



DEVELOPMENT OF NUMERACY LITERACY INSTRUMENTS TO IMPROVE HIGH-LEVEL THINKING SKILLS IN JUNIOR HIGH SCHOOL STUDENTS

Arif Hidayatullah^{1*)}, Hepsi Nindiasari², Sukirwan³

^{1,2,3} Universitas Sultan Ageng Tirtayasa, Banten, Indonesia

Email: 7778220007@untirta.ac.id

Abstract

The background to this research is that there are very few numeracy literacy questions, students are still not trained enough to work on numeracy literacy questions, and teachers are not optimal in understanding the development of numeracy literacy questions even though in an effort to improve HOTS abilities students need to get used to dealing with numeracy literacy questions. This study aims to develop a math HOTS measuring instrument for first semester VII graders of junior high school (SMP) students. The research method is research and development with ADDIE stages namely analysis, design, development, implementation, and evaluation. The instruments used in the research were numeracy literacy test questions in the form of descriptions, observation sheets, response questionnaires, and interview sheets. The research flow begins with the initial analysis, the development of a grid of numeracy literacy questions, expert validation, revision, practitioner testing, small-scale trials, revisions, and large-scale trials. The results of the study were 18 items of numeracy literacy with Competency Standards for Numbers, Sets, Algebra, and Systems of Two-Variable Linear Equations. The numeracy literacy instrument indicators developed include analytical, evaluation, and creative abilities. The questions developed have valid quality as seen from the validity test of all the items above 0.5, reliability 0.86, difficult and moderate difficulty levels, and good and sufficient discriminating power. The mean HOTS score of students was 71. The conclusion of this study was to produce a valid and reliable HOTS measuring numeracy literacy instrument for junior high school students.

Keywords: HOTS; Junior High School; Numerical literacy.

INTRODUCTION

The 21st century is the century of knowledge, where the flow of globalization and the openness of information and technology are rapidly developing and bringing changes to all aspects of life. Therefore, every individual is expected to be able to equip themselves with skills in facing the era of globalization. Literacy is one of the skills that are indispensable to adapt and be able to keep up with the development of science and technology. In the traditional view, literacy is defined as the ability to read and write simple short statements about an individual's life. Along with the times, literacy is not only the ability to read, but also related to intellectual abilities, as well as knowing how to research and solve complex problems. Therefore, literacy is fundamental for individuals to be able to participate in society and achieve their goals in work as well as and implement the fundamentals of mathematics in the various contexts that individuals need in everyday situations.

Seeing how important numeracy literacy is, it is necessary to make various efforts, especially in the learning process to train students' numeracy literacy. The mastery of literacy needs to be balanced with developing critical thinking skills in problem solving, creativity, communication, and collaboration (Ministry of Education and Culture, 2017). The development of critical thinking skills and problem-solving in mathematics learning, one of which can be achieved through the habit of high-level thinking or *Higher Order Thinking Skills (HOTS)*.

According to Hidajat (Hidajat, 2021), high-level thinking skills are a basic component in learning to produce new ideas or facts in solving a problem. Meanwhile, Whitley argues that learning HOTS requires rational thinking to gain the knowledge needed to deal with real-world situations (Gupta & Mishra, 2021). Previous discussions show that numeracy literacy requires students to be able to identify, understand and implement the basics of mathematics to solve daily problems. Thus, the use of HOTS questions in the mathematics learning process can be one of the efforts to train students' numeracy literacy skills.

The main goal of this scientific journal is to develop a valid and reliable measuring instrument to measure mathematical HOTS in junior high school students. The right instruments will assist teachers and researchers in tracking the development of students' high-level thinking skills, as well as designing effective learning strategies to improve their abilities. In this study, we will apply a structured and systematic instrument development approach to ensure that the resulting instruments have high validity and reliability. We will also involve junior high school students as research participants to ensure the relevance and readability of the developed instruments.

