can be used to detect student misconceptions that contain answers from students more directed and each question requires a limited answer so its easier to analyzed. In addition, the Structured Essay Diagnostic Test of Chemistry (SEDToC) does not take a long time because when identify student misconceptions using this instrument misconceptions can be seen easily from the barriers to understanding students experience from compiled question from and basic and up to more complex concepts, in addition this test does not provide an opportunity for students to guess the answer because the test is an essay (Fitrizia et al., 2020). Structured Essay Diagnostic Test of Chemistry (SEDToC) can identify misconceptions, obstacles to understanding the learning outcomes in students only by conducting one test only, so that the analysis of learning difficulties and remedial programs can be carried out easily, while helping teachers in the implementation of remedial programs as they should be in school. Based on the description above conducted a study entitled Development of Structured Essay Diagnostic Test Of Chemistry (SEDToC) On Acid-Base Material As An Instrument of Analysis of Student Learning Outcomes.

II. METHODOLOGY

The research that will be conducted by researchers is a type of research development or Research and Development (R&D) (Sugiyono, 2011); (Borg, 1983). This development research follows the previous research by (Treagust, 1988) modified by Zonalia Fitrizia (2020). This research conducted in three main stages, (1) Define The Content, (2) Obtaining information about student's misconceptions, (3) developing diagnostic tests. The subjects of the study were three lecturers of chemistry department of FMIPA UNP, two chemistry teachers in senior high school and students of 11th grade of science class at SMA Negeri 12 Padang. The research was conducted on 1-3 July 2021. The object of this research is the Structured Essay Diagnostic Test of Chemistry-SEDToC on Acid-Based material using research instruments in the form of literature study instruments and validation sheets.

The data of the validation sheet is processed by using CVI formula, as follows:

$$CVI = \frac{Ne}{N}$$

III. RESULT AND DISCUSSION

Research model developed by David F. Treagust (1988) modified by Zonalia Fitriza (2020).

1. Definition Content Stage

a. Identify Proportional Knowledge Statements

Identification of knowledge statement of proportionation of Acid-Base material is based on curriculum 2013 revised 2017 on syllabus. concepts of propositional knowledge statements are based on chemistry books, there are six groups of prepare propositional knowledge statements based on the concept of Acid-Bases and their prerequisites. prerequisite concepts related to the concept of Acid-Base are the concept of chemical equilibrium, chemical reactions, stoichiometry, chemical bonds, and atomic structures.

b. Developing concept maps based on proposition knowledge statements

Develop a concept maps based on the proposition knowledge statement that has been made. After analysing the concepts at the identification stage of the Proposition Knowledge Statement then the concept is changed hierarchically from the basic to the most complex concept into the concept map. There are 36 concepts identified in the table of propositional knowledge statements that will be compiled in a hierarchy on the concept map such as lewis acid, lewis base, arrhenius acid, arrhenius base, bronsted lowry acid, bronsted lowry base, strong acid, pH, H^+ , acid valence, strong base, POH, OH^- , base valence, weak acid, K_a , Weak base, K_b , acid indicator base, methyl orange, red methyl, litmus paper, blue bromtimol, phenolftalein, equilibrium law, chemical reaction, equilibrium reaction, ionization reaction, molarity, mole, volume, chemical bond, lewis structure, valence electrons, electron configuration.

c. Linking proposition knowledge statements with concept maps.

Existing concepts are then connected between propositional knowledge and concept maps to ensure all existing concepts are interconnected with each other.

d. Validate the contents

Propositional knowledge and concept map produced is done at this stage. followed by validation from 3 lecturers of chemistry department in FMIPA UNP and 2 teachers in SMAN 12 Padang. The statement of professional knowledge and produced concept map are influenced by the suggestions of the five validators. After validation the data validation sheet calculated with CVI formula and obtained mean I-CVI figures of professional knowledge and concept map of 0.98. The result of I-CVI mean value indicates that the questionnaire of proposition knowledge statement and concept map on acid-base material is valid. The CVI value of an instrument must not be lower than 0.8 (Polit, D. F., & Beck, 2006).

2. Obtaining Information Regarding Student Misconceptions

The resulting SEDToC instruments were also influenced by the results of previous research on students' lack of understanding of acid-base material through ten journals that have been studied. The conclusion of the previous study mentioned that there are still many students who have difficulty in learning acid-base materials. Students' difficulties in acid-base material are considered to stem from many misconceptions of the prerequisite knowledge of acid-base materials such as chemical reactions, chemical equilibrium, stoichiometry, and chemical bonds.

