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AN ANALYSIS OF MATHEMATICAL CONNECTION ABILITY REVIEWED FROM STUDENT LEARNING INDEPENDENCE

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Abstract:
The ability to make mathematical connections has an important role in the problem-solving process, while learning independence is an affective aspect that supports the learning process. This study aims to analyze the ability of mathematical connections based on learning independence. The research subjects consisted of 35 grade VII students at MTs Minat Cilacap. This study uses a qualitative method with a descriptive approach. Data collection techniques are in the form of mathematical connection ability tests, interviews, and learning independence questionnaires. Based on the questionnaire, students are categorized into high, medium, and low. Each category is taken by one student as a sample with a purposive sampling technique. The material used for the test is Social Arithmetic. Data analysis consists of data reduction, presentation, and conclusion. The results show that students with high independence are able to relate mathematical concepts well and apply them in a variety of situations. Students with moderate independence have sufficient understanding, but still have difficulty in relating concepts thoroughly. Students with low independence experience obstacles in connecting mathematical concepts to other situations. The implications of this study emphasize the importance of implementing innovative learning strategies that can increase learning independence and mathematical connections.

Keywords: Learning Independence, Mathematical Connection Ability, Social Arithmetic

ANALISIS KEMAMPUAN KONEKSI MATEMATIS DITINJAU DARI KEMANDIRIAN BELAJAR SISWA

Abstrak:
Kemampuan koneksi matematis memiliki peran yang penting dalam proses penyelesaian masalah sedangkan kemandirian belajar sebagai aspek afektif yang menunjang proses pembelajaran. Penelitian ini bertujuan untuk menganalisis kemampuan koneksi matematis berdasarkan kemandirian belajar. Subjek penelitian terdiri dari 35 siswa kelas VII di MTs Minat Cilacap. Penelitian ini menggunakan metode kualitatif dengan pendekatan deskriptif. Teknik pengumpulan data berupa tes kemampuan koneksi matematis, wawancara, dan angket kemandirian belajar.

Berdasarkan angket, siswa dikategorikan menjadi tinggi, sedang, dan rendah. Setiap kategori diambil masing-masing satu siswa sebagai sampel dengan teknik purposive sampling. Materi yang digunakan untuk tes adalah Aritmatika Sosial. Analisis data terdiri dari reduksi data, penyajian, dan penarikan kesimpulan. Hasil penelitian menunjukkan bahwa siswa dengan kemandirian tinggi mampu menghubungkan konsep matematika dengan baik dan menerapkannya dalam berbagai situasi. Siswa dengan kemandirian sedang memiliki pemahaman yang cukup, tetapi masih mengalami kesulitan dalam mengaitkan konsep secara menyeluruh. Siswa dengan kemandirian rendah mengalami hambatan dalam menghubungkan konsep matematis dengan situasi lain. Implikasi dari penelitian ini menekankan pentingnya penerapan strategi pembelajaran inovatif yang dapat meningkatkan kemandirian belajar dan koneksi matematis.

Kata Kunci: Kemandirian Belajar, Kemampuan Koneksi Matematis, Aritmatika Sosial

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INTRODUCTION

Mathematical connection ability is an important element in the mathematics learning process because it allows learners to connect various concepts in mathematics and relate them to other disciplines (Firdausi, Inganah, Rosyadi, & Athma, 2018). Through this ability, students can understand that mathematics does not only revolve around formulas, but also has a wide relationship with real life and various other fields of knowledge (Fatimah, 2021). A good mastery of mathematical connections can help students solve problems more effectively, because students are able to relate previous knowledge to new situations or problems faced (Gunawan, Fitrianingsih, Akhsani, Setyaningsih, & Kusuma, 2022).

Based on a statement from the National Council of Teachers of Mathematics (NCTM), mathematical connections refer to students' ability to relate concepts in mathematics, connect them with various other disciplines, and apply them in the context of daily life (Mundy, 2000). NCTM emphasizes that connections in mathematics are essential because they allow students to understand that mathematics is an integrated system and not just a collection of separate concepts, so that students are able to use this knowledge to solve various problems (Addington, Clemens, Howe, & Saul, 2000). Three main

indicators reflect the ability of mathematical connections (Jahring, 2020). First, the relationship between concepts in mathematics, namely the ability of students to combine mathematical concepts, procedures, and rules to solve problems thoroughly. Second, the relationship with other fields of science, which refers to the ability of students to apply mathematical concepts in the realm such as natural sciences, economics, and technology. Third, the relationship with real-life situations, namely the ability to use mathematical concepts in dealing with everyday problems, such as calculating finances or interpreting data. These three aspects emphasize the importance of mathematical connections in strengthening understanding as well as applying mathematics more broadly and meaningfully (Fani & Effendi, 2021).

