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DEVELOPMENT OF TEST INSTRUMENTS TO IMPROVE MATHEMATICAL CONNECTION SKILLS USING HIGHER ORDER THINKING IN ELEMENTARY SCHOOL STUDENTS

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ABSTRACT

This study aims to develop a test instrument that can improve mathematical connection skills through higher-order thinking skills (HOTS) in elementary school students. The test instrument developed is designed to measure students' ability to connect mathematical concepts with real-world contexts and solve mathematical problems with analytical and creative approaches. This research uses the ADDIE model development approach which includes the stages of needs analysis, instrument design, expert validation, trial, and analysis of trial results. The results showed that the test instrument developed had good validity and reliability and could encourage students to think critically and creatively in solving mathematical problems. The test instrument is expected to be used as a tool to improve the quality of mathematics learning at the elementary school level and encourage the development of better mathematical connection skills in students.

Keywords: development, mathematical connection ability, test

ABSTRAK

Penelitian ini bertujuan untuk mengembangkan instrumen tes yang dapat meningkatkan kemampuan koneksi matematis melalui berpikir tingkat tinggi (higher-order thinking skills, HOTS) pada peserta didik sekolah dasar. Instrumen tes yang dikembangkan dirancang untuk mengukur kemampuan peserta didik dalam menghubungkan konsep-konsep matematika dengan konteks dunia nyata dan memecahkan masalah matematis dengan pendekatan analitis serta kreatif. Penelitian ini menggunakan pendekatan pengembangan model ADDIE yang meliputi tahap analisis kebutuhan, perancangan instrumen, validasi ahli, uji coba, dan analisis hasil uji coba. Hasil penelitian menunjukkan bahwa instrumen tes yang dikembangkan memiliki validitas dan reliabilitas yang baik serta dapat mendorong peserta didik untuk berpikir secara kritis dan kreatif dalam memecahkan masalah matematika. Diharapkan, instrumen tes ini dapat digunakan sebagai alat bantu untuk meningkatkan kualitas pembelajaran matematika di tingkat sekolah dasar dan mendorong pengembangan kemampuan koneksi matematis yang lebih baik pada peserta didik.

Kata Kunci: kemampuan koneksi matematis, pengembangan, tes

A. Introductions

Mathematics has a very important role in everyday life, education, and the development of science. As a basic science, mathematics provides a foundation for logical, analytical, and systematic thinking that is indispensable in various aspects of life, including decision making, problem solving, and technological development (Devlin, 2000). In the context of education, mathematics is not only considered as a field of study but also as a tool to develop critical, creative, and high-level thinking skills, which are very important in the current era of globalization and digitalization (NCTM, 2000).

In the world of education, the urgency of mathematics is further emphasized by the National Council of Teachers of Mathematics (NCTM), which states that mathematics is needed to develop conceptual understanding, communication skills, and higher order thinking skills (NCTM, 2000). NCTM also emphasizes the importance of mathematical connection skills, namely the ability to connect mathematical concepts with other fields of science and real situations, which is an indicator of a deep understanding of mathematical material.

In its implementation, the Merdeka Curriculum since 2021 emphasizes competency-based learning. The independent curriculum directs mathematics learning to not only emphasize procedural mastery, but also encourages students to understand the relationship between mathematical concepts, relate them to other disciplines, and apply them in everyday life which is oriented towards developing high-level thinking skills or also known as High Order Thinking Skills (HOTS). This is in line with the view of the Ministry of Education, Culture, Research and Technology of the Republic of Indonesia (Kemendikbudristek RI) which emphasizes the importance of mathematics as the foundation of numeracy literacy in 21st century education, in building high-order thinking skills.

A. Introduction

Mathematics has a very important role in everyday life, education, and the development of science. As a basic science, mathematics provides a foundation for logical, analytical, and systematic thinking that is indispensable in

various aspects of life, including decision making, problem solving, and technological development (Devlin, 2000). In the context of education, mathematics is not only considered as a field of study but also as a tool to develop critical, creative, and high-level thinking skills, which are very important in the current era of globalization and digitalization (NCTM, 2000).