It is hoped that the results of this research will make a significant contribution to the development of mathematics education at the junior high school level. The resulting instruments can be used by teachers to measure and develop students' math HOTS, as well as provide a strong foundation for designing learning strategies that support the development of high-level thinking skills.

RESEARCH METHODS

This research is a type of research and development. The steps in making this research are carried out with the ADDIE development model developed by Dick and Carry with stages (*Analysis, Design, Development or Production, Implementation or Delivery and Evaluations*) (Branch, 2009)

The research flow includes five stages based on the ADDIE method described in Figure 1.

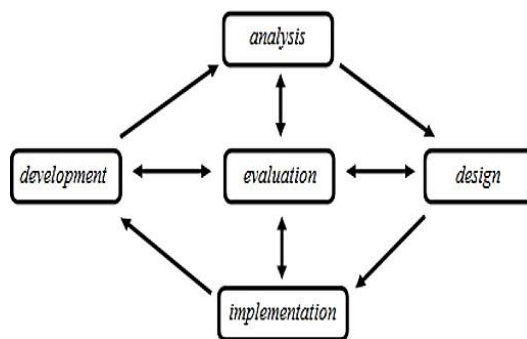


Figure 1. ADDIE's research method.

The first stage of needs analysis was carried out to find out whether the development of numeracy literacy instruments needed to be carried out. The preliminary study was carried out at Junior High School Class VII Even Semester of the 2022/2023 school year in Serang Regency. Based on the needs analysis, it was concluded that a mathematical HOTS measuring instrument is needed for junior high school students in grade VII. Then the material analysis, this activity is guided by core competencies and basic competencies that will be used as the basis for making questions for the numeracy literacy test instrument. In the analysis of this material, materials in mathematics lessons were selected to find out the ability of students to work on HOTS problems, namely Numbers, Sets, Algebra, and One-Variable Linear Equation Systems.

The second stage is Design, this stage is product design. At this stage, the researcher makes a grid of question items that include HOTS indicators, namely analysis, evaluation, and creation for each material. The total number of numeracy literacy questions is 19 questions in the form of descriptions, with each question containing three HOTS indicators.

The third stage of *Development*, namely the development of products for the manufacture of numeracy literacy test instruments, at this stage will be carried out; Validation of theories and constructs; reliability questions, revision questions, design revisions, Final Products. The expert validation includes two experts in mathematics learning evaluation and one expert in mathematics materials. The practitioner is a mathematics teacher at SMPN 1 Tirtayasa.

The fourth stage of *Implementation* (Implementation) at this stage is a trial of numeracy literacy test instrument products. The small group trial involved 10 subjects from grade VIII students of SMPN 1 Tirtayasa. The large group trial involved 30 students in grade VIII of SMPN 1 Tirtayasa.

The final stage is *Evaluation* (Evaluation) Evaluation is carried out at each stage of research starting from assessment design, product manufacturing, design validation, revision. The subjects in this study are grade VIII students of SMPN 1 Tirtayasa who come from 3 different classes, The instruments used in data collection in this study are: Validation sheet of the expert team; A Teacher's Guide to Teaching; A Student's Perception Questionnaire; Observation Sheet; Interview sheets; The numeracy literacy

test instrument is in the form of a description. The data analysis carried out on the data collection instruments is question analysis, validity of question items, difficulty level, differential power analysis, test question reliability analysis, data analysis of material expert questionnaire results, practitioner test analysis, analysis of small-scale test results. The validation of the HOT'S measuring instrument was measured using a five-scale Likert scale, with a valid level of 1-5. The score that has been obtained based on the expert's assessment is then converted into a percentage. This percentage is calculated using formula (1):

$$V = \frac{\sum x}{\sum xi} \times 100\% \quad \dots(1)$$

The description of formula (1) is V the percentage of validity of the instrument, $\sum x$ is the total sum of expert judgment, and $\sum xi$ is the sum of the total ideal value. Once the percentage results are known, the validity level of the developed instrument is then grouped into the product validity criteria shown in Table 1.

