

# MATHEMATICS CONNECTION ABILITY FOR JUNIOR HIGH SCHOOL STUDENTS BASED ON LEARNING INDEPENDENCE LEVEL

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*Submitted: February 28, 2022*

*Revised: May 31, 2022*

*Accepted: June 4, 2022*

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## Abstract

Mathematical connection ability is one of the basic mathematics skills that must be possessed by junior high school students. It turns out that so far, the student's learning outcomes in terms of mathematics have not been encouraging. This study aims to describe the mathematical connection skills of junior high school students in solving a problem in terms of learning independence. This research is a qualitative descriptive study on eighth-grade students in a junior high school in Lamongan district, East Java. Data was collected using test questions, interviews, and questionnaires. This study obtained the following results: 1) one subject (S2) who has high mathematical connection ability with low learning independence, 2) one subject (S1) who has moderate mathematical connection ability with moderately high learning independence, and 3) two subjects (S3 & S4) who have low mathematical connection skills with low learning independence. The internal causes of the lack of mathematical connection skills and student learning independence are the lack of practice questions, the lack of motivational stimulus to encourage students to study independently. While external factors are the level of test questions that are tested too difficult and the lack of supporting learning information sources.

*Keywords:* ability analysis, independence learning level, mathematical connection ability

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## 1. Introduction

Mathematics is a science in schools that must be learned by all students starting from elementary school, junior high school, middle school, high school, to college. It is because mathematics is a tool that can develop thinking (Burton, 1984; Silver & Others, 1990). Science and mathematics cannot be separated from other sciences and are always related to one another and also related to everyday life (Kiray, Gok, & Bozkir, 2015; Ng, Lay, Areepattamannil, Treagust, & Chandrasegaran, 2012). Therefore, every student feels the need to have mathematical connection skills to support their understanding of mathematics.

In the 2004 curriculum, the ability to connect mathematically is one of the basic mathematical skills that must be possessed and mastered by junior high school students. Regarding the importance of mathematical connections, NCTM argues, "when students can connect mathematical ideas, their understanding is deeper and more lasting" (National Council of Teachers of Mathematics, 2009). The meaning of these words is that when a student can connect mathematical ideas, their thinking will be deeper and will be stored in their memory for a long time. In mathematics and science concepts are hierarchical and each concept is related to one another means that when we learn a certain concept, it is necessary to first study the previous concepts as a prerequisite (Septian & Rizkiandi, 2017; Suhandri, Nufus, & Nurdin, 2017). However, in reality, in terms of mathematical connections, Indonesian school student and Mexican re-university student learning outcomes have not been satisfactory at all (Anita, 2014; Diana, Suryadi, & Dahlan, 2020; García-García & Dolores-Flores, 2021; Kenedi, Helsa, Ariani, Zainil, & Hendri, 2019).

For this paper, the following definition applies: Mathematical connection refers to the ability to recognise and make connections between

mathematical ideas, between mathematics and other subjects, and between mathematics and everyday life.

It takes the effort or attention of educators so that student learning outcomes can be achieved. One of the student factors that can bring out their potential to succeed in achieving satisfactory learning outcomes is learning independence (Arista & Kuswanto, 2018; Mulyono, 2017; Suhendri, 2015). Another researcher states that a process within a person to play an active role and not depend on others to achieve certain goals in learning is the definition of learning independence (Fajriyah, Nugraha, Akbar, & Bernard, 2019; Rustyani, Komalasari, Bernard, & Akbar, 2019).

Based on the discussion above, the researchers were very interested in conducting a study listed in the title.

## 2. Method

The paper uses descriptive qualitative research. The descriptive method is an analytical method that clearly describes the conditions of the thing being studied by collecting data, and then the data is classified, analyzed, and interpreted. The qualitative method is a process linked to everyday reality. This study aims to describe and examine the connection abilities of junior high school students in solving problems in terms of learning independence.