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The ability to connect mathematical concepts that do not prioritize mastery of mathematical material alone, then students are required to master all aspects related to other fields of science as well as everyday life. According to the National Council of Teachers of Mathematics (NCTM), mathematical connections include the ability to connect various mathematical concepts, relate them to other disciplines such as science, and apply them in everyday life (NCTM, 2000). This mathematical connection ability is one of the abilities that is highly recommended to be applied and is one of the important aspects that must be developed in mathematics learning. Mathematical connections allow learners to understand mathematics more thoroughly, so that they can apply this knowledge in more complex situations.

Mathematical connection skills enable learners to apply their understanding to problems that can be found on a daily basis. Mathematics learning should not only focus on mechanical procedures, but should also develop learners' ability to connect mathematical ideas to various contexts (Polya, 1973). Mathematical connection skills are one of the main components in mathematical literacy that support learners to become competent problem solvers (Kilpatrick, Swafford, & Findell, 2001). Thus, for learners, mathematical connection skills are very important to build a deep understanding of mathematical concepts. Without strong connections, learners tend to have difficulty in applying mathematical knowledge to new situations, both in academics and real life (Rahmat & Suryadi, 2020). Therefore, learning designed to improve mathematical connection ability will not only help learners in academic achievement, but also in the development of higher-order thinking skills that are relevant to their lives.

Mathematical connection and higher order thinking skills are important aspects that learners must have, especially at the primary and secondary education levels, as part of meaningful mathematics learning. These abilities include a metacognitive process where learners actively think about how they understand concepts, solve problems, and connect mathematical concepts both between concepts, with other fields of science, and everyday life. The process of mathematical connection and higher order thinking depends not only on what learners know, but also how they utilize that knowledge to solve problems. When learners are able to find effective ways to solve problems so as to achieve the desired goals, they show optimal mathematical connection and higher-order thinking skills (Fuady, 2016). Success in mastering a concept can be achieved when learners have higher order thinking skills.

Learners with Higher Order Thinking Skills, involve their learning in various activities designed to train mathematical connection skills. Learners are not only able to remember and understand concepts, but can also analyze, synthesize, evaluate, and create new concepts by linking to other concepts, other fields of science, and everyday life.

By thinking at a higher level, concepts that have been mastered can last long in the memory of students. Higher order thinking skills are very important for learners (Arifin & Retnawati, 2017). HOTS includes analysis (C4), evaluation (C5), and creation (C6), as described by Anderson and Krathwohl (2001). The implementation of HOTS in learning is very important because students who have this ability will be able to connect understanding in learning to be linked to solving mathematical problems effectively.

Unfortunately, the importance of mathematical connection skills through higher-order thinking is often overlooked in its application, as evidenced by the mechanical mastery of material and the achievement of prioritized test scores. Many students only focus on memorizing formulas and procedures without understanding the underlying concepts behind them and do not develop mathematical connection skills through higher-order thinking. Whereas with higher-order thinking and mathematical connection skills, students will learn more meaningfully and applicatively in its application.

The bad habits of students in solving math problems according to Alzanatul Umam & Zulkarnaen (2022) show that students often rely too much on examples given in textbooks or by teachers, without trying to solve problems independently. This inhibits their ability to connect mathematical concepts to different situations or contexts, as well as hinders the development of higher-order thinking skills and the ability to apply mathematical knowledge in unstructured conditions. Such reliance often leads to shallow and limited understanding, as well as a lack of critical thinking skills in solving math problems relevant to everyday life. Such habits hinder learners' cognitive progress in facing more complex mathematical challenges.

The development of questions specifically designed to improve mathematical connection skills and higher order thinking is very important. According to Anggraini & Muntazhimah (2021), the questions should be designed in such a way that they challenge students to think at a higher level, connect various mathematical concepts, and apply their knowledge in new and different situations. By giving learners the opportunity to face and solve problems that demand mathematical connection skills, they will be more accustomed to thinking deeply and systematically, and develop the metacognitive skills needed for success in mathematics and other fields.

