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DEVELOPMENT OF HOTS LITERACY BASED COGNITIVE ASSESSMENT TOOLS ON ACID BASE MATERIAL

Sakinah Mawaddah Hasibuan^{a*}, Iis Siti Jahro^a^aDepartment of Chemistry, Universitas Negeri Medan, Sumatra Utara, Indonesia, 20221**Abstract**

The aim of this research is to develop HOTS Literacy based cognitive assessment tools, determine the feasibility of HOTS Literacy based cognitive assessment tools based on the BSNP, material expert validators, learning experts, and to get students response to HOTS Literacy based cognitive assessment tools on acid base material. This R&D uses the 4D model (Define, Design, Develop and Disseminate). Field trials were conducted on a small scale from a single class. The validators consist of four material expert and one chemistry teacher. Pre-test, post-test results and student responses were used to collect data. According to validation by the experts', the level of feasibility according to BSNP resulted in an average percentage of 83% with the acquisition of criteria, namely high and valid/feasible. And the responses given by students in trials, the criteria were very good or high with an average percentage of 97%. It shows that the instrument considered very good, so it can be used to improve students' higher-order thinking skills.

Keywords: : Development; HOTS Literacy; Assessment Tools

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(CC BY-NC-SA 4.0)**INTRODUCTION**

In facing the 21st century, Human Resources (HR) must have the ability to think critically in solving a problem, making decisions, working together, communicating, literate in information and communication technology (ICT), as well as personal and social responsibility. This is appropriate with the demands of the 2013 Curriculum which requires students to be active, develop the ability to think critically, systematically, objectively, chronologically, and creatively in the learning process. Critical thinking skills can be trained by applying an assessment instrument based on higher-order thinking skills [5].

Critical thinking is one of the higher order thinking skills (HOTS). Critical thinking includes the ability to analyze, evaluate and create. Analysis is the ability to think in specializing certain aspects; Evaluation or considering is the ability to think in making decisions based on matters relating to the real world; and creative is the ability to think in building broad insights owned by these students. So students are directed to learn more actively and have higher-order thinking skills [12]. Students with high-order thinking skills are expected to be able to obtain a solution of a problem [3]. In higher order thinking, what is meant by thinking is not only stating facts, but also understanding facts, then connecting facts, categorizing facts, manipulating facts and using facts in new situations to solve a problem [9].

In addition to having high-order thinking skills, students in the 21st century must also be scientifically literate or scientifically literate. Scientific literacy is the ability to identify questions, acquire new knowledge,

explain scientific phenomena and draw conclusions based on scientific facts and evidence regarding scientific concepts. Scientific literacy can also be interpreted as a science and understanding of scientific concepts and processes that enable a person to make a decision based on the knowledge they have so that scientific literacy will be able to play an active role in all aspects of life, especially in the field of science they are involved in [4].

Several international studies have been conducted to measure students' literacy abilities, including the Program for International Student Assessment (PISA) is a study that aims to determine the results of the education system related to the literacy abilities of 15-year-old students. PISA studies were conducted in several developed and developing countries starting in 2000 at intervals of three years. The areas of study studied and assessed include reading literacy, mathematical literacy, and scientific literacy [4].

Indonesia is one of the countries participating in the International PISA study, but the achievements of Indonesian students are still in the low category compared to other countries and have not experienced a significant increase in the last 5 periods [8]. Based on the results of the 2018 PISA study, Indonesia ranked 75th out of 80 countries in the aspect of scientific literacy with an average of 396 and an average understanding of cognitive domains C5 and C6 of 0.08% [6].

Based on the observation results in class XI SMA Negeri 14 Medan show that, the development of cognitive assessment instruments themselves is still rarely carried out which of course affects student learning outcomes. Where, the assessment tool used

by the teacher still refers to the measurement of Low Order Thinking Skill (LOT) and also Medium Order Thinking Skill (MOT). However, it is possible to do a combination of the two levels of thinking, namely LOT and MOD. Determining the quality of the items in addition to having to be valid and reliable must also pay attention to the level of thinking ability in accordance with the demands of the 2013 Curriculum which directs learning and assessment towards High Order Thinking Skills (HOTS). However, in reality there are still items used to test cognitive abilities that do not pay attention to higher order thinking skills.

A good test instrument can actually improve the quality of the assessment results, namely being able to find out the ability profile of students. Assessment using a written test is most often used to determine students' cognitive abilities. Skill-oriented learning instruments are important to develop. Thinking skills can be developed through a conditioning to think. Therefore, it takes a process of practicing thinking through answering questions that is oriented towards higher-order thinking skills so that students are able to follow developments in science and technology [11].

