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MATHEMATICAL CONNECTION ABILITY INSTRUMENT FOR PRIMARY SCHOOL STUDENTS

INSTRUMEN KEMAMPUAN KONEKSI MATEMATIS UNTUK SISWA SEKOLAH DASAR

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Abstract

This study was motivated by the importance of mathematical connection ability for elementary school students. It was necessary to develop an instrument that suitable the indicators of mathematical connection ability to understand the students' mathematical connection ability. The goal of this research was to develop an appropriate mathematical connection ability instrument for primary school students. This study was applied using Research and Development. The participants were 34 third-grade students at an elementary school in Purwakarta, SDN Nagrikaler, chosen through purposive sampling. The instrument was an essay test consisting of six open questions about whole numbers. The indicators developed in composing questions were related to the mathematical connection ability, namely connections inter topics in mathematics, other subjects, and everyday life. The questions were made beforehand in the expert judgment, then tested to see the validity, reliability, difficulty index, and discrimination power index. The validity test analysis indicated that six items on the instrument were valid, the reliability of the test instruments was very high. Meanwhile, the difficulty level was classified as difficult and moderate, and the discrimination power was also categorized as good and very good criteria. Thus, those six developed questions could be applied to measure mathematical connections in the topic of operations of whole numbers for second-grade elementary school students and were suitable for further research instruments on similar subjects and variables even at different times and places.

Keywords: *Test Instrument, Mathematical Connections, Elementary School Students*

Abstrak

Penelitian ini dilatarbelakangi oleh pentingnya kemampuan koneksi matematis bagi siswa sekolah dasar. Penelitian ini bermaksud mengembangkan instrumen yang sesuai dengan indikator kemampuan koneksi matematis untuk memahami kemampuan koneksi matematis siswa. Penelitian ini bertujuan untuk mengembangkan instrumen kemampuan koneksi matematis yang sesuai untuk siswa sekolah dasar. Penelitian ini menggunakan metode Research and Development. Partisipan adalah 34 siswa kelas III SD di Purwakarta, SDN Nagrikaler, yang dipilih secara purposive sampling. Instrumen yang digunakan adalah tes esai yang terdiri dari enam pertanyaan terbuka tentang bilangan cacah. Indikator yang dikembangkan dalam menyusun soal berkaitan dengan kemampuan koneksi matematis, yaitu koneksi antar topik dalam matematika, mata pelajaran lain, dan kehidupan sehari-hari. Soal-soal tersebut dibuat terlebih dahulu sesuai saran expert, kemudian diuji untuk melihat validitas, reliabilitas, indeks kesukaran, dan indeks daya diskriminasi. Analisis uji validitas menunjukkan bahwa enam item pada instrumen tersebut valid dan reliabilitas instrumen tes sangat tinggi. Sedangkan tingkat kesukaran tergolong sukar dan sedang, dan daya pembedanya juga termasuk kriteria baik dan sangat baik. Dengan demikian, 6 item soal yang dikembangkan tersebut dapat diterapkan sebagai instrumen untuk mengukur *koneksi matematis dalam pembelajaran matematika pada topik operasi hitung bilangan cacah terhadap siswa kelas dua SD dan layak digunakan untuk instrumen penelitian selanjutnya pada subjek dan variable sejenis meskipun pada waktu dan tempat berbeda.*

Kata Kunci: *Instrumen Tes, Koneksi Matematis, Siswa Sekolah Dasar*

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1. Introduction

Mathematics is a subject that cannot be separated from the daily life of students. Mathematics can make it easier to carry out activities and routines every day, such as buying and selling, saving money, setting a daily or monthly schedule, counting many objects, and measuring height. The study says math can be helpful to solve the larger unit problem and understand the social issue more deeply (Osler, 2007). Teaching mathematics is a subject that can develop students' cognitive (Putri, Suwangsih, Rahayu, Afita, Dewi, & Yuliyanto, 2021). Mathematics has a crucial role in supporting the advancement of science and technology (Yuliyanto, Turmudi, Agustin, Muqodas, & Putri, 2020). Given how important mathematics is in everyday life, mathematics should be taught by emphasizing what students experience in their lives. Besides that, mathematics is one of the most important subjects to study in education, especially in elementary schools. Law No. 20 of 2003 states that mathematics is a compulsory subject for students at the primary educational level. Mathematics has a strong and clear structure and linkages between concepts, enabling students to think rationally. Thus, it is important to learn mathematics to know and understand and be proficient in applying it to other problems.

One of the objectives of learning mathematics in elementary schools is that students must have Higher Order Thinking Skills (HOTS). This high-level ability aims to develop students' analytical, evaluation, and creative power. Mathematical connection skills are part of higher-order thinking skills that need to be mastered by students (Hendriana, Rohayati, & Sumarmo, 2017; The Ministry of Education and Culture of Indonesia, 2003; Putri, Misnarti, & Saptini, 2018; Sumarmo, 2010).

The ability of mathematical connections can be observed when students link their previous understanding with the problem being solved so that students will solve the problem with its fundamental concepts (Dudung & Oktaviani, 2020). Besides, when students connect mathematical ideas, their understanding is deeper and more lasting (Ayunani, Mardiyana, & Indriati, 2020). So that, the relationship between mathematical concepts will make students feel better about the concepts and learning process not only based on memorization or relying on formulas obtained from memorization. Mathematical connections are included in the aspect of cognitive in mathematics which have to be developed properly (Kenedi, Hendri, Ladiva, & Nelliarti, 2018; National Research Council, 2001; Sugiman, 2008; Warih, Parta, & Rahardjo, 2016).

In the phenomenon that occurs, efforts to develop mathematical connection skills of elementary school students have not made significant progress. It is suitable to several factors, one of which is the limited development of items or instruments that can measure mathematical connections that teachers can apply to understand students' mathematical connection abilities in mathematics learning. As a result, students are not trained to solve mathematical problems containing mathematical connection skills and other higher-order thinking skills.

