IOSR Journal of Mathematics (IOSR-JM)
e-ISSN: 2278-5728, p-ISSN: 2319-765X. Volume 19, Issue 4 Ser. 1 (July. – August. 2023), PP 35-39
www.iosrjournals.org

Mathematical Connection

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Abstract
This article deals with mathematical connection. This connectivity is related to the ability of learners and learners to connect between one concept and another in learning activities in the classroom. In mathematics learning, this activity is called mathematical connection. Mathematical connection is one of the important abilities possessed by a learner. The importance of having mathematical connection skills is included in one of the objectives of learning mathematics in secondary school which is still used by most secondary schools in Indonesia. Mathematics consists of various topics that are interconnected. These connections are not only contained within the field of mathematics, but also in relation to other disciplines, as well as the relationship of mathematics to real life.

Keywords: *mathematical connection, math learning*

Date of Submission: 14-07-2023 Date of Acceptance: 24-07-2023

I. Introduction

The process of learning mathematics in the classroom is very urgent for a learner to do by striving and creating good learning conditions. With good learning conditions, it is expected that the learning process will take place well too. A good learning process will minimize the possibility of failure and errors in learning. Therefore, it is very important for a learner (educator/teacher) to have the ability to create good learning conditions so as to achieve an optimal level of learning effectiveness and connectivity in instructional activities.

This connectivity is related to the ability of learners and learners to connect between one concept and another in learning activities in the classroom. In mathematics learning, this activity is called mathematical connection. Mathematical connection is one of the important abilities possessed by a learner. The importance of having mathematical connection skills is included in one of the objectives of learning mathematics in secondary school which is still used by most secondary schools in Indonesia. Mathematics consists of various topics that are interconnected. This connection is not only in the field of mathematics, but also in relation to other disciplines, as well as the relationship of mathematics to real life.

Looking at the importance of mathematics, the author knows about the learning objectives of mathematics starting from the Elementary School (SD)/Madrasah Ibtidaiyah (MI) level to the Senior High School (SMA)/Madrasah Aliyah (MA) level, which include: (1) understand mathematical concepts, explain the relationship between concepts and apply concepts or algorithms, flexibly, accurately, efficiently, and precisely, in problem solving; (2) use reasoning on patterns and properties, perform mathematical manipulation in making generalizations, compiling evidence, or explaining mathematical ideas and statements; (3) solve problems that include the ability to understand the problem of designing mathematical models, solving models and interpreting the solutions obtained; (4) communicate ideas with symbols, tables, diagrams, or other media to clarify the situation or problem; (5) have an attitude of appreciating the usefulness of mathematics in life, namely having curiosity, concern, and interest in learning mathematics, as well as a tenacious and confident attitude in problem solving [1].

II. Basic Concepts Of Mathematical Connection

Mathematical connection can be defined as the linking of mathematical ideas both between topics in mathematics and with topics in other fields, as well as between mathematical topics and everyday life [2]. Herdian's view is in accordance with Bruner's theory which states that every concept in mathematics is related to other concepts. Such as between propositions and propositions, between theories and theories, between subjects and subjects, or between branches of mathematics and other branches of mathematics. If students have more opportunities to see these relationships, they will be successful in learning mathematics.

Through improving mathematical connection skills, students' thinking skills and insights into mathematics can become broader and stronger. Topics in mathematics are related to each other and also have relevance and benefits both to other fields and to everyday life. The connection is a mathematical connection

[3]. Mathematical connections can be interpreted as the relationship between mathematical concepts internally, namely related to mathematics itself or externally, namely mathematics with other fields, both with other fields of study and with everyday life [4]. Through mathematical connections, students' thoughts and insights into mathematics are increasingly open and broader, not only focused on certain content, which will then lead to a positive attitude towards mathematics itself [5].

Mathematical connection ability is the ability of students to understand that mathematics consists of various topics that are related to each other [6]. The facts that occur in the field show that students' ability to solve problems related to mathematical connections is still low. NCTM [7] states that aspects of connections between mathematical topics, aspects of connections with other fields of study, and aspects of connections with the real world of students or connections with everyday life are a description of the student's mathematical connection group. The existence of mathematical connection skills will help students in building a better understanding of mathematics [8]. Mathematical connections have an important role in solving mathematical problems and are one of the centers of attention in learning [9].

Teachers must try to design lessons that are able to integrate mathematical problems that can be solved using a variety of solution methods [10]. Kennedy & Johnson argue that mathematical connections direct students and teachers to find mathematics related to students' daily lives, especially those related to students' lives and interests, associating between mathematical concepts and topics [11]. Based on the views of researchers and experts who define mathematical connections, the author concludes that mathematical connection ability is the ability of learners or students to connect a mathematical concept with other concepts, or the field of mathematics with other fields that are closely related to real life.