In the research that will be conducted, the assessment that will be used is the HOTS-Literacy assessment. The HOTS-Literacy assessment is an assessment that presents test questions at a high cognitive level to students so that they can improve their critical thinking and creative thinking skills. HOTS assessment has three main principles, namely (1) giving stimulus in the form of text or other forms, (2) giving new problems that have not been given in class, (3) giving questions with different types of difficulties and different cognitive levels [3]. Thus, the use of the HOTS-Literacy assessment instrument is considered a means of increasing students' ability to understand material and can be used by a teacher in evaluating their learning.

METHOD

This research used Research and Development (R&D) development research. This type of Research and Development (R&D) research is a process or steps to develop new products or improve existing products, which can be accounted for. Research and development can be interpreted as a scientific way to research, design, produce, and test the validation of the products that have been produced. This research aims to modify and develop products.

This development research is a research with a procedural model, which has stages in the product development process. Product development in this research is in the form of cognitive assessment tools based HOTS-Literacy on acid base material using the 4D (Four-D) development model which consists of 4 stages of development including: Define, Design, Develop and Disseminate.

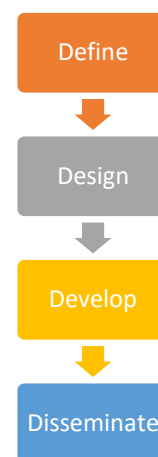


Figure 1. 4D Development Research Chart

The subject in this study is HOTS Literacy based cognitive assessment tools. As for the object in this study is the acid base material. The assessment tool will be validated by material experts and teacher. Data collection techniques aim to collect the data needed in research. In this study, data collection techniques were carried out using a questionnaire. Questionnaire is a data collection technique that is carried out by giving a set of questions or written statements to respondents to answer. The researcher gave a questionnaire to the respondents, namely SMA Negeri 14 Medan students. The questionnaire used in this study was a questionnaire with closed answers using a Likert scale and responses by giving suggestions in the column provided. For needs analysis, in this study using an interview questionnaire where the questionnaire will later be distributed or asked directly to the teacher.

At the field trial stage, apart from collecting data related to student responses to the assessment instrument, the instrument was also tested for validity, difference power test, difficulty level and reliability test. Validity is used to determine the extent to which the accuracy and accuracy of a measurement instrument in carrying out its measuring function and validity uses a product moment correlation technique measuring tool. The instrument must be declared valid, which means that the instrument can be used to measure what should be measured. To calculate the validity of the items used the Pearson Product Moment formula with:

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

Where, r : Correlation coefficient, N : The number of test takers, $\sum X$: Number of item scores and $\sum Y$: The total score of all items. And then for the difference power of a question is the ability of a question to distinguish between students with high abilities and students with low abilities [10]. The number that shows the magnitude of the differential power is called the discriminatory index (D). The discrimination index

ranges from 0 to 1. The difference power of the items is calculated using the equation:

$$DP = \frac{B_A}{J_A} - \frac{B_B}{J_B}$$

DP is the index of discriminating power, B_A is the number of upper group test takers who answered the item correctly, B_B is the number of lower group test takers who answered the item correctly, J_A is the number of upper group test takers, and J_B is the lower group test taker [1]. The criteria for the difference power index are as follows:

Table 1. Criteria for Difference Power Index

DP	Qualification
Negative	Not Good
0.00 - 0.19	Bad
0.20 - 0.39	Enough
0.40 - 0.69	Good
0.70 - 1.00	Very Good

Analysis of the level of difficulty is intended to determine whether the question is classified as easy or difficult. Difficulty level is a number that indicates how difficult or easy something is. To calculate the difficulty level of each item, the equation is used:

$$P = \frac{B}{J_x}$$

P is the difficulty index, B is the number of students who answered the item correctly, and J_x is the total number of students taking the test [1]. Difficulty index is classified as the following table:

Table 2. Difficulty Level Classification

P	Classification
0.00 - 0.29	Difficult
0.30 - 0.69	Medium
0.70 - 1.00	Easy

Reliability is the constancy of measurement. An instrument is said to be reliable or reliable if a person's answer to a statement is consistent or stable from time to time. There are two kinds of reliability, namely consistent reliability of responses and consistent reliability of combined items. The reliability that will be used in this study is consistent combined items, where the calculation of the reliability coefficient of combined item consistency uses the Alpha Cronbach formula as follows:

$$r_{ii} = \frac{k}{k-1} \left[1 - \frac{\sum S_i^2}{S_t^2} \right]$$

Where, r_{ii} : Reliability sought, k : The number of questions, S_i^2 : The variance of the scores for the i-th item and S_t^2 : Total score variance. The results of

reliability calculations are then interpreted and compared with the reliability classification according to [2] which is shown in table 3.