As for calculating the validity of the item of the numeracy literacy instrument, the formula used *Korelasi Product Moment* with Rough Numbers. As for calculating the reliability of the question items using the formula *Cronbach-Alpha*.

Table 1. Validity criteria for subject matter experts and evaluation of mathematics

No	Kriteria Validitas	Tingkat Validitas
1	$85\% < V \leq 100\%$	Sangat valid
2	$70\% < V \leq 85\%$	Valid
3	$50\% < V \leq 70\%$	Kurang valid
4	$V \leq 50\%$	Tidak valid

learning.

RESULTS AND DISCUSSION

Instrument Development Process

At the analysis stage, data was obtained that numeracy literacy instruments have not yet been developed by junior high school teachers. In addition, this stage results in the definition of HOTS that the instrument will develop. The design stage resulted in the initial design of the HOTS instrument.

This research produced a mathematical HOTS measuring instrument for grade VII semester 1 with Competency Standards of Numbers, Sets, Algebra, and One Variable Linear Equation System. The number of questions is 19 questions in the form of a description test instrument. Based on the ADDIE method, the initial design was validated by three experts, namely a mathematics learning evaluation expert and a mathematics material expert. The results show that the instrument is worth using with improvements. The validity criteria for the numeracy literacy instrument based on the three experts were analyzed with the presentation formula in number (1). The results showed that the content validation aspect was 78%, the construction validation was

85%, the language validation aspect was 80%, the time allocation was 74%, and the question instruction was 65%. Based on the expert validation criteria in Table 2, it is concluded that the student's HOTS measuring instrument is valid, but based on expert advice there are several improvements. Some of these suggestions are presented in Table 2.

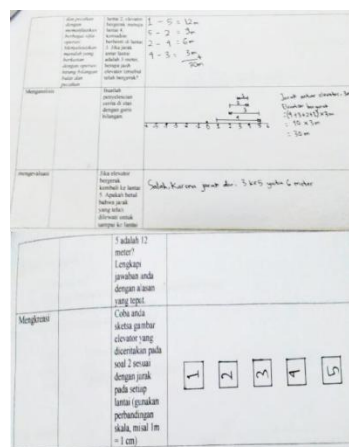
Table 2. Suggestions for improving numeracy literacy instruments and experts

Suggestions for Improvement	Repair
Inconsistency in writing question illustrations.	A packaged instant food factory will make sausages. Its nutritionists measure the right temperature for the best meat freezing as a sausage making ingredient. If the temperature is lower increasingly good in maintaining the quality of the meat, then order the following temperature starting from the best for freezing meat. -12° , 12° , -15° , -30° , 30° , 15°
The illustration in the story with the questions presented on the analysis indicator is still not very suitable	Based on the story in number 1 above, if for brand A sausages, frozen meat of brand A sausages every 2 minutes the temperature will drop by 5° . Brand B sausages frozen sausages brand B sausages drop 3° every 4 minutes, and brand C sausages frozen sausages brand C sausages every 5 minutes drop 4° . So which brand of sausage frozen meat has the highest temperature drop if taken out for 20 minutes?
Wrong in writing numbers for nominal money. It is better not to include terms outside the decree that are used as instruments.	Based on the story in question number 3 above, if the cost needed to build a shophouse is Rp. 100,000,000 and the annual rental fee is Rp. 135,000,000. While the rental fee for land without buildings is Rp. 50,000,000 and the rental fee for the arena per year is Rp. 35,000,000. So which rent is more profitable? Give your reasons!

After improvements were made based on the suggestions of the validators, the test instruments were given to the mathematics teacher of SMPN 1 Tirtayasa as a practitioner. The results based on the validity percentage stated that 82% of the instrument's validity rate means that the instrument is valid. There are several improvements, including: (1). Instructions for working on the questions need to be corrected for each SK; (2). If necessary, add questions that contain geometric elements

as a link between concepts. Then based on suggestions from practitioners, improvements were made and then small-scale trials were carried out with a total of 10 students. Coming from grade VIII students of SMPN 1 Tirtayasa.

