Instrument higher order thinking skill design in course high-class mathematics in elementary school teacher of education department

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Abstract. The background of this research is the absence of standard instruments that can measure the ability of high-level thinking in students on learning mathematics. The objective of this research is to produce valid, practical, and effective devices that can measure the strength of high-level thinking of the students majoring in elementary school teacher of education. This research is development research. The development steps of this research are theoretical analysis, formulating the operational definition, the determination of the contract, the dimensions and indicators, the preparation of the grid, the development of the items, the analysis of legibility and social desirability, field trials and data analysis. This research uses validation sheet, questionnaire and item. Based on HOT instrument validity test 85.50% with the very valid category. Practicality test result from lecturer percentage is 87% with convenient category and student percentage 84.50% with the practical category. The effect of the HOT student instrument assessment from the first trial to the second trial increased by 23% indicates a positive change in the students' HOT ability. Therefore, the HOT instrument is declared effective. HOT instruments for elementary school teacher of education students are consequently valid, practical and effective. This research implicates research can be used as a standard instrument of thinking ability of high-level students of elementary school teacher education.

1. Introduction

The thinking ability is the ability to change something that is captured by the sensory device [1]. When someone thinks, the individual will use his or her knowledge to achieve a goal [2]. Thinking ability is an essential basis in human life to achieve its goals, besides that humans also need the ability to remember to communicate with others. Descartes stated that thinking is a part of reasoning, reasoning which contains simple ideas that are mutually binding with strong logic rules [3]. Thinking ability is the ability that can process information in understanding and achieving a goal.

There are two types of human thinking abilities, namely low-level thinking ability and high-level thinking ability [4]. In rational thinking always involves low-level thinking skills to high-level thinking skills [5]. Low-level thinking skills are also called LOTS. LOTS is the ability to think an individual which consists of the ability to knowledge, understanding and applying something [6]. The ability of LOTS is only limited to remembering one fact and not being involved in critical thinking skills [7]. However, LOTS is the foundation or basis for building high-level thinking skills [8]. LOTS is an essential ability constructed to develop other thinking skills.
Other thinking skills are higher-order thinking skills called HOTS. HOTS is the ability to think that requires thinking that is more than just the ability to remember and memorise [9]. HOTS forms students to interpret, analyse, and manipulate information [10]. HOTS is the ability that refers to the ability to apply knowledge, to skills, reasoning, reflection, problem-solving, decision making, innovations and creating something new [11]. Bloom in his taxonomy states that HOTS is the ability to think in encouraging someone to apply, analyse, synthesis and conduct an assessment of something [12]. Besides that, HOT is a thinking ability that can find solutions in solving problems, solving problems in different ways, choosing the right action in solving problems, being able to select the right strategy, the overall ability of HOTS is the ability to solve non-routine problems [13,14]. HOTS is also the ability to think logically, think critically and do reasoning which is an essential ability in everyday life [15,16]. This statement means HOTS is an advanced ability that requires more ability not only the ability to remember and the ability to memorise.

Every level of education must develop HOTS abilities [17]. HOTS can train students to connect ideas and expand their thinking is to use high-level questions, namely questions that require students to do something more than just remembering information that has been learned before. The development of HOTS can teach students how to think, developing thinking skills can prepare students to become future workers who can solve problems [18]. From the above, so many of the benefits of HOTS development included students in universities, including elementary school teacher education’s students. One of the subjects that can train HOTS is the eyes of high-class mathematics education.

High-class mathematics education courses are compulsory subjects that must be taken by elementary school teacher education’s students. Learning mathematics in college is a must that is carried out by every student at the university. This statement based on four principles of mathematics learning, namely mathematics as problem-solving, mathematics as reasoning, mathematics as communication and mathematics as reasoning [19]. HOTS is an ability that must be developed for students at the university to prepare students who have intense and competitive competition.

To find out the facts in the field, researchers analysed the results of the Mid Semester exam for elementary school teacher education student’s who took high-grade mathematics education courses. The results of the review were only 17 out of 104 students who took high-class mathematics education courses that scored above 75 while the rest were under the 75 mark. The analysis of this subject was the difference in HOTS abilities of elementary school teacher education student’s because the questions given were the questions discussed earlier. Next, the researcher interviewed a mathematics lecturer majoring in elementary school teacher education. From the results of the interview, the researchers concluded that the mathematics abilities of elementary school teacher education’s students were low. There is no attempt to improve HOTS ability of elementary school teacher education’s students.

