

Development of Four-tier Diagnostic Test for Identifying Misconception in Chemical Equilibrium of Students Pharmacy Vocational School

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ABSTRACT

Chemical equilibrium material includes abstract concepts, mathematical calculations, and involves macroscopic, microscopic and symbolic representations. The characteristic of the chemical equilibrium have the potential to cause students to have difficulty understanding the material which can lead to misconceptions. One of the test instruments that is expected to be effective in identifying misconceptions in student is a Four-Tier Diagnostic Test.

This study aimed to develop a Four-tier Diagnostic Test Instrument that can identify misconceptions of chemical equilibrium in student's pharmacy vocational school, know the quality of the developed diagnostic test items and find out informations about the analysis results of the diagnostic test.

This study was a development research by Borg & Gall, 4D (defining, designing, developing, disseminating) with content validation by three validators. The participants of main field testing were 60 grade XI students of pharmacy vocational school. Data collections is to provide four-tier diagnostic test in the form multiple choice with CRI (Certainty of Response Index), observation, interview and questionnaire. It used descriptive quantitative and qualitative.

The result of is that the four-tier multiple choice diagnostic test instrument developed was declared to be feasible and met the criteria as a good problem with average validity of 3,77 and reability of the best 0,80 included in the high category, discriminating power of the items composed 8 good questions and 12 enough questions and the difficulty test items composed 18 good questions and 2 difficult questions. There are many misconceptiond from chemical equilibrium developed.

This research only developed Four-tier diagnostic test in the cognitive. The next researcher can be combine in the cognitive and afektif. Four-tier diagnostic test is able to identify misconceptions of chemical equilibrium.

Keyword: Four-tier diagnostic test, misconception, chemical equilibrium

INTRODUCTION

Learning is a process of interaction that occurs between students, teachers and their environment so that a change in behavior occurs for the better. According to Djahiri (kunandar, 2013) in the learning process the main principle that must be implemented is the process of involving all or most of the students' potential (physical and non-physical) and its meaning for themselves and their lives in the future.

In learning there is a student learning process. Piaget stated that learning is a process of constructing (forming) knowledge by students from their experiences, which takes place continuously, so that students will reconstruct their knowledge until students gain a new understanding of an object (Siregar, 2010). Therefore, before

entering formal education, each student has different experiences and thought patterns, so they can form different pre-concepts.

One concept that has a big influence in hindering the achievement of chemistry learning achievement is the existence of chemistry misconceptions within students. Misconceptions can be defined as students' conceptions that do not match the scientists' conceptions. These conceptual errors are because students develop their own understanding based on what they see and hear, to understand a concept they are learning. Without them realizing that the concept they believe in is actually wrong (Suparno, 2013).

Misconceptions that occur not only have an impact on the concept being studied, but can also influence the concepts that will be studied afterwards. Because, the concepts in chemistry are interrelated with each other, if misconceptions are not identified as soon as possible, then the misconceptions will continue to a higher level of education and it will be increasingly difficult to overcome them. It is important for teachers to know or identify misconceptions experienced by students from an early age so that misconceptions do not continue to other concepts (Khamilah, 2016).

The difficulty of students in learning chemistry is due to the fact that chemistry has special characteristics, including that most of it contains chemical concepts which are always abstract, its nature is sequential and develops quickly, it does not just contain solving tests and very many chemical concepts. with different characteristics for each topic (Middlecamp & Kean, 1985: 5-9). In line with this, Ozmen (2004: 148) revealed that the abstract concept of chemistry and the use of several chemical terms that have different meanings from everyday life terms cause chemistry to be considered difficult by students.

According to Salirawati (2010: 5) one of the main abstract topics in chemistry which often causes misconceptions among students is chemical equilibrium. This material is one of the main chemical materials studied in SMA/SMK class XI semester I. This material contains (1) dynamic equilibrium, (2) heterogeneous equilibrium and homogeneous equilibrium, (3) equilibrium constants, (4) equilibrium shifts, (5) quantitative relationships between components in equilibrium reactions and (6) chemical equilibrium in industry. The main material of chemical equilibrium requires a deep understanding of concepts and the application of concepts to solve calculation problems. This problem is what causes misconceptions to arise among students, because students sometimes find it difficult to link abstract concepts with the numbers in chemical equilibrium material calculations.