Students' limited mathematical connection ability is shown by the limited percentage of students who provide correct responses, the limited percentage on each indicator of mathematical connections, and misunderstandings produced by students. Wrongdoings made by students explain the difficulties experienced by learners. The challenge that learners frequently represent is explaining the problem and the complexity of arranging the equation or theory used to resolve the problem (Wijayanti & Abadi, 2019). Learners with inadequate mathematical connection ability cannot correlate the mathematical concept with real-life (Ariyani, Suyitno, & Junaedi, 2020). The low ability of mathematical connections is because learning activities have not facilitated students to develop their mathematical connection skills. Elementary school teachers rarely give questions that practice mathematical connection skills. The teacher is also not used to making problems related to mathematical connections. There are few developed mathematical connection ability instruments, so it is difficult for teachers to train them (Kurnianingtyas, Windayana, & Ardiyanto, 2015). Therefore, this study aimed to produce suitable mathematical connection instruments for elementary students so that teachers could understand and develop students' mathematical connection skills properly.

One strategy for developing a mathematical connection ability instrument suitable for elementary students is to create questions based on mathematical connection ability indicators. The questions that are made are then asked for consideration from the expert (expert judgment) then tested on several samples to see the validity, reliability, difficulty index, and distribution power of the questions. Questions can be given personally either in groups; moreover, they usually involve a sequence of objects that reflect the study goals (Ponto, 2015). Questions are tools that can be applied for multiple computations in several types of analysis. The questions must have a specific plan correlated to the research purposes, and it must be explicit of the start wherewith the conclusions will be utilized (Roopa & Rani, 2012).

Research says a good instrument test is marked by two conditions: validity and reliability (Putri, Wahyudy, Yuliyanto, & Nuraeni, 2020; Setiadi, Ursula, Rismawati & Setini, 2020). Furthermore, a good test instrument can be identified by analyzing the validity, reliability, discrimination index, and difficulty level of using Anates V4 (Sari & Mahendra, 2017). The main indicators of good quality measurement refer to the feasibility of validity, reliability, discrimination index, and difficulty level (Azwar, 2011; Mohajan, 2017). Researchers must properly analyze the appropriateness of the instruments developed to support an optimal research finding before implementing research begins. The tools compiled and developed must be valid, reliable, have good discrimination power with varying problem difficulty levels (Andrian, Kartowagiran, & Hadi, 2013; Manongko, 2016). An Instrument that generates records with good validity means a tool that can present essential knowledge concerning that which is being measured. Outwardly indicating validity, the results of an experiment are insignificant, and the outcomes based on those decisions could be mortifying (Elliott, McKevitt, & Kettler, 2002). A reliable tool provides a constant characteristic measure notwithstanding inconstancies in its background (Putri, Wahyudy, Yuliyanto, & Nuraeni, 2020). The difficulty level is an opportunity to answer the question on the level of certain capabilities that are usually (Patriasih, 2017). The computation of the discrimination index determines the degree to which an object can discriminate between competent learners and those who cannot do some test. The higher the distinguishing coefficient, the more able to distinguish between the two. Items range from a low of -

1.00 to a high of +1.00 (Aisyah, 2019). Thus, measuring the instrument properly, one of which is to measure the instrument's mathematical connection ability, must have validity, reliability, level of difficulty, and good discrimination power.

Based on researchers' observations, it was found that students in the class were not used to answer HOTS questions. Teachers had difficulty finding suitable teaching materials and questions to practice students' higher-order thinking skills. Therefore, researchers were interested in making instruments that could meet the four main indicators of quality measurement. The research question here was how the arrangement of a test instrument could accurately estimate the mathematical connection ability of primary school students? Based on the problem, this research aimed to produce a test that could estimate the mathematical connection ability of primary school students.

2. Research Method

This research is research on the improvement of students' mathematical connection ability instruments. The method used is Research and Development (R&D). Research and development methods in education produce a research product and ultimately validate the output. This research method has a systematic process for developing, improving, and assessing educational programs and materials (Creswell, 2009; Gall, Gall, & Borg, 2010).

The design for producing this instrument is based on the Analysis, Design, Development, Implementation, and Evaluation (ADDIE) models. In the analysis stage, the researcher reviewed problems related to the mathematical connection ability of low-grade elementary school students, a measuring instrument in the form of a test developed by the teacher whether it showed conformity with the mathematical connection ability indicator. Furthermore, at the design stage, the researcher arranged an instrument framework in the form of a blueprint based on indicators of mathematical connection ability, learning indicators, cognitive levels based on the bloom taxonomy, and difficulty level according to the researcher's view. At the development stage, the blueprint of the mathematical connection ability instrument was consulted with experts and improved based on expert judgment regarding the suitability of word use, the accuracy of the material, and psychological constructs. At the implementation stage, the researcher tested the instrument revised based on the validator's suggestions to third-grade elementary school students to assess their level of readability and understanding of the questions given. It also assessed the reliability, validity, difficulty level, and the instrument's ability in discriminating students' mathematical connection abilities. In the final stage, the evaluation, the researcher reconsidered the mathematical connection ability instrument based on the implementation results related to aspects that must be improved or readjusted based on the researcher's needs to measure mathematical connection ability.

This study involved 34 students of SDN Nagrikaler, Purwakarta Regency, Indonesia. The sample was selected using the purposive sampling technique by determining the sample with standardized considerations based on research goals. The chosen sample must meet certain requirements, such as students have received material about counting whole numbers operations. The sample representation in this study was considered to have completed the minimum stated limit for a sample size greater than 20, so the normal distribution can be used to approximate the binomial distribution. Sample sizes higher than 30 and smaller than 500 were considered suitable for most studies (Agung, 2006). A large representation of the sample would present more intensity to the validation rule (Lima-Rodríguez, Lima-Serrano, & Domínguez-Sánchez, 2015).