A large number of students face challenges in understanding the relationships between concepts in mathematics subjects. As a result, students prefer to memorize formulas mechanically rather than delve into the meaning and relationships between the concepts being learned (Muchlis, Komara, Kartiwi, Nurhayati, Hendriana, & Hidayat, 2018). One of the inhibiting factors in this understanding is low learning independence, where students tend to rely on examples of given questions and experience difficulties when facing new situations that require understanding concepts (Isnaeni, Fajriyah, Risky, Purwasih, & Hidayat, 2018). In addition, students often encounter difficulties when they have to relate mathematical concepts to real-life situations or apply them to other disciplines such as science and economics. This condition is exacerbated by learning methods that still focus on procedural stages, without giving enough emphasis to a deep understanding of the concepts being taught (Anita, 2014). Thus, a learning approach is needed that is oriented towards deepening concepts, integration between fields of knowledge, and application in real-life situations, to support the development of students' mathematical connection ability to the maximum extent (Yuliani, Praja, & Noto, 2018).

Learning activities are the main responsibility of every student as an integral part of the educational process that aims to develop their potential (Amaliyah & Rahmat, 2021). This responsibility is not limited to classroom attendance or simply receiving material from a teacher, but also includes active involvement in understanding, digging deeper, and putting into practice the knowledge gained (Fitriarosah, 2023). To support a concept-oriented approach, students need to be aware of the importance of learning responsibility. With this awareness, they will be motivated to continue improving their understanding and abilities. In this context, learning independence plays an important role as

a support in carrying out these obligations (Purnomo, 2016). This self-reliance-driven approach will help students face the challenge of understanding the relationships between mathematical concepts and relate them to real-life situations.

Independence in learning refers to the ability of students to manage and direct their learning process independently, without excessive dependence on the help of teachers or other parties. Some experts say that learning independence includes elements of initiative, a sense of responsibility, discipline, and the ability to control oneself in understanding the material and completing tasks (Akhdiyat & Hidayat, 2018). Students who have high independence are usually more active in exploring and relating various concepts in mathematics. Students also show initiative in finding solutions, understanding the relationships between concepts, and being able to apply mathematics in the context of daily life and other disciplines (Gazali, 2015). On the other hand, students with low levels of independence tend to depend on teachers and have difficulty understanding the relationship of concepts, so the learning process becomes less meaningful. Therefore, the application of exploratory learning methods can be an effective strategy to foster learning independence and improve students' mathematical connection ability (Muharomi & Afriansyah, 2022).

Research from Indriani and Sritresna (2022) revealed that some students with low self-efficacy are still able to demonstrate adequate mathematical connection ability. However, learners with medium to high levels of self-efficacy tend to show superior mathematical connection ability. Overall, when viewed based on variations in self-efficacy levels, students' mathematical connection abilities are in the good category (Indriani & Sritresna, 2022). Research conducted by Ully Hidayati and Jahring indicates that grade IX students at SMP Negeri 1 Tanggetada have various preferences in the way they learn, with the majority falling into bimodal and trimodal types. In general, the level of students' mathematical connection ability is still relatively low, especially in students who rely on auditory, reading/writing, kinesthetic, and most of the bimodal and trimodal learning styles. Only students with a trimodal learning style of the visual-auditory-kinesthetic (V-A-K) type reach the category of sufficient ability. These findings indicate that the majority of students still experience obstacles in relating mathematical concepts to other aspects of learning (Hidayati & Jahring, 2021). The difference between this study and the previous study is the in-depth identification of the characteristics of students'

mathematical connection ability based on the level of learning independence. Student learning independence has not been specifically reviewed in the process of mathematical connections, so this variable will become more interesting and innovative to be further examined.

The main problem found in learning is that students have difficulty connecting the concepts that have been learned with the concepts to be learned, especially to solve abstract and contextual problems. The results of the observation provided information related to the aspect of student learning independence. Students have varying learning independence that which directly affects the ability to manage concepts that will be used in problem solving. This condition motivates research to be carried out related to the variables of mathematical connection ability and learning independence. The expected learning outcomes are that students are able to connect mathematical concepts to solve problems and obtain learning completeness of more than 75% of the students, and are able to utilize digital-based teaching materials to support the learning process in the classroom.

This study aims to analyze the mathematical connection ability of grade VII students at MTs Minat Cilacap by considering variations in the level of independence in learning. The main focus of this study is to map the ability of mathematical connections in students with high, medium, and low levels of independence, and to examine the differences in abilities between the three. The findings of this study are expected to be a reference for educators in designing more effective learning strategies to strengthen their understanding of mathematical concepts in depth and comprehensively, by paying attention to the important role of independent learning.

