Mathematical connection profile of high school students with converger learning style

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Abstract. This study aims to describe the mathematical connection profile of high school students with converger learning styles in solving mathematics problems. This research is an exploratory descriptive study. The research subjects were first-grade students of SMA N Mojogedang with converger learning style. Data collection methods used questionnaires, tests, and interviews. Sampling was conducted by purposive sampling and snowball sampling. The analysis technique was performed through the triangulation of time and technique. The results show that the low mathematical connection ability was due to a lack of in-depth understanding of mathematical concepts. Students did not practice the concepts in trigonometry and other mathematics material so when they were given problems they could only understand the problems without being able to find solutions appropriately. The student profile with a converger learning style could generally understand non-routine and routine questions but students were unable to understand concepts on the mathematical topic itself and concepts in other mathematical topics.

Keywords: mathematical connection, David Kolb's learning style, solving mathematical problems.

1. Introduction

A student's education consists of stages that all students must go through. Since Kindergarten (Taman Kanak-Kanak/TK) until Senior High School (Sekolah Menengah Atas/SMA), students are introduced to mathematics. Mathematics has an important role in everyday life, besides, mathematics is also considered as the basis of other science fields [1]. The nature of mathematics as a structured and systematic science denotes that the concepts and principles in mathematics are interrelated to one another [2]. Mathematics will comprehend and perceive a variety of topics that influence each other and affect other knowledge [3]. The material being studied may be a prerequisite for the next materials [4]. As a continuous science, it certainly requires sufficient mathematical connection skills. Mathematical connection is a skill that must be developed and learned because adequate mathematical connection skills will facilitate students to find out the relationship of various concepts in mathematics and apply mathematics in everyday life [5].

The ability of students to interconnect topics in mathematics and to connect mathematics with everyday life is very important for students because these connections can help students understanding the concepts
that exist in mathematics [6]. This is supported by Siregar's research revealing that mathematical connection skill is an important part that must be mastered by students at every level of education [7]. Moreover, in Kenedi's research, it is disclosed that mathematical connections can improve students' thinking ability and the ability to connect concepts both inside and outside of mathematical concepts [8].

Noto states that the mathematical connection is continuity between mathematical topics, a continuity between mathematics and other disciplines, and a continuity with the real world or in everyday life [9]. According to Malasari, mathematical connection is the ability to connect mathematics internally, mathematics with other sciences, and mathematics with everyday life [10]. Coxford in Mandur's [11] research states that mathematical connection is the ability to connect conceptual and procedural knowledge using mathematical concepts in other fields and concepts in everyday life. According to Kusuma, [12] external mathematical connection is an individual's ability to find out the functionality of mathematical concepts to solve problems in everyday life. Meanwhile, mathematical connection according to Ruspiani [3] is the ability of students to relate mathematical concepts either between topics in mathematics or between mathematical concepts and concepts in other fields. Based on these statements, it can be concluded that a mathematical connection is a relationship or continuity between topics in mathematics, between mathematics and other fields, and between mathematical concepts and everyday life. The indicators used by researchers on mathematical connection ability include (1) Understanding mathematical concepts, (2) Applying mathematical concepts to solve problems properly, (3) Applying mathematical concepts from other mathematical topics to solve problems, (4) explaining objects with mathematical concepts, and (5) Using mathematical concepts on problems related to daily life properly.

Mathematical connections can be formed appropriately if students first understand the concepts they are learning [13]. Each student has a typical learning style to be able to understand concepts in mathematics [14]. David Kolb classifies students' learning styles into four: (1) Converger, individuals are fond of seeking practical applications of theory. This style is a blend of Abstract Conceptualization and Active Experimentation. (2) Accommodator, individuals prioritize exploration of challenging experiences. This style is a combination of Concrete Experience and Active Experimentation. (3) Diverger, individuals view the phenomenon from different perspectives. This style is a mixture of Concrete Experience and Reflective Observation, and (4) Assimilator, individuals understand the problem as a whole and then conclude it. This style is a blend of Reflective Observation and Abstract Conceptualization [15].

Given four classifications of learning styles according to David Kolb, the researchers are interested in finding out the mathematical connection profile of high school students viewed from converger learning styles. This converger learning style has a unique way and it is more likely possessed only by students with
high abilities. Therefore, this research was conducted at the high school level which ranks the lowest average in the National Exam in Karanganyar Regency. The research brings novelty from the research conducted by Muflihah [17] in terms of student thinking styles and research by Suhandri [18] who researched the mathematical connection profile in terms of the level of academic ability. This study is also used as a reference for the thesis "the ability of mathematical connections in solving problems viewed from David Kolb’s learning style at SMA Negeri Kebakkramat".

