

## Development of Minimum Competency Assessment (AKM) on Chemical Materials

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### Abstract

This study aims to produce a Minimum Competency Assessment (AKM) instrument on quality reaction rate material in terms of reliability, distinguishing power, validity, and difficulty level. The method used development and validation. The participants were 25 class XII students at Senior High School in Bandung, Indonesia. This research resulted in a minimum competency assessment instrument on response rate material, which consists of six complex multiple-choice questions, five multiple-choice questions, two matching questions, and seven essay questions. The development results of the validity test on the AKM instrument based on the 14 items were declared valid. The empirical validity test results obtained from 8 objective questions and seven descriptive items were declared valid. The test reliability value was calculated using the IBM SPSS 25 Cronbach Alpha application, namely in the objective question of 0.625 with high criteria. In the description question, the score was 0.613, with high criteria. The results of difficulty level analysis items obtained in the objective questions are five questions included in the moderate criteria of 0.30-0.69 and 8 items included in the difficult criteria of 0.00-0.29. The description of 5 items included in the medium criteria of 0.30-0.69 and 2 items included in the difficult criteria of 0.00-0.29. However, the test's difficulty level has not increased proportionately because there are no easy criteria items. The analysis of the discriminatory power items on the objective questions obtained very good criteria, namely nine items of 0.40-1.00. Besides, the description questions that have distinguishing power with very good criteria are four items of 0.40-1.00 and good criteria, namely two items of 0.30-0.39.

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## 1. Introduction

Education in the 21st century must ensure that students have the skills to use and utilize technology and information, skills to learn and innovate, as well as work and survive using life skills [1-3]. The US-based Partnership for 21st Century Skills (P21) identified the competencies needed in the 21st century to be communication skills (communication skills), collaboration skills (collaboration skills), critical thinking skills (critical thinking skills), and creativity skills (thinking skills) creative) [4]. These skills are then known as 21st-century skills. One way to realize 21st-century skills is to improve students' literacy skills. It has prompted the government to make a new policy by replacing the National Examination (UN) with the Minimum Competency Assessment (AKM). All students need an assessment, namely AKM, for the basic competencies to develop their capacity and participate in society positively. AKM is intended to measure competence in-depth, not just content mastery [5]. The AKM developed includes a literacy assessment and a numeracy assessment. Literacy assessment is an assessment of the ability to understand reading concepts. Literacy is a social event that requires particular abilities to communicate and get information through writing [6]. In contrast, the numeracy assessment assesses the ability to apply the concept of calculation in a context, both abstract and real [5]. Numeracy is described as the capacity to use number ideas and arithmetic operations abilities in everyday life (for example, at home, work, and involvement in community life and as citizens), as well as the ability to analyze quantitative information around them. [6]. A minimal chemical competency assessment tool is required to detect chemical literacy and numeracy. This assessment is important to understand literacy [7-9] and numeracy [10]. The significance of chemical literacy measurement tools stems from the fact that successful chemistry learning necessitates an assessment that also evaluates understanding and memorizing, and also assesses students' capacity to contribute the ideas they have understood when dealing with issues [6]. As a result, students' chemical literacy and numeracy abilities are expected to be accurately tested using the minimal competence measurement tool that will be created. The material raised is the reaction rate material. This material is important to be studied by students as a basis for applied science in industry areas, medication, and the environment. As a catalyst, it increases the rate of reaction between specific medications and elements found in the body, which is utilized to design a novel medical therapy [6]. The goal of this study is to develop a Minimum Competency Assessment (AKM) instrument for quality reaction rate material that is valid, reliable, has a high degree of difficulty, and has a high level of differentiating power.

## 2. Method

This study used the validation and development method [11]. Broadly speaking, the stage of the development and validation method in this study consisted of four steps, namely the planning, the development, the validation, and the trial stage. This research was conducted at Senior High School 15 Bandung. The participants involved in this study were 5 expert validators in the field of chemistry education and 25 high school students of class XII who had studied the material on reaction rates. The following are data processing techniques in this study.