This research was conducted with subjects consisting of 4 students of class VIII in a junior high school in the city of Lamongan. The four subjects will be referred to as Subject 1 (S1), Subject 2 (S2), Subject 3 (S3), and Subject 4 (S4). Analysis of the data obtained from 3 essay questions on the subject's mathematical connection ability, interviews, transcribing interview results, and learning independence questionnaires was completed. The questions and questionnaires used are shown in Figure 1 and Figure 2.

### QUESTIONS

1. Find the value of  $7^{2022} + 7^{2022} + 7^{2022} + 7^{2022} + 7^{2022} + 7^{2022} + 7^{2022}$ .
2. Joni has money marked with the numbers 1, 2, 4, 6, and 9. From these numbers, an odd number consisting of five digits will be formed, provided that no number is repeated. What is the difference between the largest and the smallest numbers formed?
3. The 2052th letter of the pattern O, L, I, M, P, I, A, D, E, S, A, I, N, S, N, A, S, I, O, N, A, L, O, L, I, M, P, I, A, D, E, S, A, I, N, S, ... is?

Figure 1. Question Instrument

No	Statement	Answer			
		1	2	3	4
1	I study math at least 1 hour per day without the teacher's orders				
2	I study math at least 1 hour per day without being ordered by my parents				
3	I'm passionate about learning math				
4	I am enthusiastic about mathematics				
5	I am driven to learn math				
6	I like maths				
7	I study the material before being taught by the teacher				
8	I prepare questions for the teacher related to math material that has not been understood				
9	I'm happy if the teacher gives math assignments				
10	I immediately do the math assignments given by the teacher				
11	If the teacher explains the material and I don't understand it, then I ask the teacher about the material				
12	I go to the library to read and study math books				
13	I am confident in doing math problems				
14	I am optimistic in solving problems in mathematics				
15	I do my math test without cheating				
16	I am optimistic about expressing opinions related to math material				
17	I am confident in carrying out math group learning activities				
18	When discussing, I believe I can complete group assignments				
19	I collect math assignments on time				
20	I collect the math group work report on time				
21	I re-learn the math problems that have been discussed				
22	I make a summary/digest related to the math material that I have learned				
23	I'm working on group assignments				
24	I re-learn math problems that were answered incorrectly				

Description of the answer: (1) = never / disagree; (2) = never / not agree; (3) = often / agree; (4) = always / strongly agree

Figure 2. Questionnaire Instrument

There are 3 instruments used in this study, namely questions to measure the ability of mathematical connections; the interview rubric was asked by the researcher to find out the information he wanted to know; documentation in the form of recordings, student answer sheets, and learning independence questionnaires. The student learning independence questionnaire rubric is presented in Table 1.

Table 1. Learning Independence Questionnaire Rubric

Aspects measured	Indicator	Statement number	Number of statements
Learning independence	Passion for learning	1, 2, 3, 4, 5, 6	6
	Courage and initiative	7, 8, 9, 10, 11, 12	6
	Confident	13, 14, 15, 16, 17, 18	6
	Responsible	19, 20, 21, 22, 23, 24	6
<b>Total</b>			<b>24</b>

The scoring technique on the student learning independence questionnaire is as follows. Number of items per aspect = 6; minimum score = 1; minimum value = 1 × 6 = 6; maximum score = 4; maximum value = 4 × 6 = 24; number of interval classes = 5.

$$\begin{aligned} \text{Interval distance} &= \frac{\text{maximum value} - \text{minimum value of}}{\text{number of interval classes}} = \frac{24 - 6}{5} \\ &= 3.6 \end{aligned}$$

Table 2. Conversion of Classification of Student Learning Independence

Score	Criteria
20.4 ≤ Score ≤ 24	Very high
16.8 ≤ Score < 20.4	High
13.2 ≤ Score < 16.8	Fairly high
9.6 ≤ Score < 13.2	Low
6 ≤ Score < 9.6	Very low

To obtain a mathematical connection ability test score, it is carried out scoring using an assessment adopted from Nursaniah, Nurhaqiqi, & Yuspriyati (2018), which can be seen in Table 3 below.

