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Design of Five-Tier Diagnostic Test for Misconception Identification on Stoichiometry Topic

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Abstract: Misconception is a crucial case to be researched. Many high school students experience difficulties in understanding stoichiometry material in terms of the results of the final semester exams. Diagnostic tests are a measuring tool that can help teachers identify misconceptions and help students overcome these weaknesses appropriately. This study aims to develop a five-tier diagnostic test instrument to analyze students' misconceptions about stoichiometry. This type of research uses a Research and Development (RnD) approach. The research model used is 3D. The content validity of the five-tier diagnostic test was assessed from the five validators who were declared valid. The data was obtained from the assessment of the validation sheet of 5 expert validators by obtaining an average coefficient of V of 0.876 using Aiken's V. The test instrument was tested on 28 students of SMA Simanjaya class XI. The results of the analysis of the empirical validity data of the five tier diagnostic test show that 15 out of 25 questions are valid and have high reliability.

Keywords: diagnostic tests, five tier, stoichiometry

Abstrak: *Miskonsepsi menjadi kasus yang krusial untuk diteliti. Banyak siswa SMA mengalami kesulitan dalam memahami materi stoikiometri ditinjau dari hasil ujian akhir semester. Tes diagnostik menjadi salah satu alat ukur yang dapat membantu guru dalam mengidentifikasi adanya miskonsepsi dan membantu siswa mengatasi kelemahan tersebut dengan tepat. Penelitian ini bertujuan untuk mengembangkan instrumen tes diagnostik five tier untuk menganalisis miskonsepsi siswa pada materi stoikiometri. Jenis penelitian ini menggunakan pendekatan Research and Development (RnD). Model penelitian yang digunakan yaitu 3D. Validitas isi tes diagnostik five tier dinilai dari lima validator dinyatakan valid. Data diperoleh dari penilaian lembar validasi 5 validator ahli dengan memperoleh rata-rata koefisien V sebesar 0,876 menggunakan Aiken's V. Instrumen tes diuji cobakan kepada 28 siswa SMA Simanjaya kelas XI. Hasil analisis data validitas empiris tes diagnostik five tier diCategoryahui 15 dari 25 soal valid dan memiliki reliabilitas yang High.*

Kata kunci: *five tier, stoikiometri, tes diagnostik*

▪ INTRODUCTION

Every individual has different intelligence, there are some who have strong memory, quick understanding, and some who have good reasoning abilities (Suralaga, 2021). Students' understanding of a certain concept is called conception (Dewi & Ibrahim, 2019). Understanding the concept is a requirement for students to know the correct concept and answer students correctly. Students who do not understand the concept are when students give wrong or correct answers, but they do not understand the actual concept. Misunderstanding occurs when a student answers incorrectly with the wrong concept, but believes it is the correct concept. Concept discrepancies have an impact on conceptual understanding which is called the word misconception (Ramadany, 2020).

Concept incompatibility arises because the concept of chemistry is abstract and also requires abstract thinking (Ade Monita & Suharto, 2016). Misconception is a crucial case to be researched. Misconceptions in A'yun & Suyono (2020) study are related to cognitive levels. Students who have a high cognitive level, do not necessarily experience misconceptions because students are not able to connect representations of chemical understanding. Stoichiometry is one of the chemical materials that is considered difficult as a basic material and requires an analysis of chemical calculations, so it requires a correct understanding of the concept (Anugrah, 2019).

Research that has been done regarding misconceptions is proven in the study of Lestari et al. (2021) found that 44.6% of students misunderstood the concept of stoichiometry. It has been proven that the application in the calculation of relative molecular mass does not pay attention to the number of atoms, resulting in students' perceptions that relative atomic mass is the same as relative molecular mass and it is known that there is a 65% misconception in the concept of basic chemical laws. One of the factors causing student misconceptions is the lack of interest and courage to ask questions.