Mathematical connection is described as the ability of learners to connect concepts, both in the field of mathematics (between concepts in mathematics) and from outside mathematics (with other fields outside of mathematics). Dewi stated that mathematical connection is the ability to link mathematical concepts both between mathematical concepts themselves (in mathematics) and link mathematical concepts with other fields (outside of mathematics), which include: connections between mathematics topics, connections with other disciplines, and connections with everyday [12]. NCTM (2000) states that there are five basic mathematics skills that are in accordance with the standards, namely problem-solving, reasoning and evidence, connection and representation, and effectiveness (Fina, et al., 2020). In line with the NCTM, the Ministry of Education and Culture states that the learning objectives of mathematics in the 2013 Curriculum essentially include (1) connections between concepts in mathematics and their use in solving problems, (2) reasoning, (3) problem-solving, (4) connections and representations, and (5) affective factors [13].

This mathematical connection ability is very important when students are required to have more skills in learning mathematics so that they are able to connect one mathematical concept with another, as well as connect mathematical concepts with concepts of other fields outside of mathematics which is one of the indicators of students' mathematical connection ability. This is certainly in line with the indicators listed in NCTM (2000) relating to mathematical connections. These indicators include (1) recognizing and using connections between mathematical ideas; (2) understanding how mathematical ideas are connected and built upon each other so that they are fully connected; (3) recognizing and using metamathematics in contexts outside of mathematics [6].

Meanwhile, Hendriana (2017) summarized the indicators of mathematical connections consisting of five [14], namely 1) Finding relationships between various representations of concepts and procedures, and understanding relationships between mathematical topics; 2) Understanding equivalent representations of the same concept, looking for connections between one procedure and another in equivalent representations; 3) Finding relationships between various representations of concepts and procedures; 4) Using connections between mathematics topics, and between mathematics topics and other topics; and 5) Using mathematics in other fields of study or everyday life. Meanwhile, [15] stated that the indicators of mathematical connections consist of: (1) Connections between mathematics topics; (2) Connections with other disciplines (other than mathematics); and (3) Connections with the real world or everyday life. Furthermore, Sugiman (2008) said that the connection ability has 4 aspects, namely (1) connections between mathematics topics that link concepts or principles in the same topic, (2) connections between topics in mathematics that link material in certain topics with material in other topics, (3) connections between material with other sciences besides mathematics, and (4) connections with everyday life that children may encounter [16].

Based on the opinions of these experts, the author tries to summarize the indicators of mathematical connections that can be applied in mathematics learning. These indicators include: (1) connections between the same mathematical concepts. In this indicator, how a learner (student) can understand the same concept in mathematics and be able to connect the same concept in different materials. (2) Using the connection between concepts in mathematics. Here, how learners can relate materials in a problem in order to obtain a solution to the existing problem. For example, if a student is given a problem to find the surface area of a space, then what the student must do is to use various ideas in solving problems about the surface area of a space. (3)

Building and connecting ideas in mathematics completely. This is of course looking at how the learner can use the material to solve the given problem as a whole. Suppose students are given the same problem, namely solving the surface area of a space but do not know all the sides, only given information that helps to get the unknown side, then students can work on the problem. So, in solving these problems, students' reasoning skills are needed.

Mathematical connection skills need to be instilled in students from an early age, in this case from the level of basic education. Thus, the targeted learning objectives can be achieved. NCTM echoes mathematical connection skills as one of the curriculum standards by mentioning three objectives of mathematical connection skills in school mathematics learning, namely (1) broadening students' knowledge horizons. At this point, students are given material topics that cover various aspects of the problem. Here students are not only directed to the topic of the material being presented but need to have basic knowledge or other knowledge outside the material presented. So that indirectly, students gain a lot of knowledge and experience which in turn can improve the quality of the student's knowledge. (2) view mathematics as an integrated whole not as stand-alone material. The implementation of mathematics learning in the classroom should be able to connect a concept with other concepts so that the concept does not stand alone. (3) recognize the relevance and usefulness of mathematics both at school and outside school. By having mathematical connection skills, students can connect mathematical concepts with other concepts outside the field of mathematics and can be applied in students' real lives.

This is certainly strongly supported by the government through the Ministry of Education and Culture Number 58 of 2014 explained that mathematics subjects aim to enable students to: (1) understand mathematical concepts; (2) solve problems; (3) use mathematical reasoning; (4) communicate problems systematically; and (5) have attitudes and behaviors that are in accordance with the values in mathematics [17].

Mathematics learning in formal schools is emphasized so that students can understand mathematical concepts, explain the relationship between concepts and apply concepts or algorithms flexibly, accurately, efficiently, and precisely in solving problems [15]. Thus, to answer the objectives of mathematics learning, mathematical connection skills are needed where, by having mathematical connection skills, students can connect between mathematical topics, see the relationship between mathematics and other fields of science, and use and connect mathematics in real life.