The types of problems that can improve mathematical connection skills include problems that are relevant to real situations or students' daily lives, problems with levels of difficulty ranging from basic to complex, problems that have more than one way of solving or answering, and non-routine problems that require a new or different approach from what is usually taught in class (Senjayawati & Kadarisma, 2020). In addition, problems designed to improve mathematical connection skills can also assist teachers in identifying areas where students are having difficulty, allowing for more targeted interventions. The process of developing these questions not only improves students' thinking skills but also enriches teachers' teaching strategies, so that mathematics learning becomes more effective and comprehensive (Prabowo et al., 2018).

Thus, the importance of developing questions to improve mathematical connection skills through higher order thinking of elementary school students cannot be ignored. This research was conducted to develop a test instrument on the material of building space to improve the mathematical connection ability of elementary school students. The selection of cube and beam material is based on the lack of understanding of students to understand shapes that have contents or volumes associated with other mathematical concepts, other fields of science, and their daily lives. This research is expected to help teachers in developing contextual questions on the material of cube and beam spaces so as to support the formation of students' mathematical connection skills in completing math problems

B. Research Methods

This study is a development research that aims to produce test instruments for elementary school students, with an orientation on measuring mathematical connection skills through higher order thinking. The construction of test items is designed based on cognitive levels in Bloom's Revised Taxonomy, namely aspects of analyzing (C4), evaluating (C5), and creating (C6) (Gunawan & Palupi, 2012). The instrument developed focuses on evaluating the ability of students in high-level cognitive processes in accordance with these taxonomic categories.

The research subjects consisted of 26 grade VI students at SDN 2 Nagrikaler, Purwakarta. The selection of subjects was done by nonprobability sampling technique, using purposive sampling method. In this development process, nine items of mathematical connection ability test were developed by the research. This research used the ADDIE development model, which includes five main stages: (1) analyze, (2) design, (3) development, (4) implementation, and (5) evaluation (Sugiyono, 2017). The development stages of the ADDIE model can be described as follows.

1) Analyze

The analysis stage is the first step in developing the mathematical connection skill test instrument. This process involves several important steps.

At the analysis step, curriculum analysis is carried out on the development of mathematical connection ability test instruments with space building material, this is done to identify learning outcomes and relevant learning objectives.

Then, the analysis of learner characteristics, such as age, cognitive ability, learning style, and social background, was identified to ensure that the instrument developed was in accordance with their needs and developmental level.

At this step, the researcher conducted the selection of research subjects, namely 26 grade VI students of SDN 2 Nagrikaler, Purwakarta, learning observations, and interviews to understand learning needs, identify problems such as the lack of mathematical connection problems, and plan further activities for instrument development and validation.

2) Design

The design stage in the research involved designing the test instrument which was carried out through several main steps. First, the preparation of the test instrument lattice, which includes learning outcome indicators, question types, and difficulty levels. This grid serves as a guide to ensure that the questions developed are aligned with the learning objectives.

The mathematical connection ability test instrument uses indicators of mathematical connection ability based on the National Council of Teachers of Mathematics (NCTM) standards, so the instrument must be designed to measure three main aspects that reflect mathematical connection ability. The following is an explanation of each indicator:

1. Connections between Concepts in Mathematics
   Measures the ability of students to see the relationship between various mathematical concepts or procedures.
2. Connections Between Mathematics and Other Fields
   Assesses learners' ability to apply mathematical concepts to other fields such as science.
3. Connection Between Mathematics and Daily Life
   Measuring the ability of learners to apply mathematical concepts in

real situations that are relevant to their daily lives.

Furthermore, the preparation of validation instruments was carried out to ensure the quality of the questions. Material validation was conducted by material experts to ensure that each question was in accordance with the competencies to be measured. Language validation was conducted by linguists to assess readability, grammatical appropriateness, and clarity.

