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Development of higher order thinking skill (HOTS) assessment instrument for salt hydrolysis

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ABSTRACT

This study aims to determine the results of the analysis of instrumentation requirements, the feasibility category of the Higher Order Thinking Skills an assessment instrument in terms of an expert validation. The research and the development model applied is 4-D (four-D) model. The trial design consisted of content validation tests by experts and analyzed by Aiken's formula. The assessment instrument obtained 37 items that are suitable for use, which means the assessment instrument has met the content validity by the expert judgment which has been analyzed using Aiken's V of 0.85, which means that all items are valid.

1. Introduction

Assessment of the student learning outcomes is defined as various procedures to obtain information and determine decisions related to student performance and learning outcomes. Assessment of learning outcomes is defined as teacher activities related to making decisions about a competency achievement or the student learning outcomes during the learning process (Budiman & Jailani, 2014; Wardany et al. 2015; Siahaan et al. 2021). Assessment is not a new thing in the world of education, but often in the learning process teachers only seek to improve cognitive abilities by ignoring aspects of evaluating the student learning outcomes. As a result, students' thinking skills are still relatively low because teachers are too focused on what will be taught to their students, but the assessment tools used no longer see the target to be assessed (Hikmayanti & Utami, 2019). In the learning process, teachers are expected to be able to assess the process and results of science learning comprehensively and correctly (Sudrajat, 2012). Through an assessment, teachers can identify and know the difficulties faced by students during the learning process (Mardliya et al. 2017).

In the chemistry learning process in the 2013 curriculum, teachers are expected to facilitate and encourage students to think critically, logically, and systematically, and have High Order Thinking Skills (HOTS). High Order Thinking Skills that need to be trained by teachers in managing chemistry learning in the classroom are abilities at the top level in Bloom's a cognitive taxonomy (Pratiwi et al. 2019). The purpose of learning Bloom's cognitive taxonomy is to build students' ways of thinking to be able to apply knowledge and skills to new contexts (Silaban, 2021). HOTS can also be interpreted as a thinking skill that not only requires memory skills, but requires other higher skills. HOTS questions have a contextual character so that they can show real phenomena that exists in life (Mawardi et al. 2020).

Chemistry is one of the subjects contained in the 2013 curriculum. Chemistry as part of the Natural Sciences is obtained and developed based on experiments to find answers about the what, why, and how of natural phenomena specifically related to the composition, structure, properties, transformations, dynamics, and energy of matter (Harahap et al. 2018; Pakpahan et al. 2021). Chemistry is something important, because our physical environment is strongly influenced by chemistry and full of chemicals (Sani, 2014). Chemistry is also a science that seeks answers to what, why and how natural phenomena relate to matter, structure, composition, kinetics and energetics involving skills and reasoning (Yulianci et al. 2017). The chemical concept discussed is the material of Salt Hydrolysis. To learn the concept of salt hydrolysis, we must first study the acid-base concept because the acid-base concept that underlies this material, if you don't understand then students tend to have difficulty understanding the Salt Hydrolysis material (Hikmayanti & Utami, 2019). The difficulties experienced by students in chemistry lessons will of course lead to the achievement of learning outcomes, namely the inability of students to understand and use chemical concepts in various situations (Rain et al. 2019). Based on this, the researcher created and developed a Higher Order Thinking Skills (HOTS) assessment instrument. He hopes that the development of this HOTS assessment instrument will help teachers who do not understand how to create or develop a HOTS assessment instrument, so that they will be accustomed to giving questions that contain questions.

2. Methods

This research includes research and development (Research and Development). The research and development model applied is a 4-D (four-D) model, namely: define, design, develop, and Disseminate (Damarsari, 2017).

Table 1. Research Procedure

Stage 4-D	Activity
Define	1. Needs analysis 2. Student analysis 3. Identify and detail the structure of the material and design the concept of the material 4. Analysis of the assessment instruments used 5. HOTS indicator analysis
Design	1. Choose the format and question grid used 2. Designing the initial design of the HOTS assessment instrument 3. Review the questions
Develop	1. Revised Readability Test 2. Instrument validation by experts 3. Revision 4. Product trial 5. Revision 6. Assessment instrument assembly (final design)
Disseminate	1. Deployment to Schools

This research has been carried out in Madrasah Aliyah Negeri (MAN) in Deli Serdang Regency, which is specifically for the MA Negeri 2 Deli Serdang area. This development research is oriented towards product development where the development process is described as accurately as possible. Research subjects in data collection were Two colleagues as peer reviewers, three expert lecturers as validators, namely material experts, linguists, and evaluation and assessment experts, two chemistry teachers as readability test subjects and as validators. The object of this research is the Higher Order Thinking Skills (HOTS) assessment instrument on the salt hydrolysis material. Based on the research on the development of the 4-D model, the procedure for developing the Higher Order Thinking Skills (HOTS) assessment instrument can be seen from Table 1.

