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Development of A Higher-Order Thinking Skills (HOTS) Instrument to Measure Student's Critical Thinking Abilities in Class V Elementary School

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ABSTRACT: This research and development aims to produce a feasible and practical Higher Order Thinking Skills (HOTS) instrument to measure students' critical thinking skills in grade V elementary school mathematics subjects. This research method is development research that refers to the design of Borg & Gall. The research was conduct in class V SDN 3 Sumberejo. Feasibility testing of instruments developed in this study uses expert tests, validity tests, reliability tests, differentiation power tests and difficulty tests. The results of this study showed that an eight-question instrument was obtained, which is suitable for use. The practicality of the instrument, based on the response of educators and learners as practitioners, yielded a very practical assessment. This demonstrates that the developed HOTS instrument is feasible and practical for measuring the critical thinking ability of fifth-grade elementary school students.

KEYWORDS: Critical Thinking, HOTS, Mathematic

INTRODUCTION

Mathematics is a field of study that will be accepted by students from all levels of education, from elementary school to college. It is intended to equip students with logical, analytical, systematic, critical and creative thinking as well as the ability to work together. At the elementary school level, mathematics aims to direct students to be able and skilled in using mathematical concepts in problem solving. Mathematics is a subject content that makes students skilled in preparing themselves, able to face changes that continue to occur, through practice acting critically and logically. Suryapuspitarini (2018) said that mathematics is one of the most important subjects because mathematics is a science that can train students to think logically, systematically, and creatively to solve problems.

21st century learning directs the development of competencies consisting of four abilities that must be possessed by students commonly called 4C, namely critical thinking, communication, collaboration, and creativity (Ariyana, Bestary, & Mohandas, 2018). One of the important skills that must be developed in elementary school is critical thinking. Through the development of this ability since basic education, it is expected that students will be able to solve problems faced in the world of education and in everyday life logically and critically (Pratama & Arini, 2020).

Critical thinking is used in various situations and opportunities in an effort to solve life problems. According to Firdaus, Warsono, & Jeremiah (2021), critical thinking skills will train students to examine, analyze, and evaluate information or opinions before determining, accepting, or rejecting the information. If the ability to think critically has developed in students, then students will be accustomed to taking rational steps that are supported by facts and being able to draw the right conclusions in solving problems (Handayani, 2020).

Critical thinking competence is basically owned by students, but the problem is how to bring up critical thinking competence (Octaviana & Setyaningsih, 2022). There are various efforts that can be made to bring out the critical thinking skills of students, one of which is by giving different questions than usual, namely using Higher Order Thinking Skills (HOTS) questions. These efforts can be used as a benchmark in guiding students to train themselves to think critically, creatively, cooperate, and communicate. The development of HOTS instruments is very important to prepare students to face future challenges and help in solving problems (Rahmawati, Komarudin, & Suherman, 2022). According to Madu & Aleksius (2017), using HOTS questions in mathematics learning can improve critical thinking competencies, problem solving skills, questioning skills, reasoning skills, and communication skills.

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Critical thinking skills are an important aspect in education and need to be owned by students so that they need to be developed. The achievement of students' critical thinking level has not been achieved because learning is still focused on low-level thinking skills (LOTS), namely C1 (remembering), C2 (understanding), C3 (applying). The results of the needs analysis through observations and questionnaires that have been conducted with the target of three fifth grade educators of SD Negeri 3 Sumberejo, Kemiling District, Bandar Lampung, show that the dominant problem related to the critical thinking skills of fifth grade students is that the books used in the school do not contain questions that lead to the level of critical thinking, namely HOTS. Books that contain HOTS question exercises do not exist, whereas in 21st century learning, critical thinking, collaborative, creative thinking skills are needed, one of which is by bringing up HOTS questions in learning, and the provision of HOTS questions that are still not given to students. This can be seen from the mathematics textbook for grade V of the 2013 curriculum, which only contains routine questions and has not been widely developed.

Based on the results of filling out a questionnaire by three fifth grade educators at SD Negeri 3 Sumberejo, information was obtained that educators had not developed an assessment to measure critical thinking skills, this problem indicates that in learning mathematics the critical thinking skills of students have not led to 21st century skills. This is partly due to the inaccuracy of the instruments used by educators in the learning process. The right instrument in assessing the process and learning outcomes of students is expected to make students play an active role in learning.