In this study, the output produced and verified in a test was made by the indicators of mathematical connection ability, including connections inter topics in mathematics, among other topics, and among everyday experience and adapted to the chosen mathematical material, namely material about operations count whole numbers for second-grade elementary school students. The questions of the test then scored by the scoring guidelines set out in table 1 below:

Table 1. Guidelines for Scoring Mathematical Connection Questions

No	Students' Responses to Questions	Scores
1	There is no answer/answer is not in the question/there is no correct answer.	0
2	Only part of the question was answered correctly.	1
3	Almost all aspects of the questions were answered correctly.	2
4	All aspects of the question are answered completely/clearly and correctly.	3

Source: Putri (2017)

The instrument developed was an open test related to problem-solving of count operations of whole numbers. Indicators that showed the success of students' mathematical connection abilities were determined based on three indicators, namely connections with everyday life, connections with disciplines outside mathematics, connections between mathematical topics. This investigation's mathematical connection ability indicators were based on Maruliana's research (2019).

There were three techniques applied in the implementation of R&D, namely expository, evaluative, and experimental (Sugiyono, 2016). The expository process was practiced to collect the data needed in organizing study tools to estimate the mathematical connections of primary school students. The mathematical connection ability test made was a written test item in the form of an essay. Tests that had been made in advance were consulted with experts in elementary school mathematics for expert judgment. The following phase, namely the evaluative technique applied to review the evaluation results regarding the expert judgment, revises and improves the mathematical connection ability instrument. After the instrument was improved based on the expert's advice, the test instrument was tested on the research sample. The implementation of test instruments was an activity that was part of the experimental method. The experimental approach was applied to examine the practicability of a study product utilizing analysis techniques for validity, reliability, discrimination, and instrument difficulty index measured using ANATES 4.0 software developed by To (1996). Experimental method applying a quasi-experimental design, as the subsequent round the prediction results were interpreted based on certain classifications.

Measuring the instrument's validity used the Pearson product-moment correlation coefficient analysis (rxy) and reliability for description instruments by comparing Cronbach's Alpha values. At the same time, the problem difficulty level was identified from the difficulty level value (TK) through the percentage between the representation of learners who could answer the questions accurately and the number of all students. Furthermore, the discrimination power is known from the difference in the relationship of learners in the upper group who answered accurately with the relationship of learners in the lower group that responded accurately. A tool was assumed to be valid if the instrument is applied to estimate by the aim to be covered, and a valid instrument explains that it can be applied to cover the performance to be measured (Haryeni & Yendra, 2019). The following is the validity value described based on the coefficient distribution by Guilford (1956), which was shown in table 2 below:

Table 2. Guilford's Classification of Validity Coefficients

r-Value	**Interpretation**
$0.90 \le r_{xy} \le 1.00$	Very high
$0.70 \le r_{xy} < 0.90$	High
$0.40 \le r_{xy} < 0.70$	Moderate
$0.20 \le r_{xy} < 0.40$	Low
$0.00 \le r_{xy} < 0.20$	Very low
$r_{xy} < 0.00$	Invalid

After that validity test was carried out, the next step was to test the degree of reliability. The instrument had good reliability if the source of measurement errors could be minimized. The instrument's reliability was the tool's durability if provided to a similar subject even though several people, at different times, or another place would give the equivalent effects or relatively the same (Lestari & Yudhanegara, 2017). The following was the reliability value that was interpreted based on Jackson (2009) in table 3 below:

Table 3. Guilford's Classification of Reliability Coefficients

r_{11} Value	**Interpretation**
$r_{11} < 0.20$	Very low
$0.20 \le r_{11} < 0.40$	Low
$0.40 \le r_{11} < 0.70$	Moderate
$0.70 \le r_{11} < 0.90$	High
$0.90 \le r_{11} \le 1.00$	Very high

After experimenting with the validity and reliability, the next step was to test the discriminating power regarding the questions. Discriminating power was a question item in distinguishing high, moderate, and low-ability students (Lestari & Yudhanegara, 2017). Thus, the computation of discriminating power was an analysis of the degree to which an object could determine learners who have understood competencies from students who had not/lacked competence based on several principles. The following was the reliability value interpreted based on the classification of the level of discriminating power by To (1996), as stated in table 4 below:

Table 4. Classification of the Discriminating Power Coefficient of Problem

Classification	**Interpretation**
< 10%	Very bad
10% - 19%	Bad
20% - 29 %	Moderate
30% - 49%	Good

Classification	Interpretation
> 50%	Very good

After testing the validity, reliability, and discriminating power of the questions, the next step was testing the difficulty of the questions. The difficulty level of the item was represented through the difficulty index. It could be defined as a number that stated the degree of difficulty of an item (Lestari & Yudhanegara, 2017). The easier the problem was, the larger the index number would be (Arikunto, 2012). Table 5 below presented the difficulty coefficient of the questions by Susetyo (2017):

Table 5. Classification of Problem Difficulty Coefficients

Classification	Interpretation
0% - 15%	Very difficult
16% - 30%	Difficult
31% - 70%	Moderate
71% - 85%	Easy
86% - 100 %	Very easy

Thus, if the test results from developing the mathematical connection ability instrument of students had high validity, reliability, various problem difficulty indexes, and good discriminating power, then the instrument was suitable to be applied. It was done to measure the mathematical connection ability of second-grade primary school students.

3. Results and Discussion

3.1 Results

The outcomes of this research area in a specific form of a mathematical connection ability test instrument. The indicator of the mathematical connection ability managed to arrange the test referred to table 6 as follows:

Table 6. Mathematical Connection Ability Indicator

Aspects of Mathematical Connection Ability	Indicators
The connection between topics in mathematics	1.1 Determine the mathematical concepts used to solve the problem. 1.2 Provide examples of simple questions that represent solutions to problems. 1.3 Apply mathematical concepts to solve problems.
The connection with other subjects	2.1 Determine the concept of other lessons related to the problem given. 2.2 Determine the mathematical concepts required in the given problem. 2.3 Apply mathematical concepts and other subjects in solving a given problem.

Aspects of Mathematical Connection Ability	Indicators
The connection with everyday life	3.1 Determines the mathematical symbol of the given problem. 3.2 Determine the mathematical model or sentence of the given problem. 3.3 Interpreting math solutions back into real situations.