### 2.1. Content Validity Test

The value of content validity was calculated using the CVR (content validity ratio) with the following Lawshe equation (equation 1) [12]:

$$CRV = (n_e - (N/2)) / (N/2) \quad (1)$$

The CVR results for each item were then compared with the minimum CVR value [12] in Table 1.

**Table 1.** CVR values according to literature [12].

No	<b>Level of Significant Test</b>					
	0.100	0.050	0.025	0.010	0.005	0.001
	<b>Level of Significant Two Sides Test</b>					
	0.200	0.100	0.005	0.020	0.010	0.002
1	0.573	0.736	0.877	0.990	0.990	0.990
2	0.523	0.672	0.800	0.950	0.990	0.990
3	0.485	0.622	0.741	0.879	0.974	0.990
4	0.453	0.582	0.693	0.822	0.911	0.990
5	0.427	0.548	0.653	0.775	0.859	0.990
6	0.405	0.520	0.620	0.736	0.815	0.977

## 2.2. Empirical Validity

Processing of empirical validity values was carried out using the Correlation Coefficient method using Microsoft Excel. The criteria for interpreting the value of empirical validity are listed in Table 2.

**Table 2.** Criteria in the Interpretation of Empirical Validity Values [13].

<b>Correlation coefficient</b>	<b>Criteria</b>
0.80 – 1.00	Very high
0.60 – 0.79	High
0.40 – 0.59	Sufficient
0.20 – 0.39	poor
0.00 – 0.19	Very poor
< 0.00	Not valid

## 2.3. Reliability

In this study, the processing of reliability values was carried out using the Statistical Package for Social Science (SPSS) software version 20.0 with the inter-rater method with the Alpha Cronbach technique. The following are the alpha value criteria to determine the internal consistency of reliability (Table 3):

**Table 3.** Cronbach's Alpha Criteria for Reliability.

<b>Criteria</b>	<b>Description</b>
0.00 - 0.19	Very low
0.20 - 0.39	Low
0.40 - 0.59	Sufficient
0.60 - 0.79	High
0.80 - 1.00	Very high

## 2.4. Difficulty Level

The level of difficulty is how difficult it is for an item to be answered by the test taker or respondent. Questions can be said to be good if the questions are not too difficult or too easy.

## 2.5. Distinguishing Power

The discriminatory test was carried out to determine whether or not an item was able to distinguish high-ability students and low-ability students.

### 3. Results and Discussion

#### 3.1. Content Validity

In this study, a validity test was conducted to determine the extent of the measured test. The validity test used is the content validity test using the Content Validity Ratio (CVR) method. The method is obtained based on the validator's considerations from experts in the field of chemistry education, namely four lecturers and one teacher. The following are the results of the validation test on the items developed (see Tables 6 and 7).