Student success in learning can be known through learning activities as a directed process to achieve learning goals through actions or experiences created by learning assessment (Zamzania & Aristia, 2018). One of the ways to find out the level of success of student learning is through tests. A diagnostic test is a test to determine student learning weaknesses which can be in the form of a series of questions or doing something (Rusilowati, 2015). The diagnostic test used is multiple choice because of the ease of processing and evaluating the subject (Zein & Miterianifa, 2016).

One-tier diagnostic tests or multiple-choice tests generally develop into a two-tier diagnostic test that contains students' beliefs in choosing the answers to questions. Furthermore, a three-level diagnostic test involves students' reasoning in choosing answers at the first level. The four tier diagnostic test contains the level of students' confidence in the reasons at the third level. The five-level diagnostic test is a development of the four-level diagnostic test. Five tier, namely the addition of one level of open questions to see student understanding through drawing tests (drawing), drawing conclusions or sources used by students when answering questions. Bearing in mind that the features of each question on the diagnostic test format vary additionally and confirmation is required.

Based on the reviews above, this study was conducted to determine the feasibility of a five-level diagnostic test instrument in terms of validation and reliability.

▪ METHOD

This research used a Research and Development (RnD) research approach. The type of Research and Development research used is the 4D (four D) model consisting of four stages, including: define, design, develop, and disseminate (Thiagarajan, Semmel, & Semmel, 1974). This research was only carried out up to the develop stage because the aim of this research was to determine the feasibility of a product in the form of a five tier diagnostic test.

The research was conducted at SMA 1 Simanjaya. The research subjects were conducted in class XI MIPA 2 students as many as 28 students. Methods of data collection is done by conducting interviews, questionnaires, and documentation. The data analysis performed was validity and reliability. The validity carried out includes content validity and empirical validity. Content validation testing was carried out by five experts. Content validation uses the Aiken's V coefficient formula which is presented through the following equation (Lewis R. Aiken, 1985):

$$v = \frac{\sum s}{[n(C-1)]}$$

$$s = r - lo$$

The test instrument can be said to be valid if the coefficient v count > 0.80.

Empirical validation and reliability testing was carried out by research subjects. Empirical validation test uses the product moment formula which is presented through the following equation (Zein & Miterianifa, 2016):

$$r_{xy} = \frac{N\sum XY - (\sum X)(\sum Y)}{\sqrt{(N\sum X^2 - (\sum X)^2)(N\sum Y^2 - (\sum Y)^2)}}$$

The test instrument can be said to have good validity if r count > r table.

Reliability testing uses the Cronbach's alpha formula which is presented through the following equation (Zein & Miterianifa, 2016):

$$r_{11} = \frac{k}{k-1}\left(1 - \frac{\sum SB1^2}{SBt^2}\right)$$

The test instrument can be said to have good reliability if r count > r table.

▪ RESULT AND DISCUSSION

This research is a research with a Research and Development (R&D) type approach using a 4D model but is carried out only to develop. The first stage is the define stage. In the define stage, information is collected to analyze the needs of the problem by means of interviews.

The results of interviews with chemistry teachers at SMA 1 Simanjaya, namely information obtained about the methods used in learning using the lecture method. SMA 1 Simanjaya uses the 2013 curriculum and the independent curriculum with a block system. Based on the results of the end of semester exams it is known that out of 45 students only 6 students passed based on the Material Completeness Criteria (KKM). The KKM set for chemistry is 70. The results of interviews with several students stated that they had difficulty understanding chemistry material so they had no interest in studying chemistry material more deeply.

Lack of student interest in learning is also one of the causes of misconceptions about the initial concept (Yuliati, 2017). According to Nurulwati *et al.,* (2014) misconceptions are also caused by the teaching method in understanding concepts using only one method, in this study, namely the lecture method. Based on the potential and problems, it is necessary to develop diagnostic test products.

The design stage is carried out by designing the product. The product design is carried out by making a five tier diagnostic test product. The five tier test developed is in the form of multiple choice with five levels. The questions to be made refer to the

curriculum used, namely the 2013 curriculum and the independent curriculum, the basic competencies used follow the basic competencies in the 2013 curriculum.

