Mathematical connections process for elementary school students in problem solving of statistics

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Abstract. This study belongs to the descriptive qualitative research which aims to describe the process of mathematics connections of grade 5 primary school students with high mathematical ability and low mathematical ability in problem solving of simple statistical. Subjects in this study were grade 5 students in SD Negeri 42 Pekanbaru each having different levels of mathematics ability, that is high and low. The process of mathematical connection in question is the student’s steps in connecting mathematics. Connection aspects observed in this research are (1) integrating information; (2) making connections within and across mathematical domains; (3) deciding which mathematical tools to use to solve problems; (4) solving nonroutine problems. Data analysis of the students’ mathematical connection ability use triangulation method technique that is test method and interview method. The results show that 5th grade students at SD Negeri 42 Pekanbaru were not familiar with the problem because overall the students mathematical connection skills were classified as low. So, it is very necessary to apply learning strategies that can improve student’s mathematical connection skills.

1. Introduction
Mathematics is a subject that has an important role in shaping quality students. Because mathematics is a means to study something logical and systematic. The process of learning mathematics for people who are accustomed to thinking. For that, in making the design of learning, teachers must make the process of learning mathematics into a means to improve students' mathematical thinking skills, one of which is the mathematical connection ability of students. The ability of mathematical connections is necessary for Mathematical learning because mathematics is an integrated field of study rather than a separate set of materials. As in the direction of NCTM [1] if mathematical science is a unity, it is not partitioned on separate topics. Mathematics also cannot exclude from other science and everyday life problems. Based on the theory of connectivity, mathematics has a strong relationship between concepts in mathematics, not only generating but also in its concept. A material can be a prerequisite for other materials, or special concepts needed to explain other concepts [2]. Thus, the more severe mathematical behaviour of connections between concepts, principles, and procedures in mathematics itself or with other fields commonly known as mathematical connections.

The mathematical connection popularized by NCTM in 1989 which used as one of the curriculum standards. Mathematical connections include both internal and external relations [3]. Mathematically could be interpreted as the ability possessed to see the interrelationship between the concepts of
mathematics internally that related to the mathematics itself or external relevance that is with other fields both other fields of study and daily life [1,4-6].

NCTM [1] also explains that the goal of mathematical connection ability in learning mathematics in school is to help students broaden their perspective, view math as a whole, not as a stand-alone material, and to the knowledge of relevance and usefulness of both mathematics in school and out of school. Mathematical connections make students understand what they learn in math.

The mathematical connections ability is important in the learning of mathematics is to make the mathematics material that students learn more concretely. Without a mathematical connection, students must learn and remember too many stand-alone concepts and skills [7]. The mathematical connections ability is very important for students. However, students who master the concept of mathematics are not necessarily smart in related activities to connect mathematics. In a study it was found that students were often able to register mathematical concepts related to real problems, but few students were able to explain why the concept used [8]. Thus, the mathematical connections ability should to trained students, if students are able to link mathematical ideas then the understanding of mathematics will be deeper and longer lasting because they are able to see the interrelationship between topics in mathematics, with contexts other than mathematics, and with experience of daily life [1,9,10].

Shafer and Foster [11] explain that the ability of a math connection includes: (1) integrating information; (2) making connections within and across mathematical domains; (3) deciding which mathematical tools to use to solve problems; (4) solving nonroutine problems.

To know the ability of the mathematical connection of students', students need to give problem exercises or mathematical connection problems that must to be finned a solution [12]. Solving problems is a very complex activity [13,14]. Solving problems can help students to know the relationships of various mathematical concepts and in applying mathematics to everyday life. In the problem-solving process, the connection will be difficult when the problem structure is more complex than one's thinking structure. Therefore, these problems need to elaborate into sections, so that the problem could be connected to each other [15].

Problems in mathematics are divided into two kinds [16] namely (1) Problems of finding and (2) Problem to proof. If there is a problem that cannot be done directly, because if the matter is given to someone and those people can immediately know how to solve it correctly, then the problem cannot be said problem [17]. In solving the problem, it takes a more fundamental ability to perform and perform activities in answering open questions to achieve the goals currently faced in a new chapter [18-20]. There are 4 steps in solving the problem are: (1) Understanding the problem; (2) devising a plan; (3) carrying out the plan; and (4) looking back [16,21,22].