Table 3. Reliability Classification

Reliability	Classification
0.80 - 1.00	Very High
0.70 - 0.79	High
0.60 - 0.69	Medium
< 0.60	Low

This study also collected data on student learning outcomes through pretest and posttest given to students. The data can be analyzed using the N-gain score (normalized gain) with the following equation:

$$g = \frac{\text{posttest score} - \text{pretest score}}{\text{maximum possible score} - \text{pretest score}}$$

The normalized gain calculation results are then interpreted based on the n-gain interpretation table according to [7]. These categories can be seen in Table 4:

Table 4. Interpretation of Normalized Gain Values

Value (g)	Classification
$g > 0.7$	High
0.30 - 0.70	Medium
0.00 - 0.29	Low

RESULTS AND DISCUSSION

The research was carried out through several stages, starting from the defining stage (Define) which carried out an analysis of student needs, then the designing stage (Design) the HOTS Literacy-based cognitive assessment tool on acid-base subjects, followed by the Develop stage by validating the assessment tool to material experts and practitioner experts, namely chemistry subject teachers, and field trials were carried out as the Dissemination stage by watching students work on HOTS Literacy-based learning evaluation sheets, after which students' responses to the products developed were seen. The results of this study are products in the form of a cognitive domain assessment tool based on HOTS Literacy on acid-base topics to see students' critical thinking skills and responses.

Define Results

This research begins with making observations at SMA Negeri 14 Medan. Observation activities were carried out by interviewing chemistry teachers at the school. Before conducting an analysis of student needs, the researcher first conducted interviews with chemistry teachers with the aim of finding out the curriculum used at the school, the syllabus, the teaching materials used, the learning process that took place, and knowing the obstacles encountered during learning activities. Based

on the results of an interview with one of the chemistry teachers in class XI SMA Negeri 14 Medan, it can be analyzed that the assessment tools used by the teacher are based on or follow the suitability of the 2013 curriculum, but the evaluation sheets used are still based on Low Order Thinking Skills (LOT) questions and Medium Order Thinking Skills (MOD), for questions based on High Order Thinking Skills (HOTS) themselves are still not familiar to students because the question model is rarely applied.

Table 5. Student responses toward the understanding about HOTS and scientific literacy

No	Question	Answer	
		Yes	No
1	Do you know the terms of HOTS?	44.5	54.5
2	Do you know about Scientific literacy?	81.8	18.2
3	Do you agree to apply the literacy HOTS based assessment?	100.2	0.0

Based on the results of the student needs questionnaire analysis which was distributed to 33 students of class XI MIPA, especially XI MIPA 4 at SMA Negeri 14 Medan, it was found that as much as 54.5% stated that they did not know the term High Order Thinking Skills (HOTS). Then as much as 18.2% stated that they did not know the term scientific literacy, almost all of the respondents already knew the term scientific literacy because literacy activities were often carried out at that school. And as many as 100% of students stated that it was necessary and agreed to develop and apply Literacy HOTS-based assessment tools in chemistry subject matter, especially acid-base material.

From the results of the needs analysis carried out, it can be concluded that class XI students at SMA Negeri 14 Medan need training or learning evaluation activities containing HOTS Literacy-based questions that are able to attract and train students' critical thinking skills.

Design Results

This stage consisted of 3 stages, namely selecting material, questions, compiling grids and selecting formats that were adapted to the procedures of the research on developing HOTS Literacy-based cognitive assessment tools.

In material selection, the assessment tools are prepared to cover all learning activities, but the developed assessment tools focus on cognitive assessment tools. The questions prepared relate to the subject matter of acids and bases adapted to learning indicators and cognitive levels referring to bloom's taxonomy, namely analysis (C4), evaluation (C5) and creation or creating (C6).

Arrangement of grids, the grids are arranged based on learning indicators and the learning indicators are arranged based on the basic competencies of the subject matter. The stages of preparing this grid consist of making 5 learning indicators using operational verbs that are in accordance with the bloom taxonomy and then each indicator has different cognitive levels and contains question numbers. And for the format selection, the format chosen is in accordance with the standardized format determined by the 2013 curriculum, which includes layout design, writing and images.