METHODS

This study applies qualitative methods and descriptive approaches to evaluate students' mathematical connection abilities according to the level of learning independence (Isnaeni, Fajriyah, Risky, Purwasih, & Hidayat, 2018). This approach was chosen because it focuses on a deep understanding of how students with learning independence solve math problems. A descriptive approach is used in this study to present a comprehensive picture of the characteristics of students' mathematical connection ability objectively and without manipulation. Through this method, students' mindsets as well as factors that affect the ability to make mathematical connections can be

identified, so that the results can be useful inputs for educators in designing more effective learning (Fani & Effendi, 2021).

This study involved 35 grade VIIA students at MTs Minat Cilacap as subjects. Of these, three students were selected as a sample representing the categories of high (H), medium (M), and low (L) learning independence through purposive sampling techniques. The considerations used in sampling in each category were verbal communication skills, learning discipline, attitude, and test results. This method is used so that researchers can gain a deeper understanding of the ability of mathematical connections based on the level of student learning independence (Muharomi & Afriansyah, 2022). By choosing subjects deliberately, this study can more clearly illustrate the relationship between learning independence and mathematical connection ability.

Sample grouping based on the level of student learning independence using the classification formula presented by Arikunto (in Aliyah, Yuhana, & Santosa, 2019). This categorization aims to determine the level of student learning independence, so that it can be analyzed concerning mathematical connection ability.

The score range formula is as follows:

$$Score\ Range = \frac{Highest\ Score - Lowest\ Score}{Many\ Categories} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

The data collection techniques in this study included the distribution of questionnaires, the implementation of mathematical connection tests, and interview sessions. Indicators of independence include the ability to take initiative, manage time, and seek help when needed. The questionnaire used to measure learning independence consisted of 10 statements arranged in a Likert scale format with five response options, namely: 1 = strongly disagree, 2 = disagree, 3 = doubtful, 4 = agree, and 5 = strongly agree. The purpose of this questionnaire is to assess the extent of students' level of learning independence, which is then classified into three categories: high, medium, and low. Table 1 following is about the categorization of student learning independence.

Table 1. Categorization of Student Learning Independence

Score Range	Interpretation
38 - 50	High
24 - 37	Medium
10 - 23	Low

A mathematical connection ability test is given to assess the extent to which students can relate mathematical concepts in problem solving, both in intra-mathematical, inter-disciplinary contexts, and in everyday life (Angriani, Nursalam, & Batari, 2018). The test consisted of one Social Arithmetic question in the form of a story question that included two questions. Table 2 below shows the indicators of mathematical connection ability.

Table 2. Mathematical Connection Ability Indicator

Indicators	Description
Connect with real life.	Students are able to understand and relate problems related to the surrounding situation.
Connect with a variety of mathematical concepts.	Students can use various mathematical principles to solve problems appropriately.
Connect with a variety of disciplines.	Students can understand the relationship between problems in other fields of science.

Interviews are conducted to gain a deeper understanding of how students think when solving problems, as well as to identify factors that affect the ability to build mathematical connections. In addition, the interview results play a supporting role in analyzing the results of the mathematical connection test (Aspuri & Pujiastuti, 2019).

The data analysis methods used include the stages of data reduction, data presentation, and conclusion drawing (Fadli, 2021). In the reduction stage, the data obtained from questionnaires, mathematical connection tests, and interviews are sorted, concisely arranged, and focused on information relevant to the research objectives, so that only significant data is analyzed in depth. The criteria used at this stage focus on the completeness and clarity of indicators of mathematical connection ability, including connecting with real life, connecting with a variety of mathematical concepts, and connecting with a variety of disciplines. Data presentation is carried out in the form of descriptive narratives, tables, or schemas. Conclusions are drawn by analyzing the results that have been presented to find the relationship between the two variables and answer the research objectives. This technique is used because the research focuses on an in-depth description of how students with different levels of learning independence demonstrate their mathematical connection abilities.

RESULTS AND DISCUSSION

The results of the analysis of the learning independence questionnaire revealed that there was a difference in the level of independence among the students. Of the total 35 students in class VIIA, there are 6 students who are included in the group with high learning independence, 10 students are at a medium level, and 19 other students are classified as low. For the purpose of further analysis related to the results of the mathematical connection ability test, one student was selected, each representing the categories of high (H), medium (M), and low (L).