III. Application Of Mathematical Connection In Learning

Teachers as the spearhead in the field have a very important role in developing students' mathematical connection skills. Thus, in addition to factors within students, the teacher's ability to design learning, provide motivation, use simple sentences that are easy for students to understand, the selection of methods, models, approaches, learning strategies are other factors that support the development of students' mathematical connection skills in solving the problems faced.

There are two general types of mathematical connections according to NCTM namely modeling connections and mathematical connections. Modeling connections are relationships between problem situations that arise in the real world or in other disciplines with their mathematical representations, while mathematical connections are relationships between two equivalent representations, and between the solution processes of each representation [18]. The connection can be described as follows.

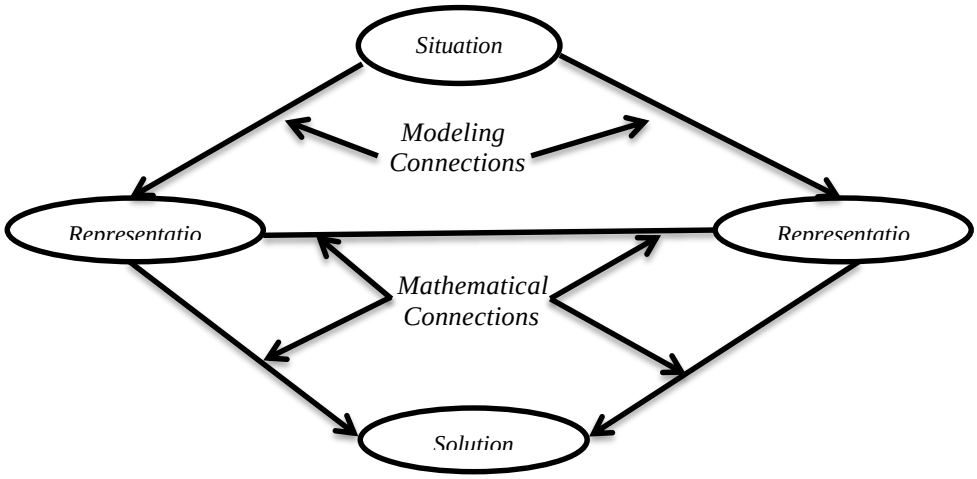

Figure 1. Two Type Connections

From this picture, the author tries to describe from the author's point of view interpreting and applying mathematical connection skills in learning mathematics. First, mathematical connections depart from situations where students face problems or issues. In this context, the teacher gives problems related to mathematics. The problem given certainly requires reasoning in solving it. Second, the mathematical connection from the context of the real situation is solved by using a certain model that is associated with other concepts, either related to mathematical concepts or with other concepts outside the field of mathematics. Third, the mathematical connection that has been modeled, must have a solution that represents the original problem given.

For example, mathematical connections, in mathematics learning, for example, are related to the problem of solving straight-line equation material. With the basic competence of solving contextual problems related to linear as a straight line equation. Suppose given the problem of an object moving with a fixed speed increase, with the description of speed = *v* and time = *t*. The relationship between v and *t* can be presented as $v = mt + n$. At time $t = 2$ *s*, the object's velocity is 3 m/s, and at time $t = 5$ *s*, the object's velocity is 15 *m/s*. Determine: (a). The equation of the relationship between v and t; (b). What is the acceleration of the object?

How to solve the problem? Are steps needed in solving the problem to obtain a solution that is by the problem at hand? To answer this question, the author tries to elaborate to obtain a representative solution to the problem. First, to solve this problem, it is necessary to know the information related to the problem in question. This information is obtained from the given problem. Second, connecting the given mathematical problem with the concepts of other fields outside of mathematics or vice versa. Third, solve the problem correctly according to the known information and the relationship between mathematical concepts and concepts in other fields outside of mathematics, to obtain a representative solution.

Let's look at another example related to mathematical connections. Richard drew two triangles on the cartesian plane. The first triangle, ΔABC, occupies the coordinates *A(0,4), B(0,0),* and *C(7,0).* While ΔDEF occupies the points *D(7, 4), E(7,0),* and *F(0,0).* Both are congruent triangles. Determine the height of the intersection point of the two triangles in another way (other than by looking at the value of the y-axis)! The problem shows the relationship between mathematical concepts. Here students need to realize that there is a square concept to solve the problem. Students need to use the concept of the cartesian plane in drawing the triangle, then use the concept of a square to find the height of the intersection in question. This certainly shows that there is a mathematical connection between the concept of the cartesian plane and the concept of a rectangle in solving the given problem. Thus the ability to connect between concepts in mathematics, both within the field of mathematics and with other fields is very necessary in building or developing children's reasoning skills.

IV. Conclusions

Mathematical ability is very important to be considered in learning mathematics where students are directed to improve and develop their reasoning in thinking by connecting between concepts in mathematics, connecting mathematical concepts with concepts in other fields outside of mathematics so that students' ability to solve given problems becomes better.

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