**Table 3.** Scoring of Mathematical Connection Ability

Measured Aspects of	Student Answers	Score
Between Mathematical Topics	Answers are correct, recognize and understand the use of mathematical concepts.	4
	Answers are correct according to the criteria requested but some are not quite right.	3
	Answers are correct, do not match some of the criteria requested.	2
	There is an answer that does not match the criteria.	1
	No answer	0
Connections Mathematics in daily life	Answers are correct, recognize and understand the use of mathematical concepts in everyday life.	4
	Answers are correct according to the criteria requested but some are not quite right.	3
	Answers are correct, do not match some of the criteria requested.	2
	There is an answer that does not match the criteria.	1
	No answer	0

The categorization of mathematical connection ability test scores by Agustiani (2020), was adopted in this study. It can be seen in Table 4 below.

**Table 4.** Categorization of Students' Mathematical Connection Abilities

Score Range (100%)	Category
Value $\geq$ 80	High
$65 \leq$ Value $<$ 80	Medium
Value $<$ 65	Low

### 3. Result and Discussion

The results obtained by researchers after testing students by giving them mathematical connection ability test questions along with an independence questionnaire study are presented below.

#### 3.1 The Subject Classification

The results of the classification of learning independence subjects are obtained according to the calculations in Table 2 and the categorization of students' mathematical connection abilities in Table 4, and the subject classifications results are shown in Table 5 as follows.

**Table 5.** Research Results Categories

Subjects	Independence Learning	Mathematical Connections	Score
S1	High enough	Medium	68.5
S2	Low	High	80.25
S3	Low	Low	60.24
S4	Low	Low	61.37

Based on the data in Table 5, we can see that the first subject (S1) has a high enough independence learning level, and S2, S3, S4 are subjects with low independence learning levels. In Table 5, we can also see that there is one subject (S2) who have high mathematical connection ability with low learning independence, one subject (S1) who has moderate mathematical connection ability with fairly high learning independence, and two subjects (S3 & S4) who have low mathematical connection ability with low learning independence.

#### 3.2 The Mathematical Connections of Subjects

The researcher used 3 essay questions to measure the mathematical connection ability and the assessment was according to the rubric in Table 3. After obtaining the test scores for each subject, they categorized their mathematical connection abilities based on independent learning. The following is a description of the answers and interviews on each subject.

##### The Subject 1

$$\begin{aligned}
 1). & 7^{2022} + 7^{2022} + 7^{2022} + 7^{2022} + 7^{2022} + 7^{2022} + 7^{2022} \\
 & = 7^{2022} \times 7 \\
 & = 7^{2022} + 1 \\
 & = 7^{2023}
 \end{aligned}$$

**Figure 3.** The answer to question number 1 by S1

Figure 3 shows that S1 is quite capable of using connections between mathematical topics, and can solve problems quite well. Related to this, the following is an excerpt from the researcher's (Q) interview instrument with the first subject (S1).

Q : In number one, what was asked?  
 S1 : Determine the value of ...  
 Q : What is known?  
 S1 :  $7^{2022}$   
 Q : How many results did you get?  
 S1 : 72023 (Seventy-two thousand twenty-three)  
 Q : Are you sure it's true?  
 S1 : Yes

The interview quoted on script 1 shows that S1 has not been able to use connections between mathematics topics.

2). 1,2,4,6,9      11111  
~~9,6,4,2,1~~ - 11111  
 = 8,5,3,1,0

**Figure 4.** The answer to question number 2 by S1

Figure 4 shows that S1 is quite capable of using connections in everyday life, and can solve problems quite well. Related to this, the following is an excerpt from the researcher's interview instrument with the first subject (S1).