1. Students in the Higher Learning Independence Category (H)

Referring to figure 1, the sample with the high independence category (H) showed test results that reflected a thorough mastery of all three aspects of mathematical connection ability. Students in this category can understand the context of problems related to daily life, as can be seen from their ability to record in detail known information, apply various mathematical concepts appropriately, obtain accurate calculation results, and relate the material they are working on with other disciplines. This finding is in line with the results of a study by Aspuri and Pujiastuti (2019), who stated that students with a high level of learning independence are able to answer all questions correctly because they can connect the knowledge.

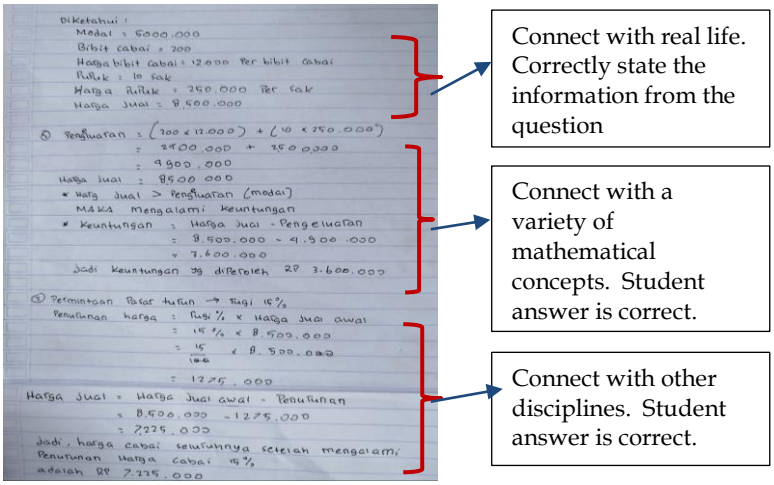

Figure 1. H Students' Test Answers

The analysis of the test was strengthened by the results of interviews with H students. Students in the high independence category (H) understand the importance of profit calculation for farmers to assess the success of their

business. H students identified key information, used precise mathematical operations, and concluded that farmers made a profit of Rp3.500.000. When the price of chili peppers fell by 15%, students also calculated the impact on profits and related these cases to real-world price fluctuations and overcame calculation challenges by double-checking the data.

2. Students in the Category of Medium Learning Independence (M)

As shown in figure 2, the sample with medium independence category (M) has mastered all three indicators of mathematical connection ability; however, some calculations have incorrect answers due to a lack of precision in the calculations M students are able to relate problems to daily life, as seen in the students' answers, they are able to mention the details of the variables known in the question, but there is one wrong variable, namely in mentioning the amount of capital. M students can connect answers with various mathematical concepts and are able to understand the relationship with other disciplines. However, for the calculation results, there is an incorrect answer, namely, in determining the selling price after experiencing a 15% decrease in the price of chili. In line with the research of explain the same thing that students with moderate independence can solve most mathematical connection problems correctly.

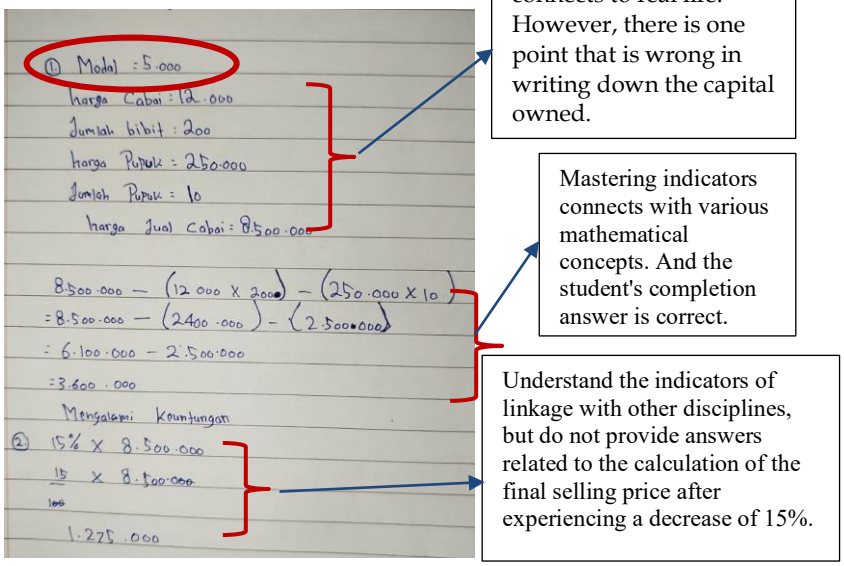

Figure 2. M Students' Test Answers

From the results of the interview with the M sample, it was found that students with learning independence are understanding the importance of calculating the profits of farming and are able to identify important information

in the questions. The M students used the correct mathematical operation in the calculation, but there was an error in writing the capital, and they did not complete the calculation of the selling price after the price decreased. Students are also able to relate questions to real situations, such as fluctuations in the price of basic materials. The main challenge faced by M students is ensuring that all data is calculated correctly.