3) Development

At the development stage, a series of validations were conducted to ensure the quality of the mathematical connection ability test instrument. This process involves three main types of validation, which are as follows.

a) Material validation, this validation aims to evaluate the suitability of the questions with mathematical connections that are the focus of learning. Material experts checked whether each question reflected the learning objectives, was able to measure the targeted competencies, and was in accordance with the indicators of mathematical connection skills.
b) Language validation, linguistic validation is carried out to ensure that the language used in the questions is clear, appropriate for the level of understanding of students, and free from ambiguity. This is important so that students can understand the questions well without linguistic barriers.
c) Validity validation, this validation aims to evaluate the level of difficulty of the questions, ensuring that the questions cover a variety of difficulties ranging from easy, moderate, to difficult. Thus, the test instrument can accommodate the different abilities of students.

This development stage ensures that the test instruments produced are of good quality, relevant to the learning objectives, and effective in measuring students' mathematical connection skills.

4) *Implementation*

In the implementation stage, the developed test instrument is tested on 26 students to evaluate its quality. This implementation process will measure:

a) Validity test, ensuring that each item is valid or in accordance with the learning outcomes. To determine the validity of the items, the Pearson Product Moment formula is used, namely:

$$r_{xy} = \frac{N\sum XY - (\sum X)(\sum Y)}{\sqrt{N\sum X^2 - (\sum X)^2)\,(N\sum Y^2 - (\sum Y)^2)}}$$

(Suherman, 2003)

Description:

r_{xy} : correlation coefficient between variable X and variable Y
N : number of data samples
x : total score of all question items obtained by students
y : the score of each question item obtained by students

Tabel 1. Validity Test Interpretation

Validity Coefficient	Description
0,90 ≤ r_{xy} ≤ 1,00	Very High Validity
0,70 ≤ r_{xy} ≤ 0,90	High Validity
0,40 ≤ r_{xy} ≤ 0,70	Medium Validity
0,20 ≤ r_{xy} ≤ 0,40	Low Validity
0,00 ≤ r_{xy} ≤ 0,20	Very Low Validity
r_{xy} < 0,00	Not Valid

b) Reliability test, using statistical methods to evaluate the consistency of test results, so that the instrument can produce stable and reliable results. To measure the reliability coefficient, the Cronbach Alpha formula is applied as follows

$$r_{11} = \left(\frac{n}{n-1}\right)\left(1\frac{\Sigma\sigma_i^2}{\sigma_i^2}\right)$$

Description:

r_{11} : Coefficient of reliability
n : Number of items
$\Sigma\sigma_i^2$: The sum of the variances of the scores of each item
σ_i^2 : Total variance

Variance formula used

$$\sigma^2 = \frac{\sum X^2 - \frac{(\sum X)^2}{N}}{N}$$

σ^2 : Variance of each item
X : Score of each item
N : Number of participants

Tabel 2. Reliability Test Interpretation

Reliability Coefficient	Description
0,90 ≤ r_{11} ≤ 1,00	Very High Reliability
0,70 ≤ r_{11}≤ 0,90	High Reliability
0,40 ≤ r_{11} ≤ 0,70	Medium Reliability
0,20 ≤ r_{11} ≤ 0,40	Low Reliability
0,00 ≤ r_{11} ≤ 0,20	Very Low Reliability

c) Differentiating power test, evaluates the extent to which the question can distinguish between students who have high and low abilities, so that only questions with good differentiating power will be retained.

The formula used to calculate differentiating power is as follows:

$$DP = \frac{S_A - S_B}{J_A}$$

(Sumarno, 2014)

Description:

r_{xy} : Distinguishing power
N : The sum of the scores of the upper group of an item
x : The sum of the scores of the lower group of an item
y : Total ideal score of an item in the upper group

Tabel 3. Differentiating Power Interpretation

Differentiating Power Coefficient	Description
Below – 10%	Very good
10% - 19 %	Good

Differentiating Power Coefficient	Description
20% - 29%	Fair
30% - 49%	Bad
50% - Above	Very Bad

d) Level of difficulty, determining the level of difficulty of a question based on the percentage of learners who can answer it correctly. Questions are categorized as easy, medium, or difficult to ensure an appropriate variation in difficulty. The formula used to calculate the question difficulty index is as follows:

$$IK = \frac{S_A + S_B}{2J_A}$$

Description:

IK : Difficulty index
S_A : The sum of the scores of the upper group of an item
S_B : The sum of the lower group scores of an item
J_A : Total ideal score of an item

Tabel 4. Interpretation of Question Difficulty

Level of Difficulty (TK)	Description
0,00 ≤ TK ≤ 0,20	Sangat Sukar
0,20 ≤ TK ≤ 0,40	Sukar
0,40 ≤ TK ≤ 0,60	Sedang
0,60 ≤ TK ≤ 0,90	Mudah
0,90 ≤ TK ≤ 1,00	Sangat Mudah

5) *Evaluation* (Evaluasi)

The evaluation stage is the last step that aims to assess the entire development process and the results of the mathematical connection ability test instrument. Evaluation is carried out to ensure that the instruments that have been tested meet quality standards and are ready for use. Data from the trial results, such as students' scores, were analyzed to evaluate the validity, reliability, difficulty level, and distinguishing power of the instrument. Instruments that have weaknesses are identified for improvement.

Based on the results of the analysis and feedback, revisions are made to questions that are invalid, have inappropriate difficulty levels, or low differentiating power. Question language was also refined if there were deficiencies in readability or clarity.

C. Research Results and Discussion

This research uses the ADDIE development model (Analyze, Design, Develop, Implement, Evaluate) to produce a mathematical connection ability test instrument. The following is a discussion of the research results based on each stage in the ADDIE model.

1) Analyze (Analisis)

At this step, the importance of mathematical connection skills in mathematics learning was identified through theory review and curriculum analysis. The literature review refers to the NCTM standards that emphasize the relationship between mathematical concepts, cross-disciplinary applications, and the relevance of everyday life. The results of the analysis showed that the instrument developed was in line with the basic competencies and learning outcomes, especially higher order thinking skills.

The characteristics of grade VI learners include cognitive abilities, learning styles, and mathematical connection development needs. Grade VI learners are generally at the concrete operational stage until the beginning of the transition to formal operations (based on Piaget's theory). They begin to be able to understand abstract concepts simply, such as relationships and patterns in mathematics, although they still need concrete support to clarify understanding. Their ability to analyze, evaluate and create solutions to simple problems begins to develop, making them ready to be trained in higher-order thinking, including mathematical connection skills. Learners at this level have diverse learning styles. Test instruments need to be designed to be accessible to a variety of learning styles, through visualization of story problems or interesting contexts.

Mathematical connections are very important for grade VI learners because they need to understand the relationships between mathematical concepts, cross-disciplinary applications, and applications in everyday life. The lack of questions that measure mathematical connection ability is the basis for the development of this instrument.

2) Design

At the design stage in this research, the mathematical connection ability test instrument was systematically designed based on the indicators set by NCTM. These indicators include connections between mathematical concepts, connections with other fields, and connections with everyday life situations.

The lattice of the test instrument was prepared to ensure that the questions made were in accordance with the learning outcomes and indicators of mathematical connection. The test instrument lattice serves as a guide in preparing questions that are aligned with the learning outcomes and indicators of mathematical connection ability. The test instrument grids can be seen in the table below.