Blueprint of mathematical connection ability questions developed in this study was material in mathematics learning on counting operations whole numbers in the first semester for second-grade elementary school students. The complete set of questions developed could be seen in table 7:

Table 7. Blueprint for Mathematical Connection Abilities

<table>
<tr><th>Mathematical Connection Ability Indicators</th><th>Learning Indicators</th><th>Cognitive Level</th><th>Questions</th><th>Item</th></tr>
<tr><td>Connection with real situations or everyday life</td><td>4.4. Solves a problem that involves the operation of counting whole numbers that are associated with everyday life.</td><td>Analyzing</td><td>Ica is playing guessing math problems from her friend. Let's help Ica to win in the game. To become a winner, Ica must fill in all of the math problems correctly. Help Ica to fill in the blanks in the following questions:
<table>
<tr><td rowspan="2"></td><td>2</td><td rowspan="2"></td></tr>
<tr><td>:</td></tr>
<tr><td>36</td><td rowspan="4"></td><td>….</td></tr>
<tr><td>…</td><td>19</td></tr>
<tr><td>…</td><td>…</td></tr>
<tr><td>…</td><td>…</td></tr>
</table></td><td>1</td></tr>
<tr><td>Connection with real situations or everyday life</td><td>4.4. Solves a problem that involves the operation of counting whole numbers that are associated with everyday life.</td><td>Analyzing</td><td>Rudi has 70 pieces of bread for his birthday party. Forty pieces of bread are red, and the rest are brown. Rudi wants to put the brown bread into six plates</td><td>2</td></tr>
</table>

Mathematical Connection Ability Indicators	Learning Indicators	Cognitive Level	Questions	Item
			equally and the red ones into eight plates equally. How much red and brown bread are on each plate?	
Connections with disciplines outside mathematics (Connections between whole number mathematics and science)	4.4. Solves a problem that involves the operation of counting whole numbers that are associated with everyday life.	Analyzing	Beben got a task from his teacher to observe the growth of 10 sprouts for one month. Beben planted five sprouts. Once a week, it grows 2 cm. While others grow 1 cm every week. How tall is each sprout that Beben plants in a month? (Note: 1 month = 4 weeks)	3
Connections with disciplines outside mathematics (Connections between whole number mathematics and Cultural Arts, and Craft)	4.4. Solves a problem that involves the operation of counting whole numbers that are associated with everyday life.	Analyzing	Yuli is drawing sunflowers in her house. The sunflower has 20 petals, but four flower petals fall in a day. How many flower petals will drop in 4 days? Draw the sunflowers with the remaining petals after falling in 4 days!	4
The connection between whole math topics and geometric shapes)	4.4. Solves a problem that involves the operation of counting whole numbers that are associated with everyday life.	Analyzing	It is known that a wardrobe contains 15 jackets of the same thickness. The wardrobe has three racks with different	5

Mathematical Connection Ability Indicators	Learning Indicators	Cognitive Level	Questions	Item
			sizes of space. The first rack is larger than the second. The second rack has a size larger than the third rack. How many jackets can be stored on each of these racks? (Note: provide a variety of possible answers)	
The connection between math topics (addition, multiplication)	4.4. Solves a problem that involves the operation of counting whole numbers that are associated with everyday life.	Analyzing	 One rose is worth 8. A hibiscus flower is worth half of a rose. How much is the total of roses and hibiscus flowers above?	6

Concerning the results of the expert judgment, it was understood that the question was feasible, valid, and reliable as a test item to estimate the capacity of a mathematical connection. The suggestions given by the validator included the words in the instrument questions that must be simplified. In one sentence, the questions should not be more than ten words to be more effective and easy for students to understand. Hence, the validator suggested that a blueprint for mathematical connections could be used provided that improvements are needed.

To support the expert's judgment results, the researcher tested the questions on a predetermined sample to understand the validity, reliability, difficulty index, and discriminating power of questions. The six questions on the test that were tested showed that the mean of all items was 5.12; the Standard deviation was 4.46; the number of subjects was 34. The results of calculating the validity from each item of the questions could be observed in table 8 below:

Table 8. Recapitulation of Mathematical Connection Validity Test Results

No Item Questions	Correlation	Significance
1	0.795	Very Significant
2	0.630	Significant
3	0.716	Very Significant
4	0.666	Significant

No Item Questions	Correlation	Significance
5	0.717	Very Significant
6	0.596	Significant
Total correlation of all items: 0.68		
Number of subjects: 34		
Item questions: 6		

Based on the information in table 8, it could be viewed that the validity test indicated that there were six valid items with a category of 0.68. It had been suggested that the following correlation coefficients: If the correlation coefficient is 0.00, it was invalid, 0.00-0.20 (very low), 0.20-0.40 (low), 0.40-0.70 (moderate), 0.70-0.90 (high), 0.90-1.00 (very high). We could also see some information that six items are considered valid in items 2, 4, and 5 classified as moderate validity, and items 1, 3, and 5 were classified as high. The following was the result of the recapitulation of the reliability test for the achievement of students' mathematical connections, which could be observed in table 9:

Table 9. The Summary of Mathematical Connection Reliability Test Results

No Subject	Subject Initials	Odd Score	Even Score	Total Score
1	AF	0	0	0
2	As	0	0	0
3	Az	0	3	3
4	Rz	0	4	4
5	Ai	0	4	4
6	Ft	0	2	2
7	Gr	0	1	1
8	Dn	0	3	3
9	HI	3	5	8
10	Fk	0	5	5
11	Zr	3	5	8
12	Dl	0	5	5
13	Af	3	5	8
14	Nf	0	5	5
15	Nz	0	5	5
16	Rf	3	5	8
17	Pv	3	4	7
18	Kv	0	2	2
19	Sh	9	9	18
20	Sk	9	9	18
21	Ai	0	6	6
22	Nr	3	5	8
23	Ys	0	3	3
24	Sr	5	6	11
25	Az	0	2	2
26	Rn	0	2	2
27	Ft	0	0	0
28	Hl	0	2	2

No Subject	Subject Initials	Odd Score	Even Score	Total Score
29	Kr	3	2	5
30	Pl	0	0	0
31	Ak	6	4	10
32	Afh	9	8	17
33	Hl	3	7	10
34	Fe	0	2	2
Standard deviation: 4.46				
Test reliability: 0.81				