Based on the results of field observations, class Especially in chemical equilibrium material, this material is considered difficult by some students because it has many symbols and formulas in the sub-topics. From the facts in the field, the level of completion in chemical equilibrium material is only 40% and 60% of students do not complete it. This shows that students do not understand the material about equilibrium. Then the learning situation at Pharmacy Vocational Schools sometimes still uses the lecture method, so that students tend to get bored and bored when they are in class following lessons. These conditions can create misconceptions among students. For this reason, it is necessary to have a test instrument that can measure students' level of understanding, so that by detecting misunderstandings and misconceptions in students, teachers can find solutions to minimize these misunderstandings and misconceptions.

This four-level multiple choice diagnostic test combined with the certainty of response index (CRI) method which has been developed by Hasan (1999: 294-299) is used to identify misconceptions experienced by students, which is a measure of the

respondent's level of confidence/certainty in answering every question asked. The four-level multiple choice diagnostic test is a development of the three-level multiple choice diagnostic test combined with the certainty of response index (CRI) on the reasons for the answers, so that the level of confidence in the answers and reasons is more accurate (Ismiara, 2015). The advantage of a four-tier multiple choice diagnostic test is that through a four-tier multiple choice diagnostic test, teachers can differentiate between the level of confidence in the answers and the level of confidence in the reasons chosen by students so they can dig deeper into the strength of their understanding. students' concepts, diagnose deeper misconceptions and plan better learning to help reduce students' misconceptions (Qisti, 2015).

METHOD

This type of research is development research (Research and Development), which is used to produce certain products or ionize products (Sugiyono, 2015). The product developed in this research is a four-tier multiple choice diagnostic test instrument which is able to reveal students' understanding of Chemical Equilibrium material.

The following are the stages of development research using the 4-D model (Thiagarajan, et al., 1974): 1. Define Stage The aim of this stage is to determine and define learning needs by analyzing the objectives and limitations of the material.

- a. The definition stages consist of:
 - 1) Needs Analysis Needs analysis aims to determine the basic problems faced in learning. This analysis will be carried out by conducting interviews with Chemistry teachers at Samarinda Pharmacy Vocational School, documenting students' grades, literacy studies related to the preparation of four-tier multiple choice diagnostic test instruments, and literacy studies related to Equilibrium material. Chemistry.
 - 2) Concept Analysis Concept analysis was carried out to analyze competency standards and basic competencies, as well as analyze learning resources on Chemical Equilibrium material.
- b. Design Stage Activities at this stage include:
 - 1) Format Selection: This stage is the selection of the diagnostic test format. The format used is a diagnostic test with a four-level multiple choice type with closed reasons.
 - 2) Initial Design: This stage is the initial design of the diagnostic test instrument. The instrument consists of a draft test question grid, 20 test questions, scoring guidelines, and results interpretation guidelines.
- c. Development Stage (Develop) This stage aims to produce a draft of a four-tier multiple choice diagnostic test instrument which functions to identify students' misconceptions about Chemical Equilibrium material. Activities at this stage include:
 - 1) Preparation of Draft I
 - a) A grid of four tier multiple choice diagnostic test questions on chemical equilibrium material.

The four-tier multiple choice diagnostic test question grid is made based on the 2013 Revised KI and KD Curriculum and syllabus, question indicators, question level categories consisting of C1 – C4, and the number of questions is 20 questions.
 - b) Four-tier multiple choice diagnostic test questions on chemical equilibrium material

Creation of a four-tier multiple choice diagnostic test question instrument based on the syllabus, KI and KD of the revised 2013 curriculum on chemical equilibrium material.

c) Answer key

Creating an answer key containing the question number, answer choices and correct reason choices

2) Validator Assessment

The test instrument design that has been prepared in draft I is then validated by the validator. Suggestions from validators were used as material to revise draft I so that a draft II diagnostic test instrument was produced.