Tabel 5. Lattice of Mathematical Connection Ability Test Instrument

No	Mathematical Connection Indicator	Description
1	Ability to Connect Between Mathematical Concepts (Geometry and Algebra) C4: Analyze C6: Describe, Create	Learners can connect the mathematical concepts of building space with the concept of one building space with another building space, algebra, understanding flat buildings, and length units in mathematical concepts.
2	Ability to Connect Between Mathematical Concepts (Geometry and Algebra) C4: Analyzing and Linking C5: Comparing	Learners are able to connect understanding between spatial figures and their properties and formulas
3	Ability to Connect Between Mathematical Concepts (Geometry and Algebra) C4: Analyze	Students are able to understand the characteristics of a spatial building and its calculation formula so that they can connect a spatial building with other spatial concepts, algebra, and simple calculations through surface area analysis and volume formulas.
4	Ability to Connect Mathematical Concepts with Other Fields of Science (Mathematical Concepts with Science) C4: Analyze C5: Comparing, Concluding	Learners are able to connect mathematical concepts with other fields of science found in everyday life, the connection is with the science field of sound properties.
5	Ability to Connect Mathematical Concepts with Other Fields of Science (Mathematical Concepts with Science) C4: Analyze C6: Describe, Create	Peserta didik mampu menghubungkan antara konsep matematika dengan bidang ilmu lainnya yang ditemukan pada kehidupan sehari-hari, koneksi yang dihubungkan yaitu dengan bidang ilmu sains sifat cahaya.
6	Ability to Connect Mathematical Concepts with Other Fields of Science (Mathematical Concepts with Science) C4: Analyze. Analyze, Solve	Learners are able to connect mathematical concepts with other fields of science found in everyday life, the connection is with the science of the nature of light.
7	Ability to Connect Mathematical Concepts with Daily Life C4: Analyzing, Examining	Learners are able to connect the mathematical concept of building space with everyday life using problems that are easy to find and often arise.
8	Ability to Connect Mathematical Concepts with Daily Life C4: Analyze, Solve C5: Conclude	Learners are able to relate the mathematical concept of building space to everyday life using problems that are easy to find and often arise.
9	Ability to Connect Mathematical Concepts with Daily Life C4: Analyzing, Solving	Learners are able to connect the mathematical concept of building space with everyday life using problems that are easy to find and often arise.

3) Development

At this stage, the test instruments that have been developed based on the design stage are submitted to expert validators for validation. Validators are mathematics lecturers who are competent in their fields. This expert validation is an important step in the process of developing test instruments or teaching materials to ensure that the instruments developed are in accordance with the required quality and relevance standards.

Tabel 6. Expert Validation Results

No	Aspect Validation	Score Validation	Description
1	Content	0,93	Valid
2	Difficulty of Question	0,80	Valid
3	Language	0,79	Valid
	Average	**0,84**	**Valid**

Validation on the material aspect obtained a high score of 0.93. This shows that the material in the test instrument is quite accurate and relevant to the learning objectives. However, there are suggestions from material experts to make some revisions, such as adding or adjusting content to better suit the needs of students and the curriculum. Some questions also need to be revised to ensure concept accuracy.

The question difficulty expert gave a validation score of 0.80 (High category), which indicates that the material presented has a good level of difficulty.

The validation on the language aspect obtained a score of 0.79 (High category). This indicates that the use of language in the test instrument is good, clear, and in accordance with the level of understanding of students. The mathematical terms used are relevant to the educational level of elementary school students. However, the validator suggested that the question instructions be explained again to make it easier for students to understand.

4) Implementation

The instrument was tested on 26 grade VI students. Each learner was given 9 description questions using indicators of mathematical connection ability. This trial was conducted to see how students responded to the questions that had been designed. The results of the testing showed.

Tabel 7. Recapitulation of Validity Test Results

No	Correlation per Question Item	Significance of Question	Item Overall Correlation
1	0, 606	Very Significant	**0, 78**
2	0, 536	Very Significant	
3	0, 670	Very Significant	
4	0, 519	Highly Significant	
5	0, 367	-	
6	0, 478	Significant	
7	0, 185	-	
8	0, 574	Highly Significant	
9	0, 714	Very Significant	
10	0, 524	Very Significant	
11	0, 474	Significant	
12	0, 572	Highly Significant	
13	-0, 210	-	
14	0, 122	-	
15	0, 388	Significant	
16	0, 587	Highly Significant	
17	0, 398	Significant	
18	0, 422	Significant	
19	0, 357	-	
20	0, 454	Significant	
21	0, 328	-	

Most of the items are in the moderate to highly significant validity category, the test instrument has a high correlation, indicating that this instrument is quite good at measuring what it is intended to measure.