The result of the small-scale trial was the presentation of student responses of 87%, meaning that the instrument was very valid. Based on interviews with the subjects, it was stated that students understood the questions presented for each indicator. Students can do it well. It takes a long time about 4 hours to do the whole question. Students feel difficulties with the questions with the creation indicators. The instructions for working on the question need to be improved. The form of right and wrong questions will be done faster by students. Based on the analysis, it was found that students were able to answer analysis and evaluation questions well, but were incomplete in answering questions with creation indicators. The results of the students' answers are



presented in Figure 3.

Figure 3. Students' Answers in Small Scale Trials

The results of the students' answers show that students can answer according to the correct answers to the questions with analyzing and evaluating indicators. However, students cannot sketch the elevator according to the scale requested in the creation indicator question. The average score of 10 students in the small-scale trial was 71 with a scale of 1-100. The scores of students in the HOTS measuring instrument trial are presented in Table 3.

Table 3. Small-scale trial scores

Learners	Score (Scale 100)
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S1	65
S2	75
S3	80
S4	60
S5	55
S6	90
S7	70
S8	80
S9	60
S10	75
Total	710 Rerata 71

Based on Table 3. That the average score of students is quite good in small-scale trials. This average score was taken completely because it had reached the KKM of mathematics subjects at SMPN 1 Tirtayasa, which was 70. Furthermore, based on the results of small-scale trials, revisions were made which included instructions on the questions and variations in the form of analysis questions by examining true or false statements.

The next stage after the revision of the results of the small-scale trial and the practitioner test is a large-scale trial. This large-scale trial involved 30 subjects from SMPN 1 Tirtayasa. The subjects selected are different from the subjects in the small-scale trial stage. The result of the large-scale trial is a mathematical numeracy literacy instrument for junior high school students in grade VII semester 1 which has been tested for quality.

The calculation of the quality of the instrument includes construct validity, reliability, differentiation, and difficulty index. Calculating the validity of the construct is used for exploratory factor analysis. The interpretation is that if the value of the KMO (*Kaiser Meyer Olkin*) is more than 0.5, then the instrument is valid (Arifin & Retnawati, 2017). The value of the SME was obtained through the help of *SPSS IBM 2.0*

Based on calculations, it was obtained that the quality of the mathematics numeracy literacy instruments for junior high school students in the first semester includes validity, reliability, differentiation, and difficulty index developed are presented in Table 4.

Table 4. Validity, difficulty, and differentiating power of question items.

Question	Validity Value	Criterion
Criterion	DP Value	Kindergarten Grades
		Criterion

X1	0,65	valid	0,26	Criticism	0,27	enough
X2	0,75	valid	0,32	keep	0,37	enough
X3	0,80	valid	0,45	keep	0,45	good
X4	0,60	valid	0,68	keep	0,55	good
X5	0,75	valid	0,20	Criticism	0,45	good
X6	0,90	valid	0,36	keep	0,67	good
X7	0,70	valid	0,42	keep	0,23	enough
X8	0,80	valid	0,32	keep	0,45	good
X9	0,60	valid	0,68	keep	0,56	good
X10	0,75	valid	0,20	Criticism	0,43	good
X11	0,65	valid	0,32	keep	0,23	enough
X12	0,86	valid	0,50	keep	0,68	good
X13	0,89	valid	0,29	keep	0,50	good
X14	0,77	valid	0,60	keep	0,67	good
X15	0,84	valid	0,32	keep	0,46	good
X16	0,89	valid	0,35	keep	0,54	good
X17	0,89	valid	0,56	keep	0,35	enough
X18	0,77	Valid	0,60	keep	0,24	enough
X19	0,67	Valid	0,65	keep	0,48	good