Q : What is the second known number?  
 S1 : 1, 2, 4, 6, and 9  
 Q : What was asked about number two?  
 S1 : Silence... (for a moment)  
 Number difference  
 Q : What number?  
 S1 : The biggest and the smallest  
 Q : What results did you get?  
 S1 : 8, 5, 3, 1, 0

The interview excerpt on script 2 shows that S1 is quite capable when using connections in everyday life.

3). HURUF KE 2052 dari POLA adalah diketahui: OLYMPIAD  
 ditanya : ...  
 Jwb :  $36\sqrt{2052}$

$$\begin{array}{r} 180 \\ 180 \\ \hline 252 \\ 252 \\ \hline 500 \end{array}$$

**Figure 5.** The answer to question number 3 by S1

Figure 5 shows that S1 is quite capable of using connections between mathematical topics, and can solve problems quite well. Related to this, the following is an excerpt from the researcher's interview instrument with the first subject (S1).

Q : Where did this number 36 come from?  
 S1 : From the name of the olympiad the same...  
 Silent  
 Q : So where did 2052 come from?  
 S1 : From the letter  
 P : That includes what is known what is being asked  
 S1 : Asked

The interview excerpt in script 3 shows that S1 has not been able to use connections between mathematical topics properly according to the specified criteria.

## The Subject 2

JAWABAN  
 1.  $7^{2022} + 7^{2022} + 7^{2022} + 7^{2022} + 7^{2022} + 7^{2022} + 7^{2022}$   
 $= 7^{2022} \times 7$   
 $= 7^{2022+1}$   
 $= 7^{2023}$

**Figure 6.** The answer to question number 1 by S2

Figure 6 shows that Subjek 2 can use connections between mathematical topics, and can solve problems well. Related to this, the following is an excerpt from the researcher's interview instrument with the second subject (S2).

Q : For question number one, what was asked?  
 S2 : Determine the value of  
 Q : What do you know about question number one?  
 S2 :  $7^{2022} + 7^{2022} + 7^{2022} + 7^{2022} + 7^{2022} + 7^{2022} + 7^{2022}$   
 Q : What is the number one result?  
 S2 :  $7^{2023}$   
 Q : Where did the results come from?  
 S2 :  $7^{2022+1}$   
 Q : Why don't you write what you know and ask?  
 S2 : Forgot sir

The interview excerpt in script 4 shows that S2 can use connections between mathematical topics. It can be seen that S2 has been able to solve problem number 1 well.

2) 1,2,4,6, dan 9 terkecil: 11111  
 9,6,4,2 dan 99999 - 11111  
 = 88888

**Figure 7.** The answer to question number 2 by S2

Figure 7 shows that S2 is able to use mathematical connections in everyday life and can solve problems quite well according to the criteria but some are not quite right in the answers. Related to this, the following is an excerpt from the researcher's interview instrument with subject 2 (S2).

Q : For question number two, what do you know?  
 S2 : numbers 1, 2, 4, 6 and 9  
 Q : What is being asked for question number two?  
 S2 : The difference between the largest and the smallest number  
 Q : From this question, what is the biggest number?  
 S2 : Nine  
 Q : What about the smallest?  
 S2 : One



Q : What is your biggest number?  
 S2 : 99999  
 Q : What's the smallest number?  
 S2 : 11111  
 Q : What are you doing?  
 S2 : Subtracted  
 Q : Are you sure?

The interview excerpt on script 5 shows that Subject 2 is capable of using mathematical connections in everyday life. It indicates that S2 has been able to solve question number 2 quite well according to the criteria but there is something that is not quite right from the answer.