Based on Table 9, it was understood that the reliability test results showed the reliability of six items with a Cronbach's Alpha score of 0.81. It had been argued that the following reliability coefficients were 0.00-0.20 (very low), 0.20-0.40 (low), 0.40-0.70 (moderate), 0.70-0.90 (high), and 0.90-1.00 is (very high). We could see some information that the six items had a high category. Furthermore, the results of the recapitulation of difficulty index test of the students' mathematical connection instrument, which could be observed in table 10:

Table 10. Recapitulation of Mathematical Connection Difficulty Index Test Results

Item	Level of Difficulty (%)	Interpretation
1	18.52	Difficult
2	44.44	Moderate
3	25.93	Difficult
4	20.37	Difficult
5	37.04	Moderate
6	48.15	Moderate

Based on Table 10, the difficulty index test indicated that the six questions were moderate and difficult. Then, the results of the recapitulation of the discrimination test about the instrument of students' mathematical connections were presented in Table 11:

Table 11. Recapitulation of Discrimination Power Test Results for Mathematical Connection Problems

No	Original Item	Ex Average	As average	Difference	Ex SD	As SD	Combined SD	t	DP (%)
1	1	1.11	0.00	1.11	1.36	0.00	0.45	2.44	37.04
2	2	2.22	0.44	1.78	0.44	0.88	0.33	5.41	59.26
3	3	1.56	0.00	1.56	1.51	0.00	0.50	3.09	51.85
4	4	1.22	0.00	1.22	1.30	0.00	0.43	2.82	40.74
5	5	2.22	0.00	2.22	1.30	0.00	0.43	5.12	74.07
6	6	2.56	0.33	2.22	1.01	0.71	0.41	5.39	74.07
Upper/Lower class: 9									
Ex: Excellent									
SD: Standard Deviation									
As: Asor									

Based on table 11, it could be understood that for the discriminating power of the six questions, they were in the good and very good categories with the results of item one (37.04), item two (59.26), item three (51.85), four (40.74), item five (74.07) and item six (74.07). As seen from the data obtained, it could be concluded that the items from the trial to see the validity, reliability, difficulty index, and discrimination power of the questions proved that six items on the instrument were valid with moderate to high categories. The reliability was very high, and the difficulty level of the questions was in the moderate and difficult categories. The discrimination between the questions was in the good and very good categories. Therefore, six items of the test questions developed could be used to measure mathematical connections and applied in mathematics learning activities.

3.2 Discussion

The process of retrieving data from the validity, reliability of the difficulty index, and the discrimination in the power of the questions indicated that the validity test of six mathematical connection questions given was 34 valid results with a r_{xy} value of 0.68 with a range of 0.59-0.79. According to Guilford (1956) and Lodico, Spaulding, & Voegtle (2006), if observed based on the validity classification table, those numbers meant the level of validity in moderate to high criteria. The value of the validity coefficient ranged from 0.00 to 1.00. The coefficient estimation of 1.00 pointed that the person proceeding with the instrument analysis and the standards test had approximately similar outcomes. In contrast, if the validity coefficient was 0, there was no correlation between the tool and its standards. The more powerful the validity coefficient value of an instrument, the more accurate the instrument was (Yusup, 2018). Through the validity test of this instrument, it could be understood that the instrument had a good level of accuracy that could be applied to precisely measure mathematical connections' ability. The study states that a validity test is needed to determine the accuracy of the data submitted (Aliyah, 2015; Shahradesi, 2019; Zahra, 2015).

Moreover, the reliability analysis was a sequence of the validity test, where only valid items were entered into the analysis (Fridayanthie, 2016). From the reliability test results using Anates software, the mathematical connection instrument's reliability value was 0.81. When linked through the reliability classification proposed by Jackson (2009), this score is in the high-reliability category. In conducting any research, not only the right decision of data collection, the instrument was necessary, but the most important thing was to make sure the instrument selected and used can work accurately (Dikko, 2016). Such high reliability showed high stability (Wang, Tsai, Chou, & Hung, 2010). Consistent instruments could measure variables in similar subjects at different times and present relatively the same responses. In this illustration, the instrument could produce if it was valid and truthful.

The difficulty index test was a sequence of the validity and reliability analysis. The results of the difficulty index analysis using the ANATES software indicated that the value of the student's mathematical connection instrument was moderate and difficult if it was linked within the reliability distribution suggested by Susetyo (2017). If the value of the difficulty level was converted into the range 0-1, item 1 became 0.18, item 2 became 0.44, item 3 became 0.25, item 4 became 0.20, item 5 became 0.37, and item 6 became 0.48. Other guidelines reveal that the level of the difficulty level of the analysis items (P) was good in the range of 0.3 to 0.7 as a description of the maximum ability of the test taker (Anderson & Krathwohl, 2001). A good level of difficulty was a moderate level of difficulty (Purwanto, 2014). The difficulty level test was to understand whether the item was too complicated or too simple because a good question was neither too difficult nor too easy (Aseptianova, Nawawi, & Yuliandina, 2019).

The question discrimination power test was a sequence of the problem difficulty index analysis using the ANATES software. Relating to the classification of the question discrimination by To (1996), it showed the value of the discrimination in the value of the students' mathematical connection instrument questions was in the good and very good categories with the acquisition of the results of item 1 (37.04), item 2 (59.26), item 3 (51.85), item 4 (40.74), item 5 (74.07) and item 6 (74.07). Good discrimination power could discriminate among learners who had high abilities and low abilities or discriminate between upper and lower groups (Pangestu, Maulana, & Alfian, 2019; Tanjung & Bakar, 2019). While high-grade discrimination power was presented for the analysis, it was not feasible to connect with other measures to discover imminent validity. It continued an impressive area for further development (Prideaux, Roberts, Eva, Centeno, Mccrorie, Mcmanus, Patterson, Powis, Tekian, & Wilkinson, 2011).