3. Students in the Low Learning Independence Category (L)

From figure 3, it can be seen that the sample with the low independence category (L) does not master the three indicators of mathematical connection ability. The first indicator connecting with daily problems is not met because the L students are unable to mention the details of the known problems in the question. The second indicator connecting with various mathematical concepts is also not met. The third indicator connecting with various disciplines is also not fulfilled, as seen in the students' answers only write numbers as the final answer. This follows the results of research from Firdausi, Inganah, Rosyadi, and Athma (2018) that students with low learning independence tend to have difficulty connecting mathematical problems.

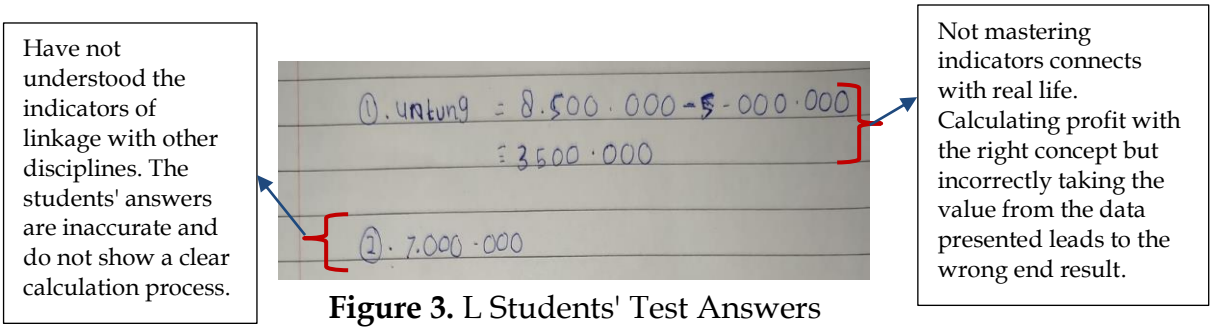

Figure 3. L Students' Test Answers

Based on the results of interviews with L sample, it was found that students who fall into the category of low learning independence face challenges in understanding the situation given in the question. Students only understand that farmers need to know whether farmers are profitable or losing, but cannot explain in detail the reasons for the importance of such calculations. In taking information from the questions, students only use the selling price and capital without considering other costs, such as the purchase of seeds and fertilizers. The steps taken in the calculation of profit are also limited, where students only use the subtraction operation between the selling price and the initial capital without calculating the total cost of production in full.

Based on the results of the mathematical connection ability test and interviews conducted on the three research samples, it can be seen that there is a clear relationship between the level of students' learning independence and the achievement of their mathematical connection ability. Thus, it can be concluded that learning independence plays a significant role in developing mathematical connection ability. Independent students tend to be better able to solve problems thoroughly, integrate various knowledge, and relate mathematics learning to the real world and across disciplines. Therefore, teachers need to foster students' learning independence in order to improve the quality of their mathematical connections.

Learning independence is an effective aspect that can support students' mathematical connection ability in the problem-solving process. The characteristics of students who have good independence include being able to connect mathematical concepts precisely. But on the other hand, students who do not have learning independence will have difficulty finding and applying concepts in problem solving (Muharomi & Afriansyah, 2022). These results are supported quantitatively by research by Septia and Soeleman (2022), who explain that learning independence has a significant correlation in developing students' mathematical connection ability. This condition scientifically explains that learning independence and mathematical connection ability have a strong relationship.

CONCLUSION

A student's mathematical connection ability varies depending on the level of learning independence. Students with high independence (H) master all indicators of mathematical connection, can relate problems to daily life, apply mathematical concepts appropriately, and understand their relationship with other fields of skill science. H students can also explain the importance of profit calculation as well as double-check the data to ensure accuracy. Students with moderate independence (M) also understand all three indicators of mathematical connection, but still experience errors in calculations, especially in determining the selling price after a price drop. M students understand the concepts in the questions, but are still not thorough in ensuring the accuracy of the data. In contrast, students with low independence (L) did not master the indicators of mathematical connection. L students have difficulty understanding problems, cannot relate information to daily life, and only use math.

Overall, students who have high learning independence tend to show superior performance in building connections between mathematical concepts. Based on this, further studies are recommended to explore creative and effective learning approaches in fostering learning independence, so that students are more able to relate mathematics materials to the context of daily life.

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