2. Research Method
This research is a descriptive-exploratory study with a qualitative approach that reveals the meaning behind the phenomenon that occurs. The subjects in this study were first-grade students of SMAN Mojogedang, Karanganyar regency. Subjects were taken through purposive sampling and then snowball sampling. The data collection technique used is a mathematical connection test that is adjusted to the mathematical connection ability indicators. In-depth interviews and test analyses are based on mathematical connection test analysis. Students were given assignments to be completed and those assignments would be evaluated and interviews were conducted with students to find out in-depth about the thinking process of ideas performed by students in solving problems. Then, interviews were conducted again at different times to validate the information obtained as well as taking other subjects with converger learning style randomly to be given the same treatment. To obtain credible data, consistent and persistent observations were made so that saturated results were obtained.

The test and interview questions were validated by three UNS lecturers, while the questionnaire items were validated by three UMS Psychology lecturers. The triangulations used in this research are method and time triangulations. The questionnaires were used to select students with converger learning style. To obtain student's learning style, David Kolb's learning style questionnaires were given which consist of four alternative answers, namely strongly agree, agree, disagree, and strongly disagree. By summing up the results in the questionnaire, the highest score was selected on the question items. Thus, students with their respective learning styles were obtained. Based on the results of the questionnaire distribution, students with converger learning styles were taken.

3. Result and Discussion

3.1 Results
Mathematical connections were measured using a written test in the form of essay questions adjusted to the mathematical connection indicators. The test was given to students with converger learning style to find out students' mathematical connection profile abilities with this learning style. Learning style grouping was obtained from questionnaires given to 34 students. The results of the questionnaire show that there were 6 students with converger learning style. Students with converger learning style were assigned with a mathematical connection test to determine their mathematical connection ability. Then, researchers grouped students into three categories of mathematical connection ability [6], namely: (1) low category if the student only meets the first indicator, (2) moderate category if the student meets up to the second or third indicators, (5) high category if the student meets four or five mathematical connection indicators. Table 1 is the results obtained from the research:
Table 1. Results of mathematical connection ability of students with converger learning style

| No | Students’ Initials | Indicators | The Level of Mathematics Connection |
|----|-------------------|------------|-------------------------------------|
| 1  | ASN               | √          | Low                                 |
| 2  | GR                | √          | Low                                 |
| 3  | ADN               | √ √        | Moderate                             |
| 4  | SAC               | √ √ √      | High                                |
| 5  | YRS               | √ √ √ √    | High                                |
| 6  | OGR               | √          | Moderate                             |

Based on the table above, 6 students with converger learning styles were given a mathematical connection ability test. The test results show that 1 student had a low level of mathematical connection ability, 3 students with a moderate level of mathematical connection ability, and 2 students with a high level of mathematical connection ability.

3.1.1 Mathematical Connection Ability Test.

1. Indicator: Understanding mathematical concepts
   Problem: It was known a regular hexagon. If the radius of the outer circle of the regular hexagon was 10 units. Find the area of the regular hexagon!

2. Indicator: Applying mathematical concepts to solve problems properly
   Problem: Determine the length of the CD from the following figure, if the length AB = 10 cm.

3. Indicator: Applying mathematical concepts from other mathematical topics to solve problems
   Problem: The area of triangle ABC with side length BC = 4 cm, angle A = 105° and angle B = 30° is?

4. Indicators: explain between objects with mathematical concepts
   Problem: A student would measure the height of a tree with a distance of $4\sqrt{3}$ m. The elevation angle formed between the eyes and the top of the tree was 30°. If the student's height measured to the eye was 1.6 m, how tall the tree would be?

5. Indicator: Using mathematical concepts properly related to everyday life
   Problem: A ship sailed from port A with a direction of 44° for 50 km. Then, it sailed again with a direction of 104° as far as 40 km to port C. What would be the distance from port A to C?
3.1.2 The Analysis of the First Subjects Answers

Figure 3. The First Subject Interview Transcript

R : "What do you know about problem number 1? Can you tell me?"
S1 : "In question number 1, there is a circle with a radius of 10 cm and inside there is a regular hexagon, ma'am, and the area of the hexagon is the question."
R : "How to solve this problem?"
S1 : "I made an auxiliary line on the hexagon, ma'am. Because the angle of one full circle is 360 so first I divided 360 into 6 parts after I found the area of one triangle I multiplied by six to become a full hexagon, ma'am"
R : "why did you use this triangle area concept?"
S1 : "It is like the material in trigonometry, ma'am. I just followed it"
R : "Do you understand the use of the concept you were using?"
S1 : "After working on this question, I understand, ma'am"
R : "after I evaluated your answers, your only correct answer is number 1. What problems did you find in questions 2 to 5?"
S1 : "For question number 2, I was confused about what steps should I take to get the side length as well as for number 3 I was confused about what method to take. For number 4 and 5, I didn't understand the questions, ma'am"
R : "Are you sure about the answer you have explained earlier?"
S1 : "Yes ma'am, I am sure"

Based on the results of test and interview above, it can be determined that the first subject completed one indicator, namely understanding the mathematical concept. Students who can only complete one indicator are classified to have a low mathematical connection category. Information obtained from subject 1 is that the subject was confused about which steps to take on the second and third indicators. The subject did not understand the problems presented in the questions. The subject was lack of confidence to solve problems with the knowledge he has. However, when the problem was presented in the form of an image, the subject could understand it even though subject 1 still encountered problems in solving it.
3.1.3 The Analysis of the Second Subjects Answers