In this case, the validity, reliability, difficulty index, and discrimination power of a tool were essential. An instrument was assumed to be valid if the instrument was applied to estimate the variable to be measured. A valid instrument determined that it could be applied to measure the performance (Haryeni & Yendra, 2019). If the data obtained is invalid, it could make incorrect conclusions (Arifin, 2017; Creswell, 2009). The quality of an instrument was assumed to be reliable if the decisions were approximately the same even though it was practiced frequently (Ghofur, Degeng, Widiati, & Setyosari, 2017). The instrument was considered reliable if the source of measurement errors could be minimized because it had good validity and reliability, which were deemed to be trustworthy (Maruti, 2015).

The validity, reliability, difficulty level, and the discrimination power of the questions related to consistency in the measurement were in line with a study, which stated that the difficulty level of the items could be expressed through a number. Besides, the discrimination power was also a certain aspect that was measured in the research where the ability of the items in discriminating high, moderate, and low-ability students. So that, the computation of discriminating power was an estimation of the degree to which an object could determine learners who had understood competencies from learners who had no/lacked competence based on certain criteria (Lestari & Yudhanegara, 2017).

Therefore, to obtain optimal research findings in measuring mathematical abilities, researchers should have properly investigated the suitability of the instruments before implementing mathematics learning. These premises could be determined empirically and logically. The instruments produced in this research had validity, reliability, and difficulty index.

4. Conclusion

The findings and discussion of this study indicated that six items were feasible to be applied as an instrument of mathematical connection ability of second-grade primary school learners in counting operations of whole numbers. These questions had been comprehensively studied based on the revised results of the expert judgment and the results of empirically and logically tested instruments. The results showed that the mathematical connection ability instrument developed in this study had fairly good validity, high reliability, various difficulty indexes, and good discriminating power. The test questions resulting from the development of the instrument in this study could be used as an alternative question for teachers in schools. Further researchers could use them to develop the mathematical connection skills of second-grade elementary school students. Of course, this research had limitations which only produced instruments to measure the ability of mathematical connections, and there were many other higher-order thinking skills that researchers could develop in more depth by referring to this research.

References

Agung, I. G. N. (2006). *Statistika Penerapan Model Rerata-Sel Multivariat dan Model Ekonometri dengan SPSS*. Yayasan Sad Satria Bhakti.

Aisyah, N. (2019). An Analysis of Summative Test on the 8th Grade of Muhammadiyah Junior High School of Yogyakarta. *Third International Conference on Sustainable Innovation 2019-Humanity, Education and Social Sciences (IcoSIHESS 2019)*, *353*, 495–499. https://doi.org/10.2991/icosihess-19.2019.86.

Aliyah, S. (2015). Hubungan Bermain Balok dengan Perkembangan Kognitif Anak Usia 4-5 Tahun di RA Miftahul Ulum Tahun 2013-2014. *SELING: Jurnal Program Studi PGRA*, *1*(1), 31–45. https://doi.org/10.29062/seling.v1i1.235.

Anderson, L. W., & Krathwohl, D. R. (2001). *A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives*. Addison Wesley Longman, Inc.

Andrian, D., Kartowagiran, B., & Hadi, S. (2013). The Instrument Development to Evaluate Local Curriculum in Indonesia. *International Journal of Instruction*, *11*(4), 921–934. https://eric.ed.gov/?id=EJ1191699.

Arifin, Z. (2017). Kriteria Instrumen dalam Suatu Penelitian. *Jurnal Theorems (The Original Research of Mathematics)*, *2*(1), 28–36. https://doi.org/10.31949/th.v2i1.571.

Arikunto, S. (2012). *Penelitian Tindakan Kelas*. Bumi Aksara.

Ariyani, W., Suyitno, H., & Junaedi, I. (2020). Mathematical Connection Ability and Students' Independence in Missouri Mathematics Project E-Learning. *Unnes Journal of Mathematics Education Research*, *9*(2), 185–189. https://journal.unnes.ac.id/sju/index.php/ujmer/article/view/33307.

Aseptianova, Nawawi, S., & Yuliandina, M. (2019). Pengembangan Asesmen Biologi Berbasis Keterampilan Berpikir Kritis Siswa Kelas XI Semester Genap di SMA Muhammadiyah 1 Palembang. *BIOEDUKASI (Jurnal Pendidikan Biologi)*, *10*(1), 1–13. https://doi.org/10.24127/bioedukasi.v10i1.2001.

Ayunani, D. S., Mardiyana, & Indriati, D. (2020). Analyzing Mathematical Connection Skill in Solving a Contextual Problem. *Journal of Physics: Conference Series*, *1511*, 1–10. https://doi.org/10.1088/1742-6596/1511/1/012095.

Azwar, S. (2011). *Reliabilitas dan Validitas*. Pustaka Pelajar.

Creswell, J. W. (2009). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches* (3rd ed.). Sage Publication, Inc.

Dikko, M. (2016). Establishing Construct Validity and Reliability: Pilot Testing of a Qualitative Interview for Research in Takaful (Islamic Insurance). *Qualitative Report*, *21*(3), 521–528. https://doi.org/10.46743/2160-3715/2016.2243.

Dudung, A., & Oktaviani, M. (2020). Mathematical Connection Ability: An Analysis Based on Test Forms. *International Journal of Advanced Science and Technology*, *29*(6), 4694–4701. http://sersc.org/journals/index.php/IJAST/article

/view/19384.
Elliott, S. N., McKevitt, B. C., & Kettler, R. J. (2002). Testing Accommodations Research and Decision Making: The Case of "Good" Scores being Highly Valued but Difficult to Achieve for All Students. *Measurement and Evaluation in Counseling and Development*, *35*(3), 153–166. https://doi.org/10.1080/07481756.2002.12069060.

Fridayanthie, E. W. (2016). Analisa Sistem Informasi Upload Promosi Harga Menggunakan SAP terhadap Kepuasan Pengguna pada PT Hero Supermarket Tbk. *Jurnal Khatulistiwa Informatika*, *4*(1), 30–43. https://doi.org/10.31294/jki.v4i1.1255.

Gall, M. D., Gall, J. P., & Borg, W. R. (2010). *Applying Educational Research*. Pearson Education, Inc.