Analysis of researchers to improve HOTS ability students need to know their HOTS ability levels. To find out the level of HOTS ability students need to develop instruments that can measure the ability of HOTS of elementary school teacher education’s students. An apparatus is a measuring tool for collecting data. In science, many experts have standardised the measuring instruments used to make measurements. In a study, if you want to use a standard measuring tool, you need data design, data submission, information retrieval about measuring instruments, testing and reporting the results of quality testing by expert experts who standardise it [20]. An apparatus is a tool that can be used to measure the level of achievement of competence [21]. Based on the opinion of the experts it was concluded that the instrument was a measuring instrument whose quality had been agreed upon and standardised by experts for measurement use.

There are three types of instruments, namely questionnaires, tests, and observations. The questionnaire is a list of written questions addressed to the respondent, the respondent's answer to all items in the questionnaire is then recorded or recorded [22]. A test is a measuring tool used in the data collection process. In the test respondents, respondents responded to the questions given in the instrument, and respondents must be able to answer the questions presented as much as possible so that the data obtained is by the actual ability of respondents [23]. Observation is a scientific activity based
on both field and text facts, and this is explained using sensory experience without any manipulation elements [24].

The instrument used to measure HOTS ability of elementary school teacher education’s students is using a questionnaire instrument because the questionnaire is an efficient data collector if the researcher knows precisely data or information is needed and how the variable that states the required information is measured. This case is by the instruments are necessary to see the ability of HOTS of elementary school teacher education’s students.

The research that supports this research is research conducted by Tanujaya which produces instruments that can measure the HOTS ability of high school students [25]. This case is different from the research that researchers have developed, namely developing HOTS Instruments for elementary school teacher education’s students. Therefore, this study aims to produce a valid, practical and useful HOTS instrument for elementary school teacher education’s students.

2. Methods
This type of research is development research. Research on the development of research methods used to produce certain products, and test the effectiveness of these products [26]. The approach used in this study is the qualitative approach. Subjects were students of elementary school teacher education Universitas Negeri Padang class 2015. Types of data in the study were primary data, namely data taken from the results of HOTS instrument validation and validation of the practicality questionnaire HOTS instrument conducted by the validator in the form of HOTS instrument validation results and practicality questionnaire. The data obtained during the trial were in the way of lecturer and student responses to HOTS students and the enhancement of students' HOTS abilities.

Data analysis techniques in the form of analysis of the validity of HOTS instruments were performed to see the data from HOTS instrument validation developed. Data obtained from the validation of teaching materials analysed for all aspects presented in the table using a Likert scale in the form of values 1 to 4. Data analysis of HOTS instrument validation instruments was calculated using the formula adapted from Purwanto [27]. Practicality analysis techniques are used to analyse data from observations of lecturer response questionnaires and student response questionnaires. questionnaire in the form of a Likert scale. Practicality questionnaire is described by formula data frequency analysis according to Purwanto. Review of effectiveness by looking at enhancing HOTS abilities of elementary school teacher education’s students.

3. Results and Discussion
As for the results of this study as follows:

3.1. Theoretical analysis
Theoretical analysis is essential in research [28]. Theoretical analysis is the first step to doing research [29]. Theoretical analysis has the aim of being a foundation between science and other sciences [30]. Therefore, the first step of the researcher is to do a theoretical analysis of HOTS and the practicality of using HOTS. Based on theoretical analysis of HOTS's ability, HOTS is a broader thinking skill, not only to remember, understand, and the ability to apply a concept but also the ability to think to analyse an idea, evaluate and even create a theory [31]. Whereas, the practicality is the level of usage and prototype implementation [32].

3.2. Formulating the operational definition
The operational definition is a definition that describes the basic principles underlying a concept [33]. The conceptual clarity of HOTS is HOTS consisting of the ability to think critically and creatively. The conceptual definition of HOTS practicality from the aspect of lecturer and student is related to the implementation process and evaluation.
3.3. The determination of the contract, the dimensions and indicators
The decision of HOTS 'ability is the ability to think critically and creatively. Then the dimensions of HOTS ability indicators are abilities that can improve critical thinking skills and students' creative thinking skills.

The dimensions of critical thinking skills are the utilisation of concepts, utilisation of principles, prediction of impacts and problem-solving. The aspects of the ability to think creatively are decision making, working on competence, trying new things, thinking divergently and imaginatively.

Determination of the lecturers' practicality about the assessment process, the suitability of the time and the implementation process while the practicalities of the student aspects are student interest, the implementation process, timeliness and evaluation. From the above, the dimension of the practicality of the lecturer is the assessment technique, time and implementation and the practicality of students is the attraction, the process of use, ease of use, time and evaluation. After developing dimensions then the next is the determination of indicators. The indicators can see in Table 1.

