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DEVELOPMENT INSTRUMENTS OF LEARNING CHEMISTRY BASED ON ANALOGY TO HIGHER ORDER THINGKING SKILLS ON SENIOR HIGH SCHOOL STUDENT IN CHEMICAL BOND

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Abstract:
The objectives of research are to develop and to determine the validity of the instrument by testing the test of students who have studied chemical bonding material. Test of empirical validity was analyzed using the Rasch model. Decision making based on MNSQ Infit and MNSQ Outfit values. The instrument test consists of 20 questions in the form of a description given to 116 students who are outside the study sample. The results showed that there were 18 valid questions and 2 invalid questions. The invalid question is declared not suitable to be used for the purpose of further analysis.

Keywords: validity, Rasch model, chemical bond

1. Introduction

Chemistry is one of the subjects that many have difficulty in learning with students at school. In general, in studying chemistry, there are three aspects that must be considered, namely macroscopic, submicroscopic and symbolic (Johnstone, 2000). At the microscopic and symbolic level it is an abstract level because it is not seen (Demircioglu & Demircioglu, 2013). Macroscopic representation is a chemical representation obtained through real observation of a phenomenon that can be seen and felt by the five senses or in the form of daily experience. Microscopic representation, which is a chemical representation that explains the structure and processes at the particle level (atoms / molecules) of the macroscopic phenomena observed. Symbolic representation is a representation of qualitative and quantitative chemistry such as

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chemical formulas, diagrams, drawings, reaction equations, stoichiometry and mathematical calculations (Johnstone, 1993). All of these concepts must be integrated with each other so that the learning objectives can be achieved. To support quality learning, an assessment instrument is needed to measure what will be measured so that it can assess students' high-level thinking skills.

2. Literature Review

As a benchmark for learning achievement, various authentic tasks must have a good level of validity so that information about students obtained from the implementation of measurements can be used properly (Nurgiyantoro, 2008: 133) Validity means measuring something to be measured. There are many types of validity that can be used to assess evaluation tools, but not necessarily all of them are met for a test tool. Validity explains how well the data collected to cover the area used for research / investigation (Ghauri and Gronhaug, 2005).

The main feature of the Rasch model is a table of probability responses to items. The probability of success depends on the difference between people's abilities and the difficulty of the item (Bond and Fox, 2015: 10). Bond and Fox (2015: 32-37) state that there are several assumptions that must be considered, namely dimensions, item fit, and ability (person and item). Rasch modeling is an analysis model used in this study, which serves to analyze the difficulty of the items in each cognitive domain.

The concept of fit is a quality mechanism that indicates that the quality of the instruments prepared is adequate. This is also used to assess the meaning of unidimensional constructs, meaning that the fit index helps researchers ensure that the Rasch requirements for the dimensions apply empirically. According to Booena, Staver, and Yale (2014: 166-173) the value of the criteria used to check the suitability of items is as follows.

a) The value of the MNSQ Outfit received: 0.5 <MNSQ <1.5
b) The value of the ZSTD Outfit received: -2.0 <ZSTD <+2.0
c) Value Point Measure Correlation (Pt Mean Corr): 0.4 <Pt Measure Corr <0.85

Based on the explanation, the purpose of this study is to determine the validity of the instrument by testing the test of students who have studied chemical bonding material. To support quality learning, assessment instruments are needed to measure what will be measured so that students can find out the knowledge in the material being studied.

3. Material and Methods

This research was conducted at the High School Science (Natural Sciences) in class XI which consisted of 4 classes with a total of 116 students. Instrument to measure students' high level thinking skills using data analysis results on chemical bonding material in the form of descriptions containing cognitive levels C4, C5 and C6. The

instrument is validated with empirical validity. The instrument consisting of 20 questions was tested on 116 students who were outside the study sample.