Ghofur, A., Degeng, I. N. S., Widiati, U., & Setyosari, P. (2017). The Effect of Communicative Language Teaching and Audio-Lingual Method on English Speaking Skill Across Different Learning Styles. *KnE Social Sciences*, *1*(3). https://doi.org/10.18502/kss.v1i3.719.

Guilford, J. P. (1956). *Fundamental Statistics in Psychology and Education*. McGraw-Hill.

Haryeni, & Yendra, N. (2019). Dampak Dimensi Servqual terhadap Kepuasan Pasien, Repurchase Intentions dan Komunikasi WOM pada Industri Kesehatan Publik. *Menara Ilmu*, *13*(10), 28–41. https://doi.org/10.31869/mi.v13i10.1621.

Hendriana, H., Rohayati, E. E., & Sumarmo, U. (2017). *Hard Skills dan Soft Skills Matematik Siswa*. Refika Aditama.

Jackson, S. L. (2009). *Research Methods and Statistics a Critical Thinking Approach* (3rd ed.). Cengage Learning.

Ministry of Education and Culture of Republic Indonesia. (2003). *UU Nomor 20 Tahun 2003 tentang Sistem Pendidikan Nasional*. Kemendikbud RI.

Kenedi, A. K., Hendri, S., Ladiva, H. B., & Nelliarti. (2018). Kemampuan Koneksi Matematis Siswa Sekolah Dasar dalam Memecahkan Masalah Matematika. *Jurnal Numeracy*, *5*(2), 226–235. https://doi.org/10.46244/numeracy.v5i2.396

Kurnianingtyas, D., Windayana, H., & Ardiyanto. (2015). Pengaruh Model Assurance, Relevance, Interest, Assessment, dan Satisfaction (ARIAS) terhadap Kemampuan Koneksi Matematis Siswa. *Jurnal PGSD Kampus Cibiru*, *3*(2). https://www.semanticscholar.org/paper/PENGARUH-MODEL-ASSURANCE%2C-RELEVANCE%2C-INTEREST%2C- DAN-Kurnianingtyas-Windayana/04231c65b04cf882625867fc66b40193116afdef

Lestari, K. E., & Yudhanegara, M. R. (2017). Analisis Kemampuan Representasi Matematis Mahasiswa pada Mata Kuliah Geometri Transformasi Berdasarkan Latar Belakang Pendidikan Menengah. *Jurnal Matematika Integratif*, *13*(1), 28–33. https://doi.org/10.24198/jmi.v13.n1.11410.29-34.

Lima-Rodríguez, J. S., Lima-Serrano, M., & Domínguez-Sánchez, I. (2015). Psychometric Properties of an Instrument to Measure Family Disease Management. *International Journal of Clinical and Health Psychology*, *15*(3), 253–264. https://doi.org/10.1016/j.ijchp.2015.05.002.

Lodico, M. G., Spaulding, D. T., & Voegtle, K. H. (2006). *Methods in Educational Research from Theory to Practice*. Jossey-Bass. https://doi.org/10.1177/001312457500700301.

Manongko, A. A. C. (2016). The Preparation and Testing of Instruments Research on

Factors Affecting the Productivity of Household Farmer. *IOSR Journal of Business and Management (IOSR-JBM)*, *18*(9), 61–73. https://doi.org/10.9790/487X-1809016372.
Maruliana, M. (2019). Analisis Kemampuan Koneksi Matematis Siswa SMA dengan Model Pembelajaran Cooperative Script Berbantuan Video Interaktif. *Jurnal Padegogik Matematika*, *2*(2), 110–117. https://doi.org/10.35974/jpd.v2i2.975
Maruti, E. S. (2015). Pengembangan Media Pembelajaran Keterampilan Menyimak dan Membaca Berbasis Multimedia Interaktif Siswa Kelas IV Sekolah Dasar. *Premiere Educandum: Jurnal Pendidikan Dasar dan Pembelajaran*, *5*(1), 49–58. https://doi.org/10.25273/pe.v5i01.324.
Mohajan, H. K. (2017). Aspects of Mathematical Economics, Social Choice and Game Theory: Jamal Nazrul Islam Research Centre for Mathematical Research. *Journal of Economic Development, Environment and People*. https://doi.org/10.13140/RG.2.2.16589.03040.
National Research Council. (2001). *Adding It Up* (J. Kilpatrick, J. Swafford, & B. Findell (eds.)). National Academy Press. http://www.wakamono-up.jp/top/pdf/Third-party_evaluation_2013_points.pdf
Osler, J. (2007). *A Guide for Integrating Issues of Social and Economic Justice Into Mathematics Curriculum*. http://www.radicalmath.org/docs/SJMathGuide.pdf
Pangestu, A., Maulana, G., & Alfian, Z. N. (2019). Analisis Tingkat Kesulitan Peserta Lomba Matematika SMP LSM XXVI HIMATIKA UNY. *Prosiding Seminar Pendidikan Matematika dan Matematika*, *1*, 1–4. https://doi.org/10.21831/pspmm.v1i0.40
Patriasih, R. (2017). Health Education Media "Smart with Your Foods" Increasing Selection of Foods Knowledge for Elementary School Students. *Innovation of Vocational Technology Education*, *13*(1), 21–26. https://doi.org/10.17509/invotec.v13i1.6260
Ponto, J. (2015). Understanding and Evaluating Survey Research. *Journal of the Advanced Practitioner in Oncology*, *6*(2), 168–171. https://pubmed.ncbi.nlm.nih.gov/26649250
Prideaux, D., Roberts, C., Eva, K., Centeno, A., Mccrorie, P., Mcmanus, C., Patterson, F., Powis, D., Tekian, A., & Wilkinson, D. (2011). Assessment for Selection for the Health Care Professions and Specialty Training: Consensus Statement and Recommendations from the Ottawa 2010 Conference. *Medical Teacher*, *33*(3), 215–223. https://doi.org/10.3109/0142159X.2011.551560
Purwanto. (2014). *Evaluasi Hasil Belajar*. Pustaka Pelajar.
Putri, H. E. (2017). *Pendekatan Concrete-Pictorial-Abstract (CPA) Kemampuan-kemampuan Matematis & Rancangan Pembelajarannya* (N. E. Suryani & R. Juliyanti (eds.)). Royyan Press.
Putri, H. E., Misnarti, & Saptini, R. D. (2018). Influence of Concrete-Pictorial-Abstract (CPA) Approach towards the Enhancement of Mathematical Connection Ability of Elementary School Students. *EduHumaniora: Jurnal Pendidikan Dasar*, *10*(2), 61–71. https://doi.org/10.17509/eh.v10i2.10915
Putri, H. E., Rahayu, P., Saptini, R. D., & Misnarti. (2016). Keterkaitan Penerapan Pendekatan CPA dan Peningkatan Kemampuan Koneksi Matematis Siswa Sekolah Dasar. *Metodik Didaktik*, *11*(1), 41–49. https://doi.org/10.17509/md.v11i1.3785
Putri, H. E., Suwangsih, E., Rahayu, P., Afita, L. A. N., Dewi, N. K. Y. A., &