3. Results and Discussion

The product of this research is the Higher Order Thinking Skills (HOTS) assessment instrument on Salt Hydrolysis. The product development results go through to define, design, develop, and disseminate stages. The results of these stages are described as follows; Based on the results of interviews with teachers in the field of chemistry studies at MAN 2 Deli Serdang, it can be described in general about the opinions, attitudes and experiences of teachers in carrying out school assessments. Which states that the curriculum applied by the MAN 2 Deli Serdang School is the 2013 Curriculum. The basic competencies in salt hydrolysis material are: (3.12) analyzing salts undergoing hydrolysis (4.12) designing, conducting, and concluding as well as presenting experimental results to determine the type of hydrolyzed salt. These basic competencies are difficult to achieve because in their presentation the teacher only uses the lecture method and the tasks or instruments given are only multiple choice questions in the textbook. Where the cognitive assessment used is still limited to C1-C3 with a level of difficulty that is still in the low category, this is because the ability of students is still lacking if a higher level question is made such as C4-C6.

At the definition stage, concept analysis is also carried out which is an important step to fulfill the principles in building the concept of a material that is used as a means of achieving basic competencies and skills. The results of the basic knowledge and the skills competency analysis can be seen in Table 2.

Table 2. Basic Competency Analysis (Adaptation from the Directorate of High School Development, 2015).

Basic competencies	Indicator
3.12 Analyze the hydrolyzed salts	3.12.1 Explain the meaning of salt hydrolysis 3.12.2 Explain the acid-base properties of a salt solution 3.12.3 write the equilibrium reaction in a salt solution 3.12.4 Measure and calculate the pH of the hydrolyzed salt solution.
4.12 Design, conduct, conclude and present experimental results to determine the type of salt that undergoes hydrolysis.	4.12.1 Explain and determine the types of salts that can be hydrolyzed in water through experiments

The next stage the design stage is the initial stage to design the assessment instrument product. In simple terms, this activity includes the formulation of test questions, then the initial product of the questions is obtained, then the last is a peer reviewer review. The results of the planning stage are described in a detail as follows. Starting with the selection of KD from the 2013 Curriculum, then the selection of Salt Hydrolysis material in the preparation of this assessment instrument is based on Salt Hydrolysis material that can represent the participants' HOTS assessment.

The next step after determining KD is determining the learning indicators for salt hydrolysis material, HOTS indicators which include C4 (analyze), C5 (evaluate), and C6 (make). The question instrument developed was a multiple choice test with 40 multiple choice questions. The next step is to design a HOTS assessment instrument which includes a question instrument grid, a HOTS question script and an answer key. The last step in the design stage is the peer reviewer review. The product of the HOTS assessment instrument was reviewed by 2 colleagues from UNIMED Chemistry

Education Postgraduate students. The peer reviewer review is carried out online by asking for suggestions and input from colleagues to improve the quality of the assessment instrument product. Suggestions and improvements in the form of writing and instrument readability, such as writing chemical compounds, chemical symbols, and correcting incorrect writing.

The next stage is the development stage. At this stage the assessment instruments that have been previously designed are assessed by expert lecturers and chemistry teachers. The develop stage aims to obtain data from the assessment instrument review and validation data. The review stage of the assessment instrument is carried out by means of a readability test. The readability test was carried out to see the readability of the instrument. The readability test was conducted online which was given to 3 students of class XI MIA at MAN 2 Deli Serdang. This was conducted using an open questionnaire in which teachers and students filled out and provided input regarding the developed instrument. The results of the readability test are summarized in Table 3.