**Table 6.** Calculation Results of CVR Items.

No	Text Suitability with Question Items				Conformity of Competence with Question Items				Conformity of Question Indicators with Question Items			
	Validator stating		CVR	Note	Validator stating		CVR	Note	Validator stating		CVR	Note
	Suitable	Not Suitable			Suitable	Not Suitable			Suitable	Not Suitable		
1.	5	0	1	Valid	4	1	0.6	Invalid	4	1	0.6	Invalid
2.	5	0	1	Valid	5	0	1	Valid	4	1	0.6	Valid
3.	5	0	1	Valid	5	0	1	Valid	5	0	1	Valid
4.	5	0	1	Valid	5	0	1	Valid	5	0	1	Valid
5.	3	2	0.2	Invalid	5	0	1	Valid	5	0	1	Valid
6.	5	0	1	Valid	5	0	1	Valid	5	0	1	Valid
7.	5	0	1	Valid	5	0	1	Valid	5	0	1	Valid*
8.	5	0	1	Valid	5	0	1	Valid	5	0	1	Valid
9.	5	0	1	Valid	3	2	0.2	Invalid	5	0	1	Valid
10.	4	1	0.6	Invalid	4	1	0.6	Invalid	3	2	0.2	Invalid
11.	5	0	1	Valid	5	0	1	Valid	4	1	0.6	Invalid
12.	5	0	1	Valid	5	0	1	Valid	5	0	1	Valid
13.	5	0	1	Valid	5	0	1	Valid	4	1	0.6	Invalid
14.	5	0	1	Valid	5	0	1	Valid	5	0	1	Valid
15.	5	0	1	Valid	5	0	1	Valid	5	0	1	Valid
16.	5	0	1	Valid	5	0	1	Valid	5	0	1	Valid
17.	5	0	1	Valid	5	0	1	Valid	5	0	1	Valid
18.	5	0	1	Valid	5	0	1	Valid	5	0	1	Valid
19.	5	0	1	Valid	5	0	1	Valid	5	0	1	Valid
20.	5	0	1	Valid	5	0	1	Valid	5	0	1	Valid

Description: Valid\* = Valid with improvements

Based on the results of the CVR calculation compared to the minimum CVR value [12], the minimum CVR value for five validators with a test significance level of 0.05 is 0.736. If the CVR value  $> 0.736$ , then the item is valid. While the CVR value  $< 0.736$  means that the item is invalid. The results showed that fourteen items were declared valid

because they had a CVR value = 1 and six were declared invalid because they had values below the minimum CVR. Invalid items consist of four items with a CVR value of 0.6 and two items with a CVR value of 0.2. Items that are declared valid are maintained. Meanwhile, the invalid items were corrected according to the suggestions from the validator. Based on Table 7, the CVR values from the results of the content validity of the twelve discourse texts, it is found that seven discourse texts can be declared valid because they have a CVR value = 1, and as many as five discourse texts are declared invalid because they have a CVR value = 0.6 or below the minimum CVR value.

**Table 7.** Text Validation CVR Calculation Results

Text Content Accuracy Match				
Text	Validator stating		CVR Value	Description
	Suitable	Not suitable		
1	4	1	0.6	Invalid
2	4	1	0.6	Invalid
3	4	1	0.6	Invalid
4	5	0	1	Valid
5	5	0	1	Valid
6	4	1	0.6	Valid
7	5	0	1	Valid*
8	5	0	1	Valid
9	5	0	1	Valid
10	4	1	0.6	Invalid
11	5	0	1	Valid
12	4	1	0.6	Invalid

Description: Valid\* = Valid with improvements.

### 3.2. Empirical Validity

The instrument tested for content validity is revised according to expert advice. Then, a development test is carried out. The questions used in the development test were only 20 items with detailed objective questions in the form of multiple-choice questions, complex multiple-choice questions, matched 13 items, and seven essay questions. Empirical validity is validity that is carried out by field testing. Using Microsoft Excel, empirical validity analysis compares the calculated r-value with the table r value. The trial was followed by 25 students with a significance level of 5%, which is 0.396. The empirical validity test is divided into two parts, namely the first part on objective questions and the second part on description questions. Based on Table 8, the empirical validity test carried out showed that eight items were declared valid and seven items declared invalid. There are six criteria for empirical validity, namely invalid, very low, low, sufficient, high, and very high. There are three items with high empirical validity that have a value of 0.60-0.79, namely number 2, number 12, and number 13. For sufficient criteria, four questions have a value of 0.40-0.59, namely: number 7; number 10; number 15, and number 20. As for the low criteria, which have a value of 0.20-0.3, there are four questions, namely at number 8; number 11; number 14, and number 19. Very low criteria with a value of 0.00 -0.19 are at number 6 and invalid criteria, which have a value of < 0.00, namely at number 17. Based on Table 9, the results show that all the items in the description can be declared valid because  $r_{\text{count}} > r_{\text{table}}$ . The criteria for the coefficient of empirical validity obtained from the seven items of description are three items that are

included in the high criteria, namely item number 4; number 16; and number 18. Three items are included in the sufficient criteria, namely, item number 1; number 5; and number 9; and one item in the low criteria, namely item number 3.