2. Methods
The type of research used in this research is descriptive research with the qualitative approach. This study aims to describe the process of mathematical connection of students in solving mathematical problems from test results and interviews on simple Statistics materials. This research was conducted in state elementary school Pekanbaru class V with heterogeneous ability level. Subjects in this study were 32 students in SD 42 Pekanbaru each having different levels of mathematics ability, that is high and low. In addition to consideration of mathematical abilities of learners, the subject of research is also in the advice of the mathematics teacher in the class. Students' math skills are grouped according to the minimum completeness criteria (KKM) established by the V grade mathematics teachers of each school in the Table 1 below.

| School Name  | KKM | Subject Code | Research subject category |
|--------------|-----|--------------|--------------------------|
| SD Negeri 42 | 68  | SA           | ≥ 68 High Ability        |
|              |     | SB           | < 68 Low Ability         |

Data collection techniques in this study using tests and interviews. Research subjects were given about the test of mathematical connection ability and interviewed 4 students who have selected to know
the students’ understanding of the test of mathematical connection ability. Aspects of mathematical connections analyzed include: (1) integrating information; (2) making connections within and across mathematical domains; (3) deciding which mathematical tools to use to solve problems; (4) solving nonroutine problems.

In qualitative descriptive research use triangulation to enter data validity for checking or as comparison data. Triangulation used in this research is the triangulation method. The method used is the test method and interview method. Thus, in this study, we will describe the mathematical connections of students in solving mathematical problems based on aspects of mathematical connections.

The test which used in essay form with 2 questions and the grille attached to Table 2 and the results of the students’ answers analyzed in accordance with the scoring books that made (attached):

### Table 2. The test grille.

| Steps in Problem Solving          | Mathematical Connection Indicators                  | Question Number |
|----------------------------------|-----------------------------------------------------|-----------------|
| 1. Understanding the problem     | 1. Integrating information                          | 1a, 2a          |
| 2. To Devise and Carry out the plan | 2. making connections within and across mathematical domains | 1b, 2b          |
| 3. Looking Back                   | 3. deciding which mathematical tools to use to solve problems |               |
|                                  | 4. solving nonroutine problems                      | 1c, 2c          |

### 3. Results and Discussion

The tests and interviews for this study conducted in May 2018. Interviews conducted during and after the tests conducted. The material for test questions is Statistics with based on competence as follows: Describe data carried with the learners themselves or the environment and how to copy them, describe the data in the form of lists, tables, drawing diagrams (pictograms), bar charts or graphs, analyze the data relate to the student's self or the environment and how to copy it, and organize and present data related to the learners themselves and compare with data from diagrams of images (pictograms), bar charts or diagram.

Based on the results of the research, descriptions of students' mathematical connections in solving math problems based on overall scores can be seen in the table 3.

### Table 3. Description of the ability of students' mathematical connections in solving math problems.

|                        | SD N 42 PKU |
|------------------------|-------------|
| Average value          | 55.6        |
| Highest point          | 19          |
| Highest score          | 79.2        |
| Lowest point           | 9           |
| Lowest score           | 37.5        |
| Number of students     | 26          |
|                        | 27          |

Based on the guideline for conversion of benchmark reference (PAP) which is used in absolute norms of five scale, the average obtained by SDN 42 Pekanbaru students in class 5 can be stated that the method and mathematical connections of students as a whole are classified as low. Furthermore, the level of ability of students is detailed based on steps in Problem Solving.

#### 3.1. The Process of Mathematical Connections of the Students with high ability

3.1.1. **Stage Understanding Problems.** At this stage is to summarize the information that finds out from the problem, what is known and asked questions. SA students can compile information that is known from the problem 1 but less precise in information about number 2. So, at this stage students can use the first mathematical connection indicator is integrating information. But SA need to more thoroughly in understanding the problem. In the interview process, students are also able to explain the answers and
the process of student answers. Students are good at explaining the information they know from the problem.

3.1.2. *Devise and carry out the plan.* The next stage is to devise and implement, at this stage of the students expected to be able to make connections into and inter-mathematics and also able to overcome the problem. SA are working on the design that has been made, but for final not correct and complete the final result is SA. The results of the test in the interview, SA can explain the steps in making the diagram are directly and easier to use. Number 2: SA are able to connect and establish connections to address problems.