3.4. The grid preparation
Before making the test, the development of the questions is first done so that the assessment material is representative and relevant to the learning material provided by the teacher to students [34]. A good grid will get questions that are relatively the same even though the problem is different [35]. The questions grid also makes it easier for the lecturer to create items. The HOTS ability grid can see in Table 1.

| Dimension                      | Indicator                                           | Number |
|--------------------------------|-----------------------------------------------------|--------|
| Concept Utilization            | 1. Having basic skills                              | 1,2    |
|                                | 2. Provide an explanation                           | 3,4    |
|                                | 3. Summing up the assumptions needed                 | 5      |
|                                | 1. Question the concept                              | 6, 7   |
| Utilization of Principles      | 2. Analyze the idea                                 | 8, 9   |
|                                | 3. Synthesize relationships between concepts         | 10, 11 |
|                                | 1. Determine the consequences of assumptions         | 12, 13 |
| Impact Prediction              | 2. Arranging assumptions                            | 14, 15 |
|                                | 3. Using the concept well and balanced               | 16, 17 |
|                                | 1. Find the source of the problem                   | 18, 19 |
| Problem-solving                | 2. Predict the cause of the problem                 | 20, 21 |
|                                | 3. Gather information in solving problems            | 22, 23 |
|                                | 1. Find some alternative solutions                  | 24, 25 |
| Decision-making                | 2. Choosing the best alternative/solution            | 26, 27 |
|                                | 3. Evaluate the decisions                           | 28, 29 |
|                                | 1. Refuse standard techniques                       | 30, 31 |
| Working limited competence     | 2. Optimizing knowledge                             | 32, 33 |
|                                | 3. High motivation and contours                     | 34, 35 |
|                                | 1. Extensive interest                               | 36, 37 |
| Trying new things              | 2. Forward / optimistic orientation                  | 38,    |
|                                | 3. Love new challenges/ideas                        | 39, 40 |
|                                | 1. Think freely, not rigid                          | 41     |
| Divergent mindset (spread)     | 2. Develop concepts                                 | 42, 43 |
|                                | 3. Modify the idea                                  | 44     |
|                                | 1. Perform a trial and error approach                | 45, 46 |
| Imaginative Mindset            | 2. Having original ideas                            | 47, 48 |
|                                | 3. Have new ideas                                   | 49, 50 |
| Amount                         |                                                     | 50     |
Practical aspects of lecturer aspects can see in Table 2.

| No | Practicality variable | Indicator                          | Number      |
|----|------------------------|------------------------------------|-------------|
| 1  | Assessment Technique   | Excellence                         | 1,2,3,4,5   |
|    |                        | Casting                            | 6,7,8       |
| 2  | Time                   | Time implementation                | 9           |
| 3  | Implementation         | Application                        | 10,11,12,13,14 |
|    |                        | Amount                             | 14          |

The practical aspects of the students can see in Table 3.

| No | Practicality variable | Indicator                                                                 | Number       |
|----|------------------------|---------------------------------------------------------------------------|--------------|
| 1  | Attractiveness         | HOTS instruments attract students to increase HOTS                         | 1,2          |
|    |                        | The linkage of HOTS Instruments with mathematics learning material        | 3            |
|    |                        | The link between HOTS instruments and everyday life                        | 4            |
| 2  | Use Process            | Instructions for working on devices are easy to understand                 | 5            |
|    |                        | The language used in the apparatus is easy to understand                   | 6            |
| 3  | Ease of Use            | The instrument makes it easy for students to know HOTS ‘abilities           | 7            |
|    |                        | The device makes it easy for students to improve HOTS abilities             | 8,9          |
| 4  | Time                   | The time given is by the number of questions done                           | 10           |
| 5  | Evaluation             | the instrument developed helps students to understand the concept of mathematics learning | 11           |

The grids that are set up then developed into questions and questionnaires.

3.5. Item development
Preparation of items from the grid made. The example of the development of the questions, The anticipation of matter from the network created. The case of developing the items for HOTS abilities are

a. The ability to think critically about the dimensions of the prediction of impacts with indicators determines the effect of assumptions.

After 10 months, Zaki's savings in cooperatives amounted to Rp. 4,200,000. The Bank provides deposit services in the form of interest of 14% / year. What is Zaki's initial savings at the bank?

b. Examples of the ability to think creatively about the dimensions of a creative mindset with indicators have original ideas.