Yuliyanto, A. (2021). Improving Elementary School Students' Self-Confidence during the Covid-19 Pandemic through Concrete-Pictorial-Abstract (CPA) Approach in Online Learning. *Jurnal PAJAR (Pendidikan Dan Pengajaran)*, *5*(2), 306–316. https://doi.org/10.33578/pjr.v5i2.8193

Putri, H. E., Wahyudy, M. A., Yuliyanto, A., & Nuraeni, F. (2020). Development of Instruments to Measure Mathematical Anxiety of Elementary School Students. *International Journal of Learning, Teaching and Educational Research*, *19*(6), 282–302. https://doi.org/10.26803/IJLTER.19.6.17

Roopa, S., & Rani, M. (2012). Questionnaire Designing for a Survey. *The Journal of Indian Orthodontic Society*, *46*(4), 273–277. https://doi.org/10.5005/jp-journals-10021-1104

Sari, D. P., & Mahendra. (2017). Developing Instrument to Measure Mathematical Reasoning Ability. *1st International Conference of Mathematics and Science Education (ICMSEd 2016)*, *57*, 30–33. https://doi.org/10.2991/icmsed-16.2017.7

Setiadi, P. B., Ursula, R., Rismawati, & Setini, M. (2020). Labour Productivity, Work Experience, Age and Education: The Case of Lurik Weaving Industry in Klaten, Indonesia. *Webology*, *17*(2), 487–502. https://doi.org/10.14704/WEB/V17I2/WEB17047

Shahradesi, Y. (2019). Hubungan Kepemimpinan, Motivasi dan Kompensasi terhadap Kepuasan Kerja Perawat Rawat Inap RSUD Sidikalang Kabupaten Dairi Tahun 2018. *Jurnal Ilmiah Kohesi*, *3*(2), 11–17. https://kohesi.sciencemakarioz.org/index.php/JIK/article/view/70

Sugiman. (2008). Koneksi Matematik dalam Pembelajaran Matematika di Sekolah Menengah Pertama. *Pythagoras: Jurnal Pendidikan Matematika*, *4*(1), 56–66. https://doi.org/10.21831/pg.v4i1.687

Sugiyono. (2016). *Metode Penelitian Kuantitatif, Kualitatif dan R&D*. Alfabeta.

Sumarmo, U. (2010). *Berpikir dan Disposisi Matematik: Apa, Mengapa, dan Bagaimana Dikembangkan pada Peserta Didik*. FPMIPA UPI.

Susetyo, B. (2017). *Statistika untuk Analisis Data Penelitian*. Refika Aditama.

Tanjung, Y. I., & Bakar, A. (2019). Development of Physical Test Instruments Based on the Conceptual Knowledge Dimension of the Revision Bloom Taxonomy. *Jurnal Pendidikan Fisika*, *8*(2), 141–148. https://doi.org/10.22611/jpf.v8i2.14831

To, K. (1996). *Mengenal Analisis Tes*. Jurusan Psikologi Pendidikan dan Bimbingan FIP IKIP Bandung.

Wang, H. S., Tsai, S. N., Chou, C. H., & Hung, H. J. (2010). The Study of Motivation and Reasoning Faculties of Game-Based Learning in Elementary School Students. *ICETC 2010 - 2010 2nd International Conference on Education Technology and Computer*, *3*, 247–251. https://doi.org/10.1109/ICETC.2010.5529554

Warih, P. D., Parta, I. N., & Rahardjo, S. (2016). Analisis Kemampuan Koneksi Matematis Siswa Kelas VIII pada Materi Teorema Pythagoras. *Prosiding Konferensi Nasional Penelitian Matematika Dan Pembelajarannya (KNPMP) I 2016*, 377–384. http://hdl.handle.net/11617/6978

Wijayanti, I. K., & Abadi, A. M. (2019). Analysis of the Difficulty of VIIIth Grade Junior High School Students in Circle Material Reviewed from the Mathematics Connection Ability. *Journal of Physics: Conference Series*, *1397*, 1–11. https://doi.org/10.1088/1742-6596/1397/1/012086

Yuliyanto, A., Turmudi, Agustin, M., Muqodas, I., & Putri, H. E. (2020). The Relationship of Self Efficacy with Student Mathematics Learning Outcomes through the Concrete-Pictorial-Abstract (CPA) Approach in Primary Schools. *JPsd: Jurnal Pendidikan Sekolah Dasar*, *6*(1), 1–14. https://doi.org/10.30870/jpsd.v6i1.7213

Yusup, F. (2018). Uji Validitas dan Reliabilitas Instrumen Penelitian Kuantitatif. *Jurnal Tarbiyah: Jurnal Ilmiah Kependidikan*, *7*(1), 17–23. https://doi.org/10.18592/tarbiyah.v7i1.2100

Zahra, N. (2015). Pengaruh Gaya Kepemimpinan terhadap Komitmen Organisasi melalui Aspek Kepuasan Kerja Karyawan dan Kepercayaan pada Sektor Perbankan. *Jurnal Manajemen dan Pemasaran Jasa*, *8*(1), 145–162. https://doi.org/10.25105/jmpj.v8i1.1406