However, there are some items with lower validity (easy category) that require revision or improvement to improve the overall quality of the instrument.

Based on the calculation results, the reliability value of the instrument was obtained at 0.78. This value indicates that the instrument has a high correlation because it is in the range of 0.70 ≤ r11≤ 0.90. In accordance with the criteria for interpreting the degree of reliability, this instrument is considered good and appropriate to be used to measure students' mathematical connection skills.

Tabel 8. Recapitulation of Results Differential Test

No	T	DP (%)	Criteria
1	2, 85	34, 29	Good
2	2, 12	25, 71	Medium
3	5, 43	45, 71	Good
4	2, 20	28, 57	Medium
5	0, 87	14, 29	Bad
6	2, 91	34, 29	Good
7	0, 67	11, 43	Bad
8	2, 35	25, 71	Medium
9	3, 04	42, 86	Good
10	4, 16	34, 29	Good
11	0, 92	11, 43	Bad
12	4, 10	40, 00	Good
13	-1, 12	-14, 29	Bad
14	0, 60	5, 71	Bad
15	1, 88	25, 71	Medium
16	3, 69	28, 57	Medium
17	3, 67	34, 29	Good
18	3, 06	37, 14	Good
19	2, 08	20, 00	Medium
20	2, 17	28, 57	Medium
21	1, 12	14, 29	Bad

Most of the items have Good to Medium criteria, which indicates that this instrument can be used with some improvements. Some items with Poor criteria require significant revision or deletion, especially items with negative DP values such as numbers 14 and 21, as they are not effective in differentiating students' abilities.

Overall, the differentiating power of this test instrument can be further improved to ensure all items can measure learners' mathematical connection skills accurately and effectively.

Tabel 9. Recapitulation of Test Results Problem Difficulty

No	Difficulty Level (%)	Interpretation
1	51, 43	Medium
2	67, 14	Medium
3	62, 86	Medium
4	65, 71	Medium
5	75, 71	Easy
6	74, 29	Easy
7	51, 43	Medium
8	64, 29	Medium
9	61, 43	Medium
10	68, 57	Medium
11	71, 43	Easy
12	60,00	Medium
13	58, 57	Medium
14	82, 86	Easy
15	70,00	Medium
16	71, 43	Easy
17	68, 57	Medium
18	70,00	Medium
19	67, 14	Medium
20	68, 57	Medium
21	61, 43	Medium

This test instrument has a dominant level of difficulty in the

Medium category, so it is generally feasible to use in the assessment process. Questions in the Easy category on numbers 6, 8, and 13 need to be re-evaluated to increase the level of difficulty in order to provide challenges that are more in line with students' abilities. Revisions to questions with Easy difficulty levels could involve adjusting the context or level of complexity to make the instrument more balanced and optimal.

5) Evaluation

The evaluation stage is the last step that aims to assess the entire development process and the results of the mathematical connection ability test instrument. Evaluation is carried out to ensure that the instruments that have been tested meet quality standards and are ready for use. At this stage, students were asked to provide feedback on the level of difficulty, clarity of questions, and relevance of questions to mathematical connection skills. Teachers provide input on the suitability of the instrument with the curriculum, applicability in learning, and benefits for student evaluation.

Then, the data from the pilot test, such as students' scores, were analyzed to evaluate the validity, reliability, difficulty level, and distinguishing power of the instrument. Instruments that have weaknesses are identified for improvement.

E. Conclusion

Based on the evaluation results of the mathematical connection ability test instrument, it was found that the overall validity value reached 0.78, which indicates that the instrument has high validity in general. The majority of the items were in the “Moderate” to “Very Significant” validity category, although there were some items with low validity, such as numbers 6 and 8, which required revision. Such revisions can be made by clarifying instructions or adjusting the level of difficulty to ensure that the items are relevant to the learning objectives.

The differentiation analysis showed that most items were in the “Good” to “Moderate” category, such as item numbers 1, 3, 8, 10, and 16. However, there were several items with “Poor” differentiation, including numbers 14, 15, 18, and 21, which had very low or even negative differentiation values. These items need to be modified to make them more effective in differentiating between high and low ability learners, as well as removing any ambiguity that may exist.