The comparison between Ucup and Ogi's money is 6: 5. Also, Ogi and Andika's salary is 4: 3. If the amount of the money for all of them is Rp. 59,000. How much is each of their money? Make another case to question the same thing and calculate the results.

The development of practicality questionnaire consists of teacher aspects and student aspects. Examples of developing teacher aspects such as the dimensions of assessment techniques with indicators of excellence are instruments that make it easier for lecturers to measure the high-level ability of students. Practical development regarding students with the dimensions of attractiveness and indicators
Develop indicators to be able to measure HOTS ability of elementary school teacher education student’s and can estimate the practicality of instruments hots based on teacher aspects and aspects of students.

3.6. The analysis of legibility and social desirability

The study of readability is done by validating the validator. An instrument is said to be valid if it has the right measuring instrument [36]. Also, validation is an act of measuring something that can be measured [37]. To make measurements about the feasibility of HOTS instruments and practicality questionnaires measured qualitatively by the validator and calculated using the formula developed by Purwanto. The instrument of HOTS ability was assessed by a validator who was an expert in mathematics and the Indonesian language. After the validator validates, revised several items. After the validator states the Valid instrument and is not biased, researchers did not change again. The average validation score is 85.50 with a very valid category.

Subsequent validation is validation for the practicality of lecturer aspects and aspects of students. Validation of useful instruments involves expert assessment experts, mathematicians and linguists. The validation of the practicality aspects of lecturers and students is done twice so that the validator states that valid instruments are used and not biased.

3.7. Field trials

As many as 150 students are objects to measure HOTS abilities. The first phase of the experiment the researchers gave 9 types of questions that represented HOTS ability dimensions. The test process is 90 minutes. Phase 1 students get an average student score of 35 with a low category. Phase 2 was tested by students to get an average score of 58 in the medium class. This result has increased by 23%. The lecturer aspect practicality test was given to the mathematics lecturers at elementary school teacher education and asked to fill in the practicality questionnaire and obtained an average of 87 with a convenient category. The practicality test of HOTS instruments from the student aspect was given after the students worked on the 2nd stage HOTS instrument. The results of the HOTS instrument pre-validity test from the student aspect obtained an average score of 84.50% with an efficient category.

3.8. Data analysis

Data analysis is essential in a study [38]. LeCompte and Schebsul stated that the report is a process for reducing data and interpreting it. After conducting a field study, the results of the survey were analysed to obtain valid data.

The results of the validity of expert experts on HOT instruments are 85.50 with a very valid category. HOTS instruments are declared valid by the validator regarding content and language density. Content validity aims to determine the feasibility of the material through expert judgment [39]. While language validity seeks to assess the possibility of the content regarding language accuracy.

This prototype is declared to be very valid, proving that the validator has stated that the prototype is suitable for use. Validity is the result of the measurement of expert judgment at the same time as to the validity of understanding between assessors [40]. The conclusion is HOTS instruments were appropriate to be used to measure the ability of HOTS of elementary school teacher education student’s.

The practicality test of HOTS instrument from the lecturer aspect is 87 with a very functional category. The practicality of the HOTS instrument must be known so that the prototype is of practical value so that the existence of the apparatus helps the lecturer. The practicality of this instrument is the level to determine the suitability of this instrument by the lecturer [41]. Judging from the results obtained that the lecturer stated that this instrument was efficient to measure HOTS ability of elementary school teacher education student’s. This result proves that the high usage of HOTS instruments.

The practicality of HOTS instruments from the aspect of students gets an average of 84.50, and this result proves the HOTS instrument regarding the student’s perspective is in the practical category.
practicality of the HOTS instrument shows that students stated that the HOTS instrument developed could be used and useful for them.

The results of the trial in the first and second stage of the field increased by 23%. This evidence shows an increase in the effects of the HOTS abilities of elementary school teacher education student’s. The results of the effectiveness of this HOTS instrument can see from the results of the above trials. A prototype is declared effective if the external results are in line with expectations [42-43]. This 23% increase from the low category to the medium class is the expectation of the elementary school teacher education department because it sees the elementary school teacher education student`s conditions that come from different multidisciplinary disciplines as well as high schools, vocational schools and other schools. This fact proves that HOTS students' abilities are still in the medium category. The need for additional efforts to improve the ability of HOTS.

4. Conclusion
The development of HOTS instruments for elementary school teacher education student’s is declared valid, practical and useful. This fact can see from the validation results of 85.50% with a very particular category. The lecturer’s practicality test is 87% with efficient results, and the practicality aspects of the students are 84.50% with functional groups. Effectiveness was seen from the increase in HOTS ability of students by 23%.

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