3) Limited Scale Trial

In this case, the researcher tested the product on research subjects, namely class XI Pharmacy students. The initial field trial, which is usually called the Preliminary Field Test and Revision, is a trial intended to test the readability of the question instrument product. This stage is a small-scale trial that requires 12 class XI Pharmacy students at the Samarinda Pharmacy Vocational School. In this step, students are given valid questions. This trial was carried out to determine the weaknesses and deficiencies in the question instrument by analyzing reliability, level of difficulty, and differential power as well as by providing a questionnaire on students' responses to the question instrument. The answers from the limited scale trial were used as material to revise draft II to produce a draft III diagnostic test instrument.

4) Wide Scale Trial

The draft II diagnostic test instrument which had been revised into draft III was then tested on 60 Samarinda Pharmacy Vocational School students. The results of wide-scale trials will be used as material to identify misconceptions that occur among students, then if there are deficiencies in draft III it will be revised again so that a draft IV diagnostic test instrument (finished product) is produced.

This research was carried out at the Samarinda Pharmacy Vocational School, Jl. Athlete at Pon Perum Bumi Usaha Kencana (BPK) Kec. Loajan Ilir Samarinda City. This research took place in the even semester of the 2019/2020 academic year. The research implementation phase was carried out in October – November 2019. The limited scale trial subjects were students in class XI Pharmacy, consisting of 12 students. The subjects of the wide-scale trial were students in classes XI-A and XI-B Nursing, consisting of 60 students.

The data collection techniques in this development research are: interviews, tests, questionnaires and documentation, while the data analysis techniques are in the form of validity tests, reliability tests, analysis of the level of difficulty of questions, distinguishing power and analysis of the instruments created.

RESULT AND DISCUSSION

Result

Based on the results of teacher interviews and field observations, it was found that there were problems in the Chemical Equilibrium material where the percentage of students not completing it reached 60%, so it was necessary to carry out a diagnostic assessment to see the problems that caused many students not to achieve completeness in this material.

The diagnostic assessment tool developed consists of: question indicators, question grid, work instructions, and a four-level diagnostic test instrument. The four-

tier diagnostic test instrument includes four levels, namely: the first level is conceptual questions with 5 answer choices, the second level is CRI for the answer choices, the third level is an explanation of the choice of answers to the questions and the fourth level is CRI for the reasons for the answers chosen. .

Expert validation analysis showed that the instrument developed was suitable for use with minor revisions. After the instrument is validated, a limited scale test is carried out. The limited scale test was carried out on 12 students as test samples with a test instrument consisting of a validity test, reliability test, distinguishing power and difficulty level of question items. The limited scale test results of the four-level diagnostic test instrument device are in table 1.1 as follows :

Table 1.1 Recapitulation of Limited Scale Diagnostic Test Analysis

Number of Question	Analysis of question items			
	Validity	Difficulty Level	Different Power	Result
1	Valid	Currently	Poor	Used
2	Valid	Currently	Enough	Used
3	Valid	Currently	Enough	Used
4	Valid	Currently	Enough	Used
5	Valid	Currently	Bad	Used
6	Valid	Currently	Bad	Used
7	Valid	Currently	Enough	Used
8	Valid	Hard	Bad	Used
9	Valid	Currently	Enough	Used
10	Valid	Currently	Good	Used
11	Valid	Currently	Bad	Used
12	Valid	Currently	Bad	Used
13	Valid	Currently	Enough	Used
14	Valid	Hard	Enough	Used
15	Valid	Currently	Enough	Used
16	Valid	Hard	Enough	Used
17	Valid	Currently	Good	Used
18	Valid	Currently	Enough	Used
19	Valid	Currently	Good	Used
20	Valid	Currently	Poor	Used

Through the Draft III diagnostic test instrument (finished product), students' final scores and misconceptions experienced by students can be identified.