Table 1: Grid of Instruments for Higher Level Thinking Skills

Content	Indicators of Content	Indicators of HOTS								Number of Question
		C4			C5		C6			
		a*	b*	c*	d*	e*	f*	g*	h*	
Element stability, Lewis symbol and Ion bond	Explain the tendency of an element to achieve stability	1, 2, 3								2
	Describing valence electron arrangements of noble gas atoms (duplets and octets) and valence electrons not noble gases (Lewis structures)						4			4
	Explain the process of forming Ion bonds	5, 6								6
	Determine the relationship of ion bonds with the properties of ion compounds	7, 8								8
Covalent Bonds and Coordination bonds	Describes the process of forming a single covalent bond, double and triple	9, 10, 11, 12								11
	Explain the formation of covalent bonds of coordination in several compounds				13, 14, 15					13
	Explain the process of forming metal bonds and their relationship to the physical properties of metals.	16, 17, 18, 19, 20								20

Description: a). Differentiating, b). Organizing, c). Attributing, d). Checking, e). Critiquing, f). Generating, g). Planning, h). Producing

In this study empirical validation was carried out using the Rasch model with Winstep software. According to Booena, Staver, & Yale (2014), the criteria for validity are MNSQ Outfit: 0.5 <MNSQ <1.5; ZSTD Outfit accepted: -2.0 <ZSTD <+2.0; Pt Mean Corr: 0.4 <Pt Measure Corr <0.85. Based on the criteria, items number 2, 6, 8, 9, 15, and 22 are not appropriate.

4. Results and Discussion

The Winstep program that is open in this analysis can be seen in the Fit Order Item output table as shown in Table 2.

Table 2: Item Fit

Number of question	Value of *Outfit*		
	MNSQ	ZSTD	Pt-Measure Corr
17	3,42	6,1	-0,37
3	1,83	1,6	0,04
8	1,42	3,1	0,31
12	1,12	1,0	0,60
10	0,93	-0,4	0,53
15	0,99	0,0	0,49
16	1,12	0,7	0,14
11	0,92	-0,3	0,50
18	0,83	-0,8	0,63
4	0,74	-1,1	0,53
19	0,94	-0,4	0,71
13	0,86	-0,9	0,46
9	0,88	-0,8	0,50
6	0,85	-0,9	0,40
20	0,80	-0,6	-0,08
1	0,60	-0,1	0,10
7	0,75	-1,6	0,42
5	0,65	-2,7	0,68
2	0,64	-2,6	0,50
14	0,64	-3,6	0,47

Based on the results of the analysis in Table 3, the questions that are not fit are found in items number 17 and 3. This is because in question number 17 there are three criteria that are not fulfilled, namely the criteria for MNSQ outfit, ZSTD outfit, and pt-measure corr. Whereas for question number 3 there are two criteria that are not fulfilled, namely the criteria for MNSQ outfit and criteria for pt-measure corr.

Items number 8, 12, 10, 15, 16, 11, 18, 4, 19, 13, 9, 6, 20, 1, 7, 5, 2, and 14 in the criteria for pt-measure corr appear not to be fulfilled, but the question can still be used because it still meets two other criteria. Questions categorized as fit with a model of at least two criteria must be fulfilled (Sumintono and Widhiarso, 2015: 72). So that from 20 questions with 116 respondents, there are 2 invalid questions and 18 questions that are declared valid. The invalid question was declared not feasible to use for analysis purposes in this study.

Summary of item numbers valid and invalid questions can be seen in Table 3.

Table 3: Valid and Invalid Question Numbers

Valid Question Number	Invalid Problem Number
8, 12, 10, 15,16, 11, 18, 4, 19, 13, 9, 6, 20, 1, 7, 5, 2, dan 14	17 dan 3

5. Recommendations

Research instruments that are good but valid must also have good reliability. The suggestions for future researchers are to be able to pay attention to the level of reliability of good and correct research instruments.

6. Conclusion

Based on the results of the analysis and discussion, it can be concluded that the validity of the analogy-based chemical learning instrument for analyzing high-level thinking skills in chemical bonding material can be used properly according to the valid and invalid criteria of a problem used. In this study, validity as a significant research instrument for review. The purpose of validity is to improve the skills and knowledge of test validity to students. So the conclusion is that valid questions have 18 questions and those that are invalid are 2 questions.

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Gusti Arisandi is a student of Master of Education in Chemistry, Graduate School, Yogyakarta State University, Indonesia. His interest as a researcher is about the validity of analogy-based chemistry learning instruments to analyze students' high-level thinking skills in chemical bonding material.

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