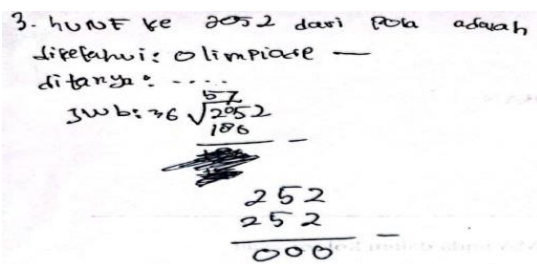


Figure 8. The answer to question number 3 by S2

Figure 8 shows that S2 has not been able to use connections between mathematical topics properly according to the specified criteria. Related to this, the following is an excerpt from the researcher's interview with the S2.

Q : What do you know about the third question?  
 S2 : National Science Olympiad  
 Q : For what is asked?  
 S2 : 2052  
 Q : Have you finished answering question number three?  
 S2 : Not yet  
 Q : Where are these 36 from?  
 S2 : From the letters of the national science olympiad

The interview excerpt in script 6 shows that S2 has not been able to use connections between mathematical topics properly according to the specified criteria.

**The Subject 3**

$$\begin{aligned}
 & 1. 7^{2022} + 7^{2022} + 7^{2022} + 7^{2022} + 7^{2022} + 7^{2022} + 7^{2022} \\
 & = 7^{2022} \times 7 \\
 & = 7^{2022} + 1 \\
 & = 7^{2023}
 \end{aligned}$$

Figure 9. The answer to question number 1 by S3

Figure 9 shows that S3 is quite capable of using connections between mathematical topics and can solve problems quite well. Related to this, the following is an excerpt from the researcher's interview with S3.

Q : For question number one, how many results did you get?  
 S3 :  $7^{2023}$   
 Q : Then what is known about what is being asked from question number one?  
 S3 : Determine the value of  
 Q : Determine what the value includes? including what is known, or is it included in the question?

The interview excerpt in script 7 shows that S3 has not been able to use connections between mathematical topics well.

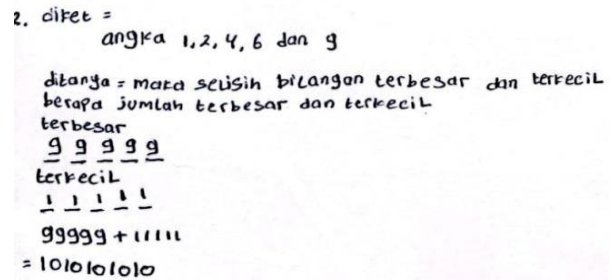


Figure 10. The answer to question number 2 by S3

Figure 10 shows that S3 is able to use mathematical connections in everyday life, and solves problems quite well but does not meet the criteria. Related to this, the following is an excerpt from the researcher's interview with S3.

Q : What do you know about the second question?  
 S3 : Silent...  
 Q : What is known?  
 S3 : 1, 2, 4, 6, and 9  
 Q : What is the question that is being asked?  
 S3 : Difference between the largest and smallest numbers  
 Q : How much do you get for the results?  
 S3 : Silent...  
 Q : For the results?  
 S3 : Silent...  
 Q : Are you sure about this answer?  
 S3 : Not yet

Interview quotes on script 8 show that S3 has not been able to use connections in everyday life well.

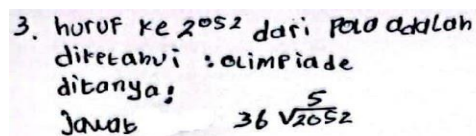


Figure 11. The answer to question number 3 by S3

Figure 11 shows that S3 has not been able to use connections between mathematical topics well. Related to this, the following is an excerpt from the interview instrument of the researcher with S3.

Q : For number three, haven't you?  
 S3 : Silent...  
 Q : How come this is not done number three why?  
 S3 : Silence... (for a moment). Not yet

The interview excerpt from script 9 shows that S3 has not been able to use connections between mathematical topics well.

**The Subject 4**

$$\begin{aligned} & 1. 7^{2021} + 7^{2022} + 7^{2022} + 7^{2022} + 7^{2022} + 7^{2022} + 7^{2022} \\ & = 7^{2022} \times 7 \\ & = 7^{2022} + 1 \\ & = 7^{2023} \end{aligned}$$

Figure 12. The answer to question number 1 by S4

Figure 12 shows that S4 is quite capable of using connections between mathematical topics and can solve problems quite well. Related to this, the following is an excerpt from the researcher's interview with S4.