**Table 8.** Empirical Validity Test Results of Objective Questions

Question Number	Empirical Validity	r Table	Description	Criteria
1	0.748	0.396	Valid	High
2	0.190	0.396	Invalid	Very low
3	0.428	0.396	Valid	Sufficient
4	0.346	0.396	Invalid	Low
5	0.576	0.396	Valid	Sufficient
6	0.397	0.396	Valid	Low
7	0.622	0.396	Valid	Tinggi
8	0.615	0.396	Valid	Tinggi
9	0.343	0.396	Invalid	Low
10	0.500	0.396	Valid	Sufficient
11	-0.033	0.396	Invalid	Invalid
12	0.172	0.396	Invalid	Low
13	0.560	0.396	Valid	Sufficient

**Table 9.** Results of Empirical Validity Test Questions Description

Question Number	Empirical Validity	r Table	Description	Criteria
1	0.547	0.396	Valid	Sufficient
2	0.399	0.396	Valid	Low
3	0.679	0.396	Valid	High
4	0.420	0.396	Valid	Sufficient
5	0.483	0.396	Valid	Sufficient
6	0.609	0.396	Valid	High
7	0.691	0.396	Valid	High

### 3.3. Reliability Test

The instrument that has been developed is also tested for reliability. A reliability test aims to measure the extent of a measuring instrument, which provides a truly reliable picture of a person's ability. The test reliability value was calculated using the IBM SPSS 25 Cronbach Alpha application. Based on the interpretation, the objective questions obtained a value of 0.625 with high criteria, while the description questions obtained a value of 0.613 with high criteria.

### 3.4. Difficulty Level

The level of difficulty of the items was carried out to determine the proportion of the subject answering certain items correctly. Questions can be said to be good if the questions are not too difficult or too easy [13, 14]. The results of the analysis of the level of difficulty are shown in Table 10.

**Table 10.** The Results of The Analysis of The Level of Difficulty in The Objective Questions

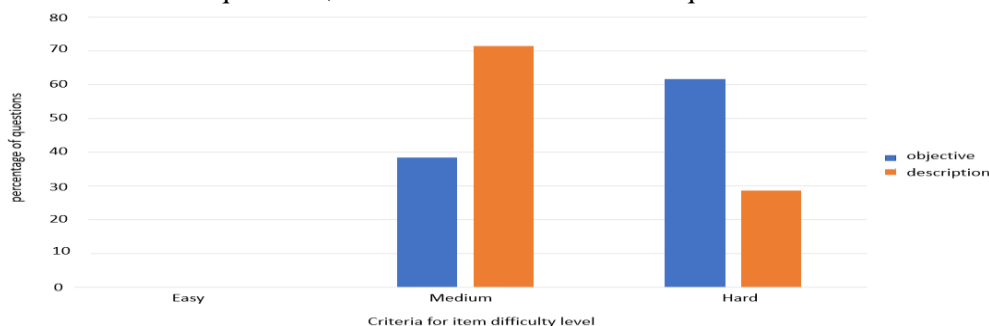
Question Number	Difficulty Level	Criteria
1	0.40	Average
2	0.56	Average
3	0.48	Average
4	0.24	Difficult
5	0.24	Difficult
6	0.28	Difficult
7	0.32	Average
8	0.28	Difficult
9	0.08	Difficult
10	0.24	Difficult
11	0.20	Difficult
12	0.20	Difficult
13	0.64	Average