The HOTS questions developed use three categories of higher order thinking based on Bloom's taxonomy by Anderson and Krathwall (2001), namely, C4 (analyze), C5 (evaluate), and C6 (create), where each level has its own criteria that can be adopted into the questions and learning objectives to be achieved. HOTS questions do not mean long and complicated questions, but the stimulus given in the form of descriptions, information, news, tables, pictures, and so on is relevant and appropriate.

Giving HOTS questions will gradually change the thinking of students in terms of reasoning and solving problems, students who are initially unfamiliar with HOTS questions need to be given regular HOTS-type problem exercises so that students will slowly have the ability to think at a high level. HOTS questions are needed by high-grade students, because high-grade students not only need the ability to memorize, but also to train the thinking power of students to be able to reason, logically and critically in solving a problem, in order to prepare students who are ready for all changes in this revolutionary era.

Based on this, it can be concluded that the instruments applied are still not optimal and there is a need to develop HOTS instruments to measure students' critical thinking skills. This aims to train students' critical thinking skills in solving problems, while educators can train their skills in developing HOTS-based questions. Therefore, it is necessary to study more deeply the development of HOTS instruments in improving students' critical thinking skills, especially in mathematics learning.

RESEARCH AND METHOD

This research is a development research or Research and Development (R&D). The development model used in this study refers to the R&D research model according to Borg and Gall (1989). Sugiyono (2018) explains R&D is a research method used to produce certain products, and test the effectiveness of certain products. This is in accordance with the research to be carried out by researchers, namely developing a product in the form of an instrument.

The research was conducted in the odd semester of the 2023/2024 academic year at SD Negeri 3 Sumberejo, Kemiling, Bandar Lampung. The subjects in this study were fifth grade students of SD Negeri 3 Sumberejo.

The Research and Development model used is only seven research steps, namely, 1) research and information collecting, 2) planning, 3) initial product development (develop preliminary form of product), 4) initial field testing (main field testing), 5) revising the initial product (main product revision), 6) main field testing (operational field testing), and 7) refining the final product revision.

Data collection was carried out using test and non-test techniques. The test technique is used to collect quantitative data which aims to assess whether the instrument developed has met the criteria of valid and reliable and feasible to use in learning assessment to measure critical thinking skills. The non-test technique is used to obtain qualitative data by reviewing the test instrument by experts in the form of a questionnaire which is analyzed by Aiken's V formula. The distribution of Aiken's V index acquisition categories can be seen in Table I.

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Table I. Aiken's V Scoring Criteria

No	Indeks Aiken (V)	Category
1	X > 0,84	Very Valid
2	X > 0,68 – 0,84	Valid
3	X > 0,52 – 0,68	Moderate Validity
4	X > 0,36 – 0,52	Less Valid
5	X ≤ 0,36	Invalid

Source: (Retnawati, 2016)

In addition, educators and students in the small group test were given a questionnaire to find out the responses to the critical thinking assessment instrument.

Data that is suitable for use in this study is valid and reliable data. Testing the validity of the question using product moment correlation with the help of the Microsoft Office Excel 2010 program with testing criteria if rcount ≥ rtabel with α = 0.05, then the question item is declared valid, while the reliability test is tested using the Cronbach Alpha formula, with testing criteria if rcount > rtabel with α = 0.05, then the question item is declared reliable.

The HOTS instrument developed is based on a grid that is adjusted to the critical thinking indicators according to Normaya (2015) which refers to Facione presented in Table II.

Table II. Critical Thinking Indicators

General Indicators	Indicator
Interpretation	Understand the problem as shown by writing the known and the question correctly.
Analysis	Identify relationships between statements, questions, and concepts given in the problem shown by making mathematical models appropriately and giving explanations appropriately.
Evaluation	Using the right strategy in solving the problem, complete and correct in performing calculations
Inference	Make conclusions appropriately.

The analysis of critical thinking indicators was calculated in two ways, first by calculating the average score of critical thinking skills with the formula:

$$Average\ Score = \frac{Total\ Score\ of\ Each\ Critical\ Thinking\ Ability\ Indicator}{Number\ of\ Students}$$

Second, calculate the percentage of the average score with the formula:

$$\%\ Score = \frac{Average\ Score}{Maximum\ score\ obtained} \times 100\%$$

The percentage score obtained is then converted to qualitative values based on several categories in Table III.