Q : Question number one, what was asked?  
 S4 : Determine the value of  
 Q : Then what is known?  
 S4 : 7000 uh... seven 2022  
 Q : How come the number one that is known and asked is not written down?  
 S4 : Forgot

The interview excerpt on script 10 shows that S4 has not been able to use connections between mathematical topics well.

2. Diket: angka 1, 2, 4, 6 dan 9

Ditanya: mana Seisih bilangan terbesar dan terkecil berapa jumlah terbesar dan terkecil

$$\begin{array}{r} 99999 \\ + 11111 \\ \hline 111110 \end{array}$$

Figure 13. The answer to question number 2 by S4

Figure 13 shows that S4 is quite capable when using connections in everyday life, and solves problems quite well but does not meet the criteria. Related to this, the following is an excerpt from the researcher's interview with S4.

Q : For question number two, how many results did you get?  
 S4 : (Silence for a moment)  
 Q : What do you know from question number two?  
 S4 : 1, 2, 4, 6, and 9  
 Q : Then what was asked?  
 S4 : Difference between the largest and smallest numbers

Q : What will the difference between the largest and the smallest numbers be?  
 S4 : (Silence for a moment)  
 Plus  
 Q : If the difference is added?  
 S4 : (He was silent)

The interview excerpt on script 11 shows that the S4 has not been able to properly use the connection in everyday life.

3. huruf ke 2052 dari pola adalah

Diketahui: olimpiade

Ditanya: ... 5

Jawab:  $36\sqrt{2052}$

Figure 14. The answer to question number 3 by S4

Figure 14 shows that S4 is not good at using connections between math topics. The following excerpt from the researcher's interview instrument with the fourth subject (S4).

Q : For number three, haven't you?  
 S4 : Not yet  
 Q : Why isn't this done, why?  
 S4 : Can't

The interview excerpt on script 12 shows that S4 has not been able to use connections between mathematical topics well.

Regarding the results obtained, it shows that the low mathematical connection of students is because students seem to have difficulty understanding the tests given, often they work according to their assumptions but do not understand the concept. Shodikin, et al. (2019) found pre-service teachers did similar actions. In this study, the ability of mathematical connections in modeling existing problems is still not good, students often forget and don't write it down. When conducting interviews, many of the subjects looked nervous and afraid, making it difficult for them to express their hearts or thoughts. The learning independence of the four subjects, revealed three with results in line with some reseach results that suggest the learning independence of students is still low (Anita, 2014; Diana et al., 2020; García-García & Dolores-Flores, 2021; Kenedi et al., 2019; Wastono, 2015).

In tackling these problems, teachers or educators could often give practice questions requiring mathematical connections when learning takes place, teachers could also hold story sessions in front of the class, for each student so that they could bring out their potential thinking and heart without feeling nervous or afraid anymore. The

teacher also should provide learning innovations so that when learning takes place the main focus is on the students, no longer teachers, to help them become independent in learning, to think critically, and to think learning is fun and no longer boring. The role of parents is also needed to motivate their children to be more active and independent in learning.

#### 4. Conclusion

The low ability of students in mathematical connection and independent learning contributes to their difficulty working on problems. They were not able to understand the concept. Internal factors that influenced this include the students themselves, lack of practice questions, lack of motivational stimulus to encourage students to study independently. External factors that affected students include the level of questions given that were too difficult.

Based on the results of this study, it is recommended for teachers to always motivate students in the learning process, increase practice questions, encourage independent study, never give up spirit and choose a learning model that is more oriented to student needs. To strengthen the ability of mathematical connections, teachers can get used to reflecting on student understanding, at the beginning and at the end of learning.

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