Based on Table 10, the results of the test of the level of difficulty on the objective questions contained five items included in the moderate criteria, namely items number 2, 6, 7, 12, and 20. Eight items were included in the difficult criteria, namely items number 8, 10, 11, 13, 14, 15, 17, and 19. The proportion of the difficulty level on the objective questions is not good because it does not have items with easy criteria and has too many difficult questions. Based on Table 11, there are five items included in the moderate criteria, namely items number 3, 4, 5, 9, and 16. Two items were included in the difficult criteria, namely items number 1 and 18. The proportion level of the difficulty in the description is not good because it does not have items with easy criteria. The results of the calculation of the level of difficulty in the objective and description questions are compared to see the percentage of the number of questions based on the level of difficulty. Figure 1 shows a comparison of the percentage of the number of questions based on the level of difficulty of the items on the objective and description questions.

**Table 11.** Results of Analysis of Difficulty Levels in Problem Descriptions

Question Number	Difficulty Level	Criteria
1	0.21	Difficult
2	0.38	Average
3	0.47	Average
4	0.48	Average
5	0.42	Average
6	0.38	Average
7	0.19	Difficult

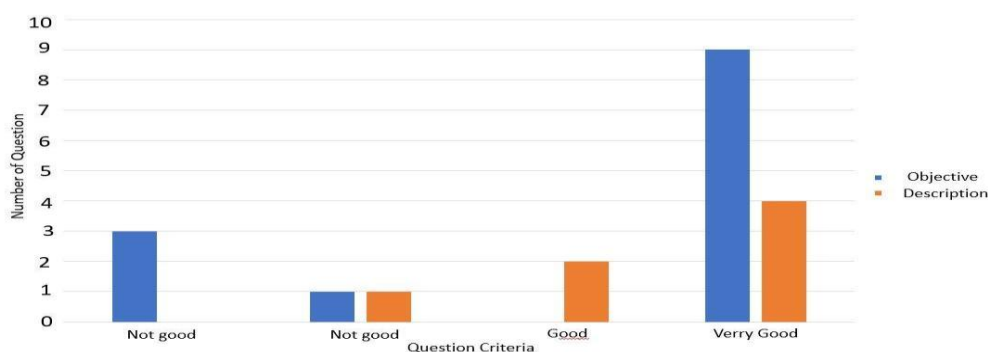
Based on Figure 1, the largest percentage is a matter of difficult criteria. The smallest criteria are questions with moderate criteria. While in the description the largest percentage is a matter of medium criteria and the smallest is a matter of difficult criteria. The two parts of the question, both objective and description, do not have easy criteria questions. The proportion of questions developed can be said to be not good because the proportion is not close to 3:4:3. The proportion of a good level of difficulty is (1) 30% is easy, (2) 40% is moderate, and (3) 30% is difficult. For objective questions, the percentage of questions is that there are no easy criteria questions, 38.46% for moderate criteria questions, and 61.54% for difficult criteria questions. In the description questions, there are no easy criteria questions, 71.43% medium criteria questions, and 28.57% difficult criteria questions.



**Figure 1.** Difficulty Level Chart

### 3.5. Distinguishing Power

The discriminatory power test is carried out to find out how much the ability of a test item can distinguish high-ability test takers from low-ability test takers. Before calculating the discriminatory power of questions, students are first grouped into upper, middle, and lower groups. The division of groups is done by sorting the students with the highest score to the lowest score, which is then divided into 27% of the upper group, 27% of the lower group, and the rest of the middle group. In the trial conducted, the number of students who took the test was 25 people. Therefore, the upper and lower groups were 7 people each. The calculation of the discriminatory power of the questions is in the appendix. Figure 2 is a graph that shows the number of questions for each question distinguishing power criteria. Based on Figure 2, the criteria for distinguishing questions. The criteria are divided into four, namely not good, average, good, and very good. There are objective questions that have distinguishing power with very good criteria, namely 9 items, poor criteria, namely 1 item, and bad criteria, namely 3 items. While the description questions that have distinguishing power with very good criteria are 4 items, good criteria are 2 questions, and the criteria are not good, namely 1 item. Items that have excellent discriminatory power mean that the items can distinguish students who belong to the upper group and students who belong to the lower group.