Development Results

At this stage, HOTS Literacy based cognitive assessment tools on acid base material is a product of this development research which is adapted to aspects such as the criteria for a good assessment tool according to the BSNP, preparation of assessment tools with learning materials and questions with indicators of higher order thinking, after that the tools The assessment was validated by 5 validators consisting of 4 material expert validations, namely a lecturer majoring in chemistry FMIPA UNIMED and 1 practicing expert validation, namely a chemistry teacher at SMA Negeri 14 Medan.

In addition, at this stage, the results of several tests were carried out, such as validity, difference power, level of difficulty and reliability tests. For validity test, there were four items that were considered invalid, because the number of students who could answer the questions correctly so that the questions are considered easy to solve.

For difference power test, there are three questions with good differentiating power categories. Then there are eight questions with sufficient differentiating power category, for the low and negative category, there are no questions with those categories.

For analysis of the level of difficulty, there are five questions with a hard level of difficulty, then there are six questions with a medium level of difficulty and no questions with easy difficulty levels. Therefore, it can be concluded that the distribution of difficulty levels on the validity test questions is uneven, where there are difficult and moderate levels.

Table 6. Test result of reliability, validity, and N-Gain

No	Test	Score	Category
1	Reliability (Cronbach's alpha)	0.64	Medium
2	Validity (Expert validation)	83.00	High
3	N-Gain	0.25	Low

The results of the reliability test, namely the questions used from the total questions before

validation were obtained Cronbach's Alpha value or $r = 0.64$ (Table 6). It was found that the reliability value of the multiple choice questions in this study was included in the medium category and deserved to be tested.

And for the instrument validation, the five validators consisting of 4 material expert validators and 1 chemistry teacher, it can be seen that the overall percentage results obtained were 83% (Table 6). This means that the HOTS Literacy-based cognitive domain assessment materials and tools on the subject of acids and bases are indicating the category "very high" and "decent" based on the BSNP.

Disseminate Results

The dissemination stage of this research was carried out in class XI SMA Negeri 14 Medan which was carried out by distributing products, namely HOTS Literacy-based questions. In addition, it also looks at how students respond to the HOTS Literacy-based assessment instrument on acid-base topics. The validation instrument and student responses use a Likert scale. And at this stage of dissemination a limited scale trial was also carried out, namely by giving a pretest and posttest so that you could see changes in learning outcomes and able to calculate the N-Gain value.

The results of the limited field trials above, it was found that the N Gain value was 0.25 (Table 6) by fulfilling the low category. This shows that by giving pre-test and post-test treatment there is an increase in student learning outcomes even though it is not significant, this is because the questions presented are rated HOTS.

For the response questionnaire distributed to 33 students. The student response questionnaire used was a Likert scale. The responses given by students to the assessment instrument on the subject of acids and bases gave a positive response. This is in accordance with the average percentage shown, which is 97%. So, based on the results of the average percentage, it is included in the very high or very attractive category.

CONCLUSION

Based on the results of the data analysis that has been carried out in this study, the following conclusions can be drawn:

1. The results of the analysis of the needs for assessment instruments at SMA Negeri 14 Medan stated that they needed an assessment tool in the cognitive domain based on HOTS Literacy on acid-base subjects and based on a questionnaire, it was found that 100% of students agreed to develop assessment tools, especially cognitive domains based on HOTS Literacy as a form of training thinking skills for high level students.
2. The development of a HOTS Literacy-based cognitive assessment tool was carried out by

creating an initial product, then it was validated by 5 validators consisting of 4 material expert validators and 1 practitioner expert validator, namely a chemistry teacher at SMAN Negeri 14 Medan . This assessment tool follows the BSNP criteria and several feasibility tests are carried out, such as validity, reliability, discriminatory power and level of difficulty tests.

3. The level of feasibility of the HOTS-based cognitive assessment device Literacy on acid-base subjects based on assessment according to the BSNP resulted in an average percentage of 83% with the acquisition of criteria, namely high and included in the valid/feasible category.
4. Based on the responses given by students in trials of the HOTS-based cognitive assessment tool Literacy on the subject of acids and bases, the criteria were very good or high with an average percentage of 97%. This shows that the HOTS Literacy-based cognitive assessment tool developed is considered very good, so it can be used to improve students' higher-order thinking skills.

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