Table 3. Readability Test Results

No	Indicator	Readability Test Results
1	Allocate time to solve problems	The test instrument developed has a time allocation of 100 minutes. The subject of the readability validation test generally agreed that the time allocation given was inappropriate and insufficient for students to work on the questions.
2	Conformity in measuring higher order thinking skills	The test subject stated that almost all of the test items developed gave rise to the HOTS indicator. So that its use is appropriate to measure the high-level thinking ability of students.
3	The suitability of the salt hydrolysis material indicator.	The test subject stated that each test item developed was in accordance with the salt hydrolysis material indicators in the learning syllabus
4	Sentence structure in the developed questions.	The test subject stated that almost all of the test items developed did not cause multiple interpretations
5	The suitability of writing questions with the rules of writing test questions.	The test subject stated that each test item developed was in accordance with the rules of writing a test sola.
6	The standard of words, terms in test questions.	The test subjects stated that almost all of the test items developed were written in standard Indonesian.
7	The accuracy of writing chemical symbols.	The test subject stated that the writing of chemical symbols in the developed test questions was appropriate.
8	Writing vocabulary that is not known to students.	The test subject stated that there were almost no foreign terms that were not known to the students, only that the students were less familiar with the existing chemical formulas.
9	Accurate use of punctuation marks.	The test subject stated that the use of punctuation marks on the items developed was almost exactly right.
10	Writing questions in the developed instrument	The test subject stated that all the questions had used the type and size of the letters proportionally, and were clearly legible.
11	Presentation of images on the developed test questions.	The test subject stated that all the questions in the picture presentation were able to help students understand the questions.

After the readability test was carried out, revisions were made to the suggestions and inputs given. At the expert judgment stage, it is carried out to prove content validation, which consists of aspects of constructs, language, and material in the form of the suitability of the Higher Order Thinking Skills (HOTS) indicator and the accuracy of the salt hydrolysis concept.

In the expert judgment stage, the initial product assessment was carried out on the HOTS instrument as many as 40 questions equipped with a grid of questions and answer keys. The assessment was carried out by 5 experts who were material experts, linguists, evaluation and assessment experts, and 2 chemistry teachers. The validity of the content of the items was assessed from the aspects of construction, language, and material in the form of suitability of indicators (indicators of higher order thinking skills) and the truth of the salt hydrolysis concept, through expert agreement. The adjustment of the items made by the validator is assessed in the form of a score of 1-4. The highest score is 4 while the lowest score is 1. The score results are then analyzed using Aiken's V.

Based on the data, it shows that the validation results by the validators on each item using the Aiken's formula almost all items are declared good, this is evidenced by the average Aiken index of 0.85 which is included in the high category. Good provisions are based on the score given by the validator totaling 40 questions or about 100% of the items are said to be valid. The results of the validation of experts on the HOTS assessment instrument can be seen in Table 4.

Table 4. Expert Validation Results on the HOTS Assessment Instrument

Validator	Indeks Aiken	Criteria
Material Expert (Lecturer)	0.89	High
Linguist	0.92	High
Evaluation and Assessment Expert	0.84	High
2 Teachers	0.77	Currently
Average	0,85	High

Based on the results of the validation analysis by the 4 experts, namely material experts, linguists, evaluation and assessment experts, and teachers as practitioners, summarized in the Table 1, the Aiken index for material experts is 0.89 with high criteria, linguists 0.92 with high criteria, 0.84 evaluation and an assessment experts with high criteria, and 0.77 teachers with moderate criteria. The expert validates assessment of the HOTS an assessment instrument still needs the improvement both in terms of a material, construction, and language aspects so that a good question assessment instrument is obtained and is easily understood by respondents. Based on the results of the four validates, this shows that all of the items submitted are valid and can be used further to be tested for an empirical validity with an average of 0.85 with high criteria. The experts in this study were five people, which included 3 expert lecturers as validates, namely material experts, linguists, and evaluation and assessment experts, as well as 2 chemistry teachers as chemistry learning assessment practitioners at MAN 2 Deli Serdang.

Empirical validation is carried out directly by testing the instrument that has been revised and analyzed using the Rasch model. Using the Rasch model for testing the validity of the instrument, the results can be more varied because the validity of the instrument can use various criteria so that the resulting instrument can be more trusted (Erfan et al. 2020). The validity analysis using the Rasch Model can be said to be better because of its consistency (Panayides et al. 2010; Abdaziz et al. 2018). The advantages of Rasch modeling compared to other methods, especially the classical test theory are that it provides a linear measure with equal intervals, performs an accurate estimation process (calibration), is able to predict missing data (missing data), is able to detect model inaccuracies, and produces measurements replicable (Wright & Mok, 2004).

4. Conclusion

The conclusions obtained from the research that has been carried out are: the HOTS Assessment Instrument which was developed for SMA/MA class XI on the salt hydrolysis material as many as 40 questions, the assessment instrument meets the content validity by expert judgment which is analyzed using Aiken's V index of 0.85 of which 37 questions said to be valid, which means that almost all item items are valid and in accordance with the 2013 curriculum. In the learning process at the school, teachers challenge students to train students to have higher-order thinking skills, and teachers can make their own HOTS instruments according to the characteristics of students.

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