In terms of difficulty level, the majority of the items were in the “Medium” category, which is ideal for differentiating students' abilities. However, some items, such as numbers 6, 8, 13, 15, and 19, were classified as “Easy,” making them less challenging. Therefore, the level of complexity of these items needs to be increased, for example by adding application contexts or expanding the variety of calculations, while still maintaining suitability for learners' abilities.

Based on these results, several steps are recommended for the development of test instruments, including improving item instructions to avoid learner confusion, replacing or removing items with negative power differentials, and distributing difficulty levels more evenly. After the revisions are made, the instrument should be retested to ensure that the improvements have a positive impact on the validity, power differential, and difficulty level of the questions.

Overall, the mathematical connection ability test instrument has met the criteria of validity and good difficulty level. However, revisions to some items are still needed to improve the differentiation and overall effectiveness of the instrument. With the improvements made, it is expected that this instrument can be more optimal in measuring students' mathematical connection skills.

REFERENCES

Arifin, Z. & Retnawati, H. (2017). Pengembangan nstrumen Pengukur Higher Order Thinking SkillsMatematika Peserta didik SMA Kelas X. *PHYTAGORAS: Jurnal Pendidikan Matematika, 12*(1), 98-108.

Anderson, L. W., & Krathwohl, D. R. (2001). *A taxonomy for learning, teaching, and assessing: A revision of Bloom's Taxonomy of educational objectives.* New York: Longman.

Devlin, K. (2000). *The language of mathematics: Making the invisible visible.* Henry Holt and Company.

Fuady, I. (2016). Peran koneksi matematis dalam pembelajaran. *Jurnal Matematika dan Pendidikan Matematika*, *7*(2), 34-47.

Gunawan, P., & Palupi, D. (2012). Implementasi taksonomi Bloom revisi dalam pembelajaran matematika. *Jurnal Pendidikan dan Kebudayaan*, *14*(3), 56-65.

Kemendikbudristek. (2021). *Kurikulum Merdeka: Pedoman Implementasi Pembelajaran.* Jakarta: Kemendikbudristek.

Kilpatrick, J., Swafford, J., & Findell, B. (Eds.). (2001). *Adding it up:*

Helping children learn mathematics. National Academy Press.

Muntazhimah, M. & Anggraini, A. (2021). Pengembangan Instrumen Kemampuan Berpikir Reflektif Matematis Peserta didik Madrasah Aliyah. *Jurnal Pendidikan Matematika AKSIOMA, 10*(4), , 2465-2476.

National Council of Teachers of Mathematics (NCTM). (2000). *Principles and standards for school mathematics.* Reston, VA: NCTM.

Polya, G. (1973). *How to solve it: A new aspect of mathematical method.* Princeton University Press.

Prabowo, E., Hidayat, W., & Suherman, R. (2018). Pengembangan soal berbasis koneksi matematis. *Jurnal Pendidikan Matematika Indonesia*, *3*(2), 89-98.

Rahmat, A., & Suryadi, D. (2020). *Analisis Kemampuan Koneksi Matematis Peserta didik Dalam Pembelajaran Berbasis Masalah. Jurnal Pendidikan Matematika, 14*(2), 123–136.

Umam, M. & Zulkarnaen, R. (2022). Analisis Kemampuan Pemahaman Konsep Matematis Peserta didik Dalam Materi Sistem Persamaan Linear Dua Variabel. *Jurnal EDUCATIO, 8*(1), 306-308.

Senjayawati, E., & Kadarisma, F. (2020). Soal kontekstual berbasis koneksi matematis. *Jurnal Inovasi Pendidikan Matematika*, *12*(1), 67-81.

Sugiyono. (2017). *Metode penelitian pendidikan: Pendekatan kuantitatif, kualitatif, dan R&D*. Bandung: Alfabeta.

Suherman, E. (2003). *Strategi pembelajaran matematika kontemporer*. Bandung: JICA.