The develop stage produces an instrument product which is developed in the form of 25 five tier questions which are equipped with the creation of a grid, instructions for

Kisi-Kisi Lembar Instrumen Soal *Five Tier* Diagnostik Tes

Mata pelajaran: kimia
Materi : hukum-hukum dasar kimia dan stoikiometri
Kelas : X
Kurikulum : Merdeka
Tahun : 2022/2023
Kompetensi dasar:
3.10 Menerapkan hukum-hukum dasar kimia, konsep massa molekul relatif, persamaan kimia konsep mol, dan kadar zat untuk menyelesaikan perhitungan kimia.
4.10 Mengolah data terkait hukum-hukum dasar kimia, konsep massa molekul relatif, persamaan kimia konsep mol, dan kadar zat untuk menyelesaikan perhitungan kimia

Indikator pembelajaran	Indikator soal	Level kognitif	No. soal	Rancangan soal	Jawaban tier		
					I	III	V
Menerapkan konsephukum Dalton untuk menyelesaikan perhitungan kimia	Diberikan data massamasing-masing reaksi senyawa, diharapkan siswa dapat menentukan perbandingan massa dalam senyawa tersebut	C3	4	Suatu unsur A dan B bereaksi membentuk dua senyawa. Senyawapertama 1,5 gram A bereaksi dengan 1,8 gram B, sedangkan senyawa kedua 0,5 gram A bereaksidengan 0,3 gram B. Jika pada kedua senyawa massa unsur B sama maka perbandingan massa unsur A dalam kedua senyawa tersebut adalah... a. 1:1 b. 2:1 c. 1:2 d. 1:4 e. 4:1 Alasan yang tepat untuk jawaban anda adalah..... a. Perbandingan massa unsur memiliki perbandingan bulat dan sederhana b. Perbandingan massa unsur A selalu lebih besar dari massa unsur B c. Perbandingan massa unsur tidak selalu tetap d. Perbandingan massa unsur A sama dengan massa unsur B e. Perbandingan massa unsur B selalu lebih besar dari massa unsur A Konsep yang berkaitan sesuai pada pertanyaan di atas dan cara anda dalam menyelesaikan soal di atas adalah...	C	A	Konsep hukum Dalton massa unsur ditentukan dari perbandingan massa unsur tertentu dengan massa unsur yang lain pada senyawa I unsur A dikalikan 1 dan pada senyawa II dikalikan 6 $1{,}5 \times 1 : 0{,}5 \times 6$ 1,5 : 3 1 : 2

working on the questions, five tier questions, answer keys, and scoring guidelines. The grid questions that have been made are presented in Figure 1.

Figure 1 The grid of item number 4

The develop stage is also carried out in two steps (Thiagarajan, Semmel, & Semmel, 1974), namely expert appraisal and developmental testing. Expert appraisal is an evaluation and evaluation step for a product. while developmental testing is carried out on a small scale trial.

Expert appraisal is carried out by evaluating tests by asking for validation from expert validators. Expert validators are three UIN Walisongi lecturers and two high school chemistry teachers. Content validation analysis data was obtained from the results of the assessment of 5 expert validators through validation sheets. Product validation is done by asking for expert opinion regarding the feasibility of the instrument by providing a questionnaire in the form of a validation sheet. Items can be said to be valid if the value of V≥0.80 with 5 Averages is based on an error level of 5%. The results of the content validation test are shown in Table 1.

Table 1 Results of content validation test analysis

Question	Average					V	Category
	1	2	3	4	5		
1	21	23	23	24	22	0.88	High
2	21	23	23	24	23	0.89	High
3	21	23	23	25	23	0.9	High
4	21	23	20	25	21	0.85	High
5	21	21	22	25	23	0.87	High
6	21	23	22	25	23	0.89	High
7	21	23	23	24	23	0.89	High
8	21	23	23	25	22	0.89	High