**Figure 2.** Distinguishing Power Analysis of Questions



### 3.6. Analysis of the Quality of Question

The quality of the instrument is shown from the results of data analysis for each item including validity, reliability, level of difficulty, and distinguishing power. Table 12 is the quality of the AKM instrument developed. Based on the two tables (Tables 12 and 13), there are still items that are not feasible. Among them, some items have empirical validity on the criteria of low, very low, invalid, and items that have poor and bad distinguishing power. On the questions that are not good or not good, improvements are made to improve the quality of the questions developed so that they are worthy of being used as evaluation tools. Meanwhile, questions that are already good can be maintained or saved. Based on above results, this competency is important to evaluate the education level and student understanding [15, 16], specifically when dealing with covid pandemic [17-19] that makes teachers to work hard to think the best strategies in teaching [20-29].

**Table 12.** Quality of AKM Question Items in the Form of Objective Questions

Question Number	Empirical Validity		Reliability	Difficulty Level		Distinguishing Power	
	Value	Description		Value	Description	Value	Description
1	0.748	High	0.625 (Acceptable)	0.40	Average	0.86	Very good
2	0.190	Very Low		0.56	Average	0.14	Not good
3	0.428	Sufficient		0.48	Average	0.57	Very good
4	0.346	Low		0.24	Difficult	0.43	Very good
5	0.576	Sufficient		0.24	Difficult	0.57	Very good
6	0.397	Low		0.28	Difficult	0.43	Very good
7	0.622	High		0.32	Average	0.86	Very good
5	0.615	High		0.28	Difficult	0.57	Very good
6	0.343	Low		0.08	Difficult	0.14	Very good
7	0.500	Sufficient		0.24	Difficult	0.43	Very good
8	-0.033	Invalid		0.20	Difficult	-0.14	Not good
9	0.172	Low		0.20	Difficult	0.29	Average
10	0.560	Sufficient		0.64	Average	0.86	Very good

**Table 13.** The Quality of AKM Question Items in the Form of Description

Question Number	Empirical Validity		Reliability	Difficulty Level		Distinguishing Power	
	Value	Description		Value	Description	Nilai	Description
1	0.547	Sufficient	0.613 (Acceptable)	0.21	Difficult	0.29	Not good
2	0.399	Low		0.38	Average	0.36	Good
3	0.679	High		0.47	Average	0.52	Very good
4	0.420	Sufficient		0.48	Average	0.43	Very good
5	0.483	Sufficient		0.42	Average	0.36	Good
6	0.609	High		0.38	Average	0.71	Very good
7	0.691	High		0.19	Difficult	0.50	Very good

## Conclusion

The Minimum Competency Assessment (AKM) on the reaction rate material developed obtained the content validity test results, namely, 14 items were declared valid. The empirical validity test obtained the results of 8 objective

questions, and seven descriptive items were declared valid. The test reliability value was obtained on the objective questions of 0.625 with high criteria, while on the description questions, the value of 0.613 was obtained with high criteria. The results of the analysis of the level of difficulty of the items obtained in the objective questions are five questions included in the moderate criteria of 0.30-0.69 and 8 items included in the difficult criteria of 0.00-0.29. While in the description of the five items included in the medium criteria of 0.30-0.69 and 2 items included in the difficult criteria of 0.00-0.29. However, the level of difficulty of the test has not met a proper proportion because there are no easy criteria items. The results of the analysis of the discriminatory power of items on the objective questions obtained very good criteria, namely nine items of 0.40-1.00. In contrast, the description questions that have distinguishing power with very good criteria are four items of 0.40-1.00 and good criteria, namely two items of 0.30-0.39.

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