![Figure 4. The Second Subject Interview Transcript](image)

R : "What do you know about problem number 2? Can you explain?"
S1 : "All I know is to find the length of the DC side, ma'am"
R : "How to find it?"
S1 : “First, I looked for the other side that could be found, ma'am. Because in the triangle, only the angle D was known, so I needed to find BD or BC. Because the only possibility was BD, I used the theorem that a full triangle is 180°, ma'am. So, I used the concept of sine ratio to find the side length"
R : "Why did you use the concept of sine?"
S1 : "Because it is not possible to find the BD side, ma'am"
R : "Do you understand the use of the concept you were using?"
S1 : "I understand, ma'am"
R : "after I evaluated your answers, you only have correct answers for numbers 1 and 2, what problems did you find in questions 3 to 5?"
S1 : "I was confused ma'am, it was a dead-end, ma'am."
R : "But do you understand the meaning of the story?"
S1 : "I understand a little ma'am, but I didn't know if it was right or wrong, ma'am"
R : "Well, you understood what was meant by the problems, your abstraction of the problem is appropriate"
S1 : "I see, ma'am"
R : "Yes, then are you sure about the answer you have explained earlier?"
S1 : "Yes ma'am, I am sure"
Based on the results of test and interview, it can be determined that the second subject completed the two indicators properly. Students who can complete the two indicators are classified as students with the moderate mathematical connection category. Information obtained from subject 2 is that the subject understood the questions but the subject experienced problems during the problem-solving in numbers 3 to 5. The subject understood the problems well but the student could not connect mathematical concepts properly.

3.2 Discussion
Based on the results of tests and interviews with students with converger learning style, there were students with converger learning styles who have a low mathematical connection. However, the average students are classified as moderate and high connection abilities. Most of the students understood the intended purpose of the questions posed by the researchers and students were able to turn the story question into an understandable illustration or a mathematical sentence that could be solved.

The first subject could only solve problems related to indicators of understanding mathematical concepts. The student encountered difficulty working on problems with indicators of applying concepts to solve problems because the student was confused about which steps or ideas to take first. Questions on indicators two, three, four, and five require a good understanding of the concept and connections in order to find the right solution. Meanwhile, the first subject could not find the correct solution in numbers 2 to 5. This phenomenon is included in the low category, although the subject could understand the question correctly, there were problems in understanding the concept of trigonometry. This is in line with the previous research which explains that learning styles affect students' mathematical abilities, it is necessary to make efforts to increase and develop, from the perspective of knowledge, understanding, learning methods, and student skills [19]. From the results of the subject one’s answers, the student only understood the meaning of the questions. The mathematical connection and the application of concepts were still low.

The second subject could solve indicators of understanding mathematical concepts and applying mathematical concepts to solve problems properly. However, the second subject did not solve problems related to indicators of applying mathematical concepts from other mathematical topics, explaining between objects with mathematical concepts, and using mathematical concepts in problems related to everyday life appropriately. The student experienced confusion in the third question because to find \( \sin 105^\circ \) the student had to use another concept to obtain the value of \( \sin 105^\circ \). So, in question 3 the student completed only until the concepts used. The second subject experienced problems with misunderstanding of the questions so that the subject obtained incorrect results. The second subject also experienced errors in algebraic operations and selection of concepts in trigonometry so that the subject could not find the right results. This is in line with research that explains various kinds of algebraic errors can result in the failure to solve problems [20]. From the results of subject two’s answers, the student was able to apply mathematical concepts but could not connect mathematical concepts correctly.

Based on the problems shown, it can be concluded that there are several errors in solving the mathematical connection problems of students with converger learning style. It happens in the problem-solving process, which is a deep understanding of the concept of trigonometry, students do not practice the concepts in trigonometric material and other mathematics material so when they find these problems they can only understand the problems without being able to get correct solutions. The low mathematical connection is influenced by previous knowledge and the lack of practice to understand mathematical concepts as well as daily life [21]. Students with converger learning style can understand questions that are
non-routine and routine but students are lack understanding concepts on the mathematical topic itself and concepts in other mathematical topics.

4. Conclusion

Based on the results of the tests and interviews conducted, it can be concluded that only some of the students with a converger learning style have high mathematical connection skills in completing the mathematical connection tests. Of all the subjects, there were 6 students with converger learning styles, 1 with low ability, 3 with moderate ability, and 2 with high ability. The low mathematical connection ability is due to a lack of in-depth understanding of mathematical concepts, students do not practice the concepts in trigonometric material and other mathematics material, so when they face these problems they can only understand problems without being able to get the right solutions. Students with converger learning style can generally understand questions that are non-routine and routine but students are lack of understanding the concepts on the mathematical topic itself and concepts in other mathematical topics. Therefore, it is necessary to understand concepts in mathematics as well as concepts in other mathematical topics. So that students can find solutions to problems. In addition, further research is expected to be able to explore other information that can be done for the ability to solve student problems related to learning styles.

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