Question	Average					V	Category
	1	2	3	4	5		
9	21	23	23	20	24	0.86	High
10	21	23	23	25	23	0.9	High
11	21	23	23	25	23	0.89	High
12	21	23	23	25	21	0.87	High
13	21	23	22	20	24	0.84	High
14	21	23	23	24	22	0.87	High
15	21	23	23	25	22	0.88	High
16	21	23	23	25	23	0.89	High
17	21	23	23	25	23	0.89	High
18	21	23	22	21	22	0.83	High
19	21	23	23	25	23	0.89	High
20	21	23	23	20	23	0.84	High
21	21	23	23	25	22	0.88	High
22	21	23	23	25	22	0.88	High
23	21	22	23	24	24	0.88	High
24	21	23	23	25	23	0.89	High
25	21	23	22	24	22	0.86	High
Rata-Rata						0.876	

Developmental testing for collecting assessment data on the questions being developed. Results of trials to obtain empirical validation data and reliability. Empirical validation test is used to measure the validity of the test based on field observations. The instrument is said to be valid if r count>r table. R count of 0.374 with 28 students as research subjects if the error rate is 5%. Based on the results of the empirical validation analysis test, 15 of the 25 valid questions were obtained which are presented in Table 2.

Table 2 Results of empirical validation test analysis

Question	r count	r count	criteria
1	0,37		invalid
2	0,62		valid
3	0,57		valid
4	0,50		valid
5	0,19		invalid
6	0,44		valid
7	0,37		invalid
8	0,33	0,374	invalid
9	0,50		valid
10	0,45		valid
11	0,28		invalid
12	0,41		valid
13	0,58		valid
14	0,14		invalid
15	0,10		invalid

4.1 Suatu unsur A dan B bereaksi membentuk dua senyawa. Senyawa pertama 1,5 gram A bereaksi dengan 1,8 gram B, sedangkan senyawa kedua 0,5 gram A bereaksi dengan 0,3 gram B. Jika pada kedua senyawa massa unsur B sama maka perbandingan massa unsur A dalam kedua senyawa tersebut adalah...
a. 1:1
b. 2:1
c. 1:2
d. 1:4
e. 4:1

4.2 Apakah anda yakin dengan jawaban anda?
o Yakin
o Tidak yakin

4.3 Alasan yang tepat untuk jawaban anda adalah...
a. Perbandingan massa unsur memiliki perbandingan bulat dan sederhana
b. Perbandingan massa unsur A selalu lebih besar dari massa unsur B
c. Perbandingan massa unsur tidak selalu tetap
d. Perbandingan massa unsur A sama dengan massa unsur B
e. Perbandingan massa unsur selalu tetap

4.4 Apakah anda yakin dengan jawaban anda?
o Yakin
o Tidak yakin

4.5 Konsep yang berkaitan sesuai pada pertanyaan di atas dan cara anda dalam menyelesaikan soal di atas adalah...

Question	r count	r count	criteria
16	0,55		valid
17	0,54		valid
18	0,14		invalid
19	0,60		valid
20	0,55		valid
21	0,37		invalid
22	0,71		valid
23	0,39		valid
24	0,31		invalid
25	0,41		valid

Reliability is carried out to determine the validity or accuracy of a question (Zein & Miterianifa, 2016). Reliability testing uses the Cornbach's alpha formula and a result of 0.8 is obtained which indicates that the product has high validity, so the test instrument is suitable for use (Sari & Nada, 2022). The example of question number 4 which has the validity and validity of the questions is presented in Figure 2.

Figure 2 Five tier test questions number 4

▪ CONCLUSION

Based on the results of the research and discussion, it can be concluded that the development of a five-tier test instrument on stoichiometry material means that 15 out of 25 multiple choice questions are declared feasible with the following details:
Content validation obtained an average validation value of 0.876 from the assessment of the five validators including very valid criteria for each item. The results of the analysis of small-scale trial data obtained empirical validity obtained 15 out of 25 questions declared valid based on r count > r table using the product moment formula with r table 3.74 if N is 28. Reliability of the items obtained from the results of r count 0.8 > r table used 0.70, which is stated to have good question reliability.

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