3. Developing Diagnostic Tests

a. Create a problem grid

The results of stages one and two are so important to use at the stage of creating the problem grid. Develop a grid designed to ensure that the development of SEDToC instruments already includes all statement and concept propositions in the concept map.

b. Developing SEDToC instruments

The stage of developing SEDToC in accordance with the curriculum 2013 revised on 2017 syllabus acid-base material and compiled from the basic concept (atomic structure) to the Acid-Base concept. The development stage of the question is based on

the content determination stage and the information obtained related to the misconceptions of students that have been done. The question starts from the basic concept of atomic structure, chemical bonding, stoichiometry, chemical reactions, equilibrium to the most complex concept of acid-base matter.

c. Continuing refinements

At this stage, improvements are made to make sure the overall SEDToC instrument can be used to identify misconceptions, inhibition materials and analysis of learners' learning outcomes in acid base materials. Then the SEDToC test instrument is conducted a test that aims to determine the validity, reliability, index of difficulty and power differences against the SEDToC test instrument.

VALIDITY, RELIABILITY, DIFFICULTY INDEX AND DIFFERENTIATION

The validity, reliability, difficulty index and differentiation of SEDToC need to be tested through the importance all of them to measure and evaluate instruments. Validity test using Guttman scale questionnaire in the form of questions with yes or no answers on the validation sheet. This is chosen so the answer obtained is a valid answer or not the instrument that has been created, so that the validator can only choose one icon "yes" or "no". The SEDToC Reliability Test was determined by Alpha Cronbach to show the instrument had matched the research conducted.

The SEDToC instrument can be valid if it has been checked by all five validators. After validation, the several parts of the instrument of SEDToC needs to be improved such as changes in the number of moles and volume, the change of the word from the original "ionization reaction of the solution" to "ionization reaction from" ; "Acid valence of HCl solution?" becomes "HCl acid valence?" ; and "Degree of ionization (α) of CHCOOH solution" to "Degree of ionization (α) CHCOOH". After two improvements, the validity of the SEDToC instrument is obtained by the mean I-CVI gain 0.98. The I-CVI mean value obtained indicates that the SEDToC instrument in the Base Acid material is valid. The CVI value of an instrument must not be lower than 0.8 (Polit, D. F., & Beck, 2006).

SEDToC that has been validly tested to 20 senior high school students at SMAN 12 Padang to know the reliability, difficulty index and differentiation of SEDToC produced. The results showed the Structured Essay Diagnostic Test of Chemistry (SEDToC) instrument test on Acid-Base material for high school students developed has been valid in content and has a very high reliability of 0.94. Analysis of the difficulty index of SEDToC test instrument was categories as 36 questions with easy categories, 13 questions with medium categories and 10 questions with difficult categories. Analysis in terms of the power of different questions obtained as many as 18 questions with bad categories, 18 questions with enough categories, 20 questions with good categories and 3 questions with very good categories.

Based on the results of the study using Structured Essay Diagnostic Test Of Chemistry (SEDToC) test instruments on acid base material proves that SEDToC test instruments can identify misconceptions, inhibition materials and analysis of learners' learning outcomes in acid base material. From the 20 students who worked on the SEDToC instrument test on Acid-Base material, it is known that students tend to experience misconceptions and are hampered by the concept of stoichiometry and chemical equilibrium, obtained by 7 students achieving scores above the standard point 80 and 13 other students get a score below standard 80.

IV. CONCLUSION

The results showed the Structured Essay Diagnostic Test of Chemistry (SEDToC) test instrument on Acid-Base material for high school students developed has been valid in content, has a very high reliability of 0.94. The difficulty index analysis obtained as many as 36 questions with easy categories, 13 questions with medium categories and 10 questions with difficult categories. Analysis in terms of the power of different questions obtained as many as 18 questions with bad categories, 18 questions with enough categories, 20 questions with good categories and three questions with very good categories. Structured Essay Diagnostic Test of Chemistry (SEDToC) instruments in Acid Base material have been proven to identify misconceptions, inhibition materials and analysis of student learning outcomes at SMAN 12 Padang.

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