Table III. Critical Thinking Ability Criteria Guidelines

Percentage	Category
86% - 100%	Excellent
76% - 85%	Good
60% - 75%	Fair
55% - 59%	Poor
≤ 54%	Very poor

Source: (Budiyono, 2017)

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RESULT AND DISCUSSION

Data analysis in this study consists of data feasibility analysis and data practicality analysis of HOTS instruments to measure critical thinking skills.

A. Feasibility of HOTS Instrument Products

The feasibility of HOTS instruments to measure students' critical thinking skills is seen from the assessment of three experts, namely evaluation experts, material experts, and linguists. Evaluation expert validation aims to get input on the accuracy of the instrument in measuring what should be measured. The results of the evaluation expert validation are presented in Table IV.

Table IV. Evaluation Expert Validation Result

No	Assessment Aspect	Aiken Score	Interpretation
1	Content Feasibility	0,700	Valid
2	Construction	0,750	Valid
Holistic Aiken Index		0,725	Valid

Based on Table IV, it can be seen that the average score obtained from the evaluation expert validation is 0.725. It can be said that the product is valid. Validators also conveyed suggestions and input, namely one question must accommodate four indicators, with the conclusion that the product is suitable for testing with revisions according to suggestions.

Linguist validation aims to get input on language accuracy and correctness of writing. The results of the linguist validation are presented in Table V.

Table V. Result of Language Expert Validation

No	Assessment Aspect	Aiken Score	Interpretation
1	Language	0,800	Valid
Holistic Aiken Index		0,800	Valid

Based on Table V, it can be seen that the average score of the linguist validation is 0.800. It can be said that the product is valid. The validator also conveyed suggestions and input, namely pay attention to the writing of punctuation marks and the use of conjunctions in composing sentences based on PUEBI to produce effective sentences.

Material expert validation aims to get input on the suitability, and correctness of the material on the assessment instrument. The validator guides and directs about aspects of material suitability and content quality on the instrument.

The results of the material validation are presented in Table IV.

Table VI. Material Expert Validation Result

No	Assessment Aspect	Aiken Score	Interpretation
1	Construction	0,650	Moderate Valid
2	Substance	0,583	Moderate Valid
Holistic Aiken Index		0,615	Moderate Valid

Based on Table IV, it can be seen that the average score of the material expert validation is 0.800. It can be said that the product is quite valid. The validator also conveyed suggestions and input, namely correcting the wrong answer key.

The results of the research conducted are relevant to previous research by Rosidin, et al (2018) entitled " *The Development of Assessment Instrument for Learning Science to Improve Student's Critical and Creative Thinking Skills"*. The results showed that the instrument had a high category in the aspects of language, construction, and content based on expert and practitioner validation as a requirement for a feasible instrument. The research is in accordance with the theory of Sunarti and Rahmawati (2014) and Permendikbud Number 104 of 2014 which states that in preparing the instrument, it is necessary to pay attention to the

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construction/evaluation aspects, material aspects, and language aspects. The assessment instrument developed is not only tested for feasibility in the construction/evaluation aspects, material aspects, and language aspects as a requirement for a feasible instrument.

The instruments developed are not only tested for feasibility, but also seen based on the value of validity, reliability, difficulty level of questions, and differentiating power. According to Rosidin (2017), a good measurement instrument is an instrument that is carefully designed and empirically evaluated to ensure the accuracy of usage information and also meets the following requirements: 1) valid, 2) reliable, 3) objective, 4) practical and easy to use. Therefore, the instruments developed in this study were also tested for validity, reliability, differentiation and favorability. As a result, 8 HOTS instruments were obtained that were valid, reliable, had differentiating power and difficulty levels that were suitable for use.

The results of the research conducted are relevant to previous research by Fatmawati (2022) entitled "Development of Mathematics Higher Order Thinking Skills (HOTS) Problem Instruments on Critical Thinking Ability of Grade IV Elementary Students". This study aims to determine the feasibility of the instrument. The results of this study indicate that the developed mathematics learning outcomes test instrument items have difficulty levels in the easy, medium, and difficult categories, the validity of the developed mathematics learning outcomes test items is 100% valid, the reliability coefficient of the mathematics learning outcomes test instrument is in a very high category, and the differentiation index of the developed mathematics learning outcomes test items are all in the good category.

B. Practicality of HOTS Instrument Products

HOTS instruments to measure critical thinking skills in this development research were also tested on educators and students to see the practicality of the instruments developed. The results of students' responses assessed on the aspects of attractiveness, convenience, and usefulness can be seen in Table VII.