Discussion

Based on the results of recapitulation of misconceptions experienced by each student. There were 16 students experiencing low misconceptions, 39 students experiencing moderate misconceptions and 5 students experiencing high misconceptions. Based on this data, the students of the Samarinda Pharmacy Vocational School experienced moderate misconceptions.

Based on the results of the recapitulation of misconceptions per question item, there was 1 question item in the high misconception category, 18 question items in the

medium misconception category and 1 question item in the low category. The results of the recapitulation can be seen in the following table :

Table 1.2 Percentage of misconception categories per question item

Number of Question	P		TPK		Mi		Me	
	Σ	%	Σ	%	Σ	%	Σ	%
1	12	20	5	8.33	30	50	13	21.67
2	22	36.67	10	16.66	22	36.67	6	10
3	13	21.67	11	18.33	27	45	9	15
4	22	36.67	6	10	21	35	11	18.33
5	7	11.67	8	13.33	43	71.67	2	3.33
6	7	11.67	8	13.33	37	61.67	8	13.33
7	22	36.67	7	11.67	26	43.33	5	8.33
8	28	46.67	7	11.67	23	38.33	2	3.33
9	25	41.67	7	11.67	24	40	4	6.66
10	27	45	5	8.33	22	36.67	6	10
11	25	41.66	7	11.67	21	35	7	11.67
12	12	20	15	25	23	38.33	10	16.67
13	20	33.33	5	16.67	31	51.67	4	6.66
14	11	18.33	8	13.33	35	58.33	6	10
15	13	21.67	21	35	24	40	2	3.33
16	20	33.33	6	10	23	38.33	11	18.33
17	24	40	8	13.33	16	26.67	12	20
18	13	21.67	9	15	33	55	5	8.33
19	15	25	12	20	23	38.33	10	16.67
20	15	25	6	10	28	46.67	12	20

Based on the results of field tests given to identify students' understanding of the concept, it is known that the percentage of students who understand the concept is 29.42% or 18 students, the percentage of students who do not understand the concept is 14.25% or 9 students, the percentage of students who do not understand the concept is 14.25% or 9 students. experiencing misconceptions was 32.42% or 19 students and the percentage of students who guessed the answer was 23.91% or 14 students.

The test results show that the four tier multiple choice developed can be a reference in identifying students' conceptual understanding. It can be seen that several students were identified as understanding the concept, not understanding the concept, experiencing misconceptions and guessing the answer. This is in line with Kaltkci who believes that the four tier multiple choice assessment instrument is more accurate in detecting the level of students' understanding of a concept and the data obtained is in accordance with the facts.

CONCLUSION

Based on the results of research regarding the development of a four-tier multiple choice test instrument to determine students' conceptual understanding, it can be concluded as follows:

1. The results of the concept understanding test at the Samarinda Pharmacy Vocational School with a sample of 60 students were obtained with various concepts. Based on the results of field tests given to identify students' understanding of the concept, it is

known that the percentage of students who understand the concept is 29.42% or 18 students, the percentage of students who do not understand the concept is 14.67% or 9 students, The percentage of students who experienced misconceptions was 44.3% or 27 students and the percentage of students who guessed the answer was 12% or 7 students.

2. Based on the analysis of the four-tier multiple choice diagnostic test, it is known that there are 13 students who experience high misconceptions, 31 students who experience moderate misconceptions and 16 students who experience moderate misconceptions.
3. Based on the sub-concept of chemical equilibrium material, there are findings of misconceptions in class XI students of Samarinda Pharmacy Vocational School with misconceptions in the medium category.
4. Based on the findings, the causes of students' misconceptions are as follows:
 - Wrong preconceptions are characterized by students' assumptions about the similarity of compounds in homogeneous equilibrium.
 - Students' associative thinking assumes that the equilibrium constant formula is products divided by reactants.
 - Incorrect reasoning is indicated by an error in interpreting the sign [] in the concept of equilibrium.
 - The use of verbal language in teachers is too high.
 - The teacher's vocals are too small.
 - Teacher explanation confusion.

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