The validity value based on Table. 5 is all more than 0.5, meaning that all question items are valid and the instrument is valid. As for the difficulty level, the question items are all difficult and moderate. This is natural considering that the HOTS question is indeed not an easy and routine matter. The differentiating power is good and sufficient. This means that this instrument can distinguish between students who can do and students who can't. The reliability of the instrument is calculated using *the Cronbach-Alpha* formula with the help of IBM 2.0 SPSS. The reliability criterion is that *the Cronbach-Alpha* value of more than 0.7 is said to be usable and reliable (Hayati & Lailatussaadah, 2016). Based on these calculations, the reliability value of the numeracy literacy instrument for junior high school students in the first semester is 0.86. This value is more than 0.5, which means that the instrument is reliable.

In general, the mathematical HOTS measuring instrument for junior high school students in grade VII in the first semester can be used. This instrument contains indicators of analysis, evaluation, and creation. The opinion of Arifin & Retnawati (2017) states that to make HOTS questions valid, reliable, and suitable for use, it must contain the ability to think critically and creatively. Of course, the ability to think critically is clearly contained in the ability to analyze and evaluate. It is further stated that the right instrument can certainly measure the HOTS ability of students. This instrument can be used to train and familiarize students to do and face HOTS form questions. The HOTS form question is needed as an effort to improve students' HOTS skills. Students' activities to work on or solve a problem can support the improvement of HOTS skills. Abdullah, Abidin, Ali (2015) produced a finding that students' activities in problem

solving are activities that can produce HOTS.

Furthermore, it is said that the proper numeracy literacy instrument no longer contains routine questions. It is natural that the difficulty level of the instrument developed by the researcher is of hard and medium level. This means that HOTS questions are not the type of questions that are easy to do. Usually, routine questions only contain knowledge or procedural indicators. However, this indicator is not included in the realm of HOTS capabilities. (Pratama & Retnawati, 2018) states that in the dimension of knowledge, the level of knowledge about facts is not included in HOTS. It is further stated that the task level by stating that the task level with the HOTS character, namely the work steps are unpredictable, not a routine problem, contains many solutions, requires more effort in doing it. The HOTS is based on the cognitive level, namely analysis, evaluation, and creation.

Discussing HOTS is certainly not just about discussing the level of knowledge. Furthermore, Pratama & Retnawati (2018) stated that tasks for HOTS can be deepened based on the characteristics of HOTS tasks, the dimensions of skills, cognitive levels, and knowledge levels. The results of this study show that the average score of students is 71. This average is only 1 point above the KKM. These results show that the students' HOTS abilities are not very good. This result is in line with a study (Arifin & Retnawati, 2017) which stated that the HOTS scores of high school students are not good.

This ability must continue to be trained so that there is no confusion for students in working on mathematics problems that are classified as high-level thinking. When students are given questions that are different from the teacher's examples, they look confused about solving the problem (Yuni, Alghadari, & Wulandari, 2019).

It can be concluded that HOTS type questions that require high-level thinking can train students to think at the level of analysis, evaluation, and creation so that these questions must be further developed in the 2013 curriculum in order to support the improvement of students' mathematical literacy skills (Suryapuspitarini, Wardono, & Kartono, 2018).

CONCLUSION

Based on the results of the research, a mathematical HOTS measuring instrument for first-semester junior high school students was developed as many as 18 questions with indicators of analysis, evaluation, and creation. Competency standards include numbers, sets, algebra, and two-variable linear equation systems. The instrument was declared valid and reliable with the difficulty level of the questions being medium and difficult, while the differentiating power of the questions was good and sufficient. The average number of students in answering questions about the HOTS measuring instrument is 71 (scale 0-100).

This research can be used as one of the materials to measure the HOTS ability of junior high school students in grade VII. This research can be further developed to analyze at which level the HOTS of junior high school students in Indonesia is located. For teachers, it can be used as a reference for daily test questions in the form of HOTS to train students' HOTS activities.

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