Table VII. Result of Learner Response

No	Aspect	Score	Interpretation
1	Attractiveness	96,67%	Very Practical
2	Convenience	88,33%	Very Practical
3	Usefulness	85,56%	Very Practical
Average Percentage		90,19%	Very Practical

Based on Table VII, the results of the trial of students' responses in the aspect of attractiveness obtained a value of 96.67%, in the aspect of convenience obtained a value of 88.33%, and in the aspect of usefulness obtained a value of 85.56%. It can be concluded that in general the results of the assessment of students are in the "Very Practical" criteria.

The results of the educator's response on the aspects of attractiveness, convenience, and usefulness can be seen in Table VIII.

Table VIII. Educator Response Result

No	Aspect	Score	Interpretation
1	Attractiveness	100%	Very Practical
2	Convenience	88,33%	Very Practical
3	Usefulness	88,89%	Very Practical
Average Percentage		92,41%	Very Practical

Based on Table VIII, the results of the trial of students' responses in the aspect of attractiveness obtained a value of 100%, in the aspect of convenience obtained a value of 88.33%, and in the aspect of usefulness obtained a value of 88.89%. It can be concluded that in general the results of the students' assessment are in the "Very Practical" criteria.

This is supported by research by Yuparing, Wiyono, and Sutadji (2023) "Assessment Instrument for Higher Order Thinking Skills (HOTS) in Mathematics Class IV SD Negeri 4 Tanggung" The results of the practicality of the instrument from the student response

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questionnaire obtained results for the material aspect of 80%, the construction aspect of 82%, the language aspect of 84%, and the aspect of usefulness and practicality of 84%. The results of data analysis of the results of the educator questionnaire obtained the percentage of material aspects reaching 86%, construction aspects reaching 85%, language aspects reaching 89%, and aspects of usefulness and practicality reaching 87%. Based on the predetermined score criteria, it was concluded that each respondent assessed the HOTS instrument in mathematics subjects as practical to use.

The product of critical thinking assessment-based test instruments for mapping the learning outcomes of elementary school students on cognitive competence is able to facilitate and benefit educators in conducting assessments. Based on the explanation in the form of the results of the expert practitioner test as evidenced by the quality of the instrument, the theory and relevant research which is the basis of reference in the development of the instrument, an assessment of the feasibility of the instrument with practical criteria or can be used in research and development is obtained.

C. Analysis of Student's Critical Thinking Ability

Based on the identification of critical thinking skills with indicators according to Normaya (2015) which refers to Facione, the results are presented in Table IX.

Table IX. Result of Critical Thinking Ability Identification

No	Indicator	Average
1	Interpretation	75,63%
2	Analysis	62,81%
3	Evaluation	55,21%
4	Inference	54,17%
Average		61,95%

Based on Table 9, there is information in each indicator, namely on the interpretation indicator, where students rewrite what is asked and what is known from the problem obtained a result of 75.63%, then on the analysis indicator, namely students analyze the problem with the concept relationship, questions from the problem are identified by making mathematical models and explaining the score of 62.81%, on the evaluation indicator where students use strategies in calculations obtained a result of 55.21%, and the inference indicator, namely students make conclusions obtained a result of 54.17%.

The results of the research conducted are relevant to research by Rosliani and Munandar (2022) entitled "Analysis of Mathematical Critical Thinking Ability of Class VII Students on Fraction Material". The results of the study based on each indicator are known that the interpretation indicator is in the high category, 100% of students can interpret correctly, the analysis indicator is in the medium category, 50% of students can make mathematical models, the evaluation indicator is in the low category, 15% of students who are able to use strategies in calculations, and the inference indicator is in the low category, 15% of students who are able to conclude correctly.

Based on these results, it shows that in using the product developed by the researcher, namely the HOTS Instrument, it can measure the critical thinking skills of students in grade V mathematics subjects at SDN 3 Sumberejo.

CONCLUSION

Based on the results of the research and discussion, the following conclusions can be obtained:

1. Based on the assessment results on the evaluation expert test, linguists, material experts, validity test, reliability, difficulty level, and differentiation, the instrument developed can be declared feasible.
2. Based on the results of filling out questionnaires by students and educators, the assessment instruments developed with indicators of attractiveness, convenience, and usefulness can be said to be practical.

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