3.1.3. *Looking back.* In the next stage, students are expected to explain the results according to the original context by making conclusions from the results they are working on. SA to make some conclusions from the election they made. Things that encourage the interview process is done, the students are able to explain some conclusions from the diagram that they make.

3.2. *The Process of Mathematical Connections of the Low ability*

3.2.1. *Stage Understanding Problems.* The connection process on SB is preceded by any information relating to the problem number 1. While number 2, SB information correctly but not yet complete. When conducting interviews, students are also unable to explain their information well.

3.2.2. *Devise and Carry out the plan.* Use the results of answers students can be poorer that both cannot answer correctly and correctly. Learning from the test results, the students did not make the bar chart correctly and clearly. On problem number two, SB cannot solve the problem. After the interview, it was read that SB were unable to provide connection indicators in making in-and-inter-mathematical connections as well as problems. SB cannot connect the material and assign problems that will address the problem. The material has been expressed by their math teacher. The teacher discusses the reasons that can be used for the problems, but SB still do not solve the problem.

3.2.3. *Looking back.* SB cannot make some conclusions correctly, in other words only the origin of answering. This happens because they cannot solve the problem correctly. Thus, cannot declare a mathematical connection indicator "solving a non-routine problem".

Based on the above discussion, it can illustrate the relationship between each Subject with the connection indicator in solving the problem in simple statistics in Table 4.

**Table 4.** Description of the ability of students' mathematical connections-based indicator.

| Indicator of Assessment                                                                 | Average | Ideal Score | Highest Score | Lowest Score |
|----------------------------------------------------------------------------------------|---------|-------------|---------------|--------------|
| Identify known, questionable, and unneeded elements                                     | 5.19    | 6           | 6             | 2            |
| Formulate mathematical problems or compile mathematical models and application of various strategic problems inside or outside of mathematics | 3.69    | 6           | 5             | 2            |
| To describe the results according to the context of the origin by making conclusions   | 4.42    | 6           | 6             | 2            |
| Identify known, questionable, and unneeded elements                                     | 3.38    | 6           | 6             | 0            |

Furthermore, the level of students' abilities detailed for each category can be seen in the following table 5.
4. Conclusion
Based on the result of the study of the mathematical connection process of students in solving simple statistical problems with Polya steps can be concluded as follows. There is a difference between high-ability students and low-ability students in solving simple statistical problems. Students with high-ability categories are able to solve problems by performing a complete connection process compared to students with low math skills. Low-ability students are also not doing the process Looking back because it cannot connect to the original problem Thus, it can be concluded that students who have high mathematical skills also have a better mathematical connection ability than students who have low math skills. However, 5th grade students at SD Negeri 42 Pekanbaru were not familiar with the problem because overall the student’s mathematical connection skills were classified as low. So, it is very necessary to applied learning strategies that can improved student’s mathematical connection skills.

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Appendices

Table A1. Test Assessment Rubric.

| Number | Stage of Solving Mathematical Problems | Aspects of Mathematical Connection | Assessment Indicator | Value Criteria | Score |
|--------|----------------------------------------|-----------------------------------|----------------------|----------------|-------|
| 1a, 2a | Understanding the problem               | Integrating information           | Identify known, questionable, and unneeded elements | No answer | 0     |
|        |                                        |                                   |                      | Write down what is known and what is ask but wrong | 1     |
|        |                                        |                                   |                      | Write down what is known and asked but still not quite correct and complete | 2     |
|        |                                        |                                   |                      | Write down what is known and asked correctly and completely | 3     |
| 1b, 2b | To Devise and Carry out the plan        | making connections within and across mathematical domains | Formulate mathematical problems or compile mathematical models and application of various strategic problems inside or outside of mathematics | No answer | 0     |
|        |                                        | deciding which mathematical tools to use to solve problems |                      | any answer but wrong | 1     |
|        |                                        |                                   |                      | There is a correct but incomplete answer | 2     |
|        |                                        |                                   |                      | The answer is true and complete | 3     |
| 1c, 2c | Looking Back                            | solving nonroutine problems       | To describe the results according to the context of the origin by making conclusions | No answer | 0     |
|        |                                        |                                   |                      | There is a correct answer but only one conclusion | 1     |
|        |                                        |                                   |                      | There are correct answers but only two to three conclusions | 2     |
|        |                                        |                                   |                      | The correct answer is all and more than three conclusions | 3     |
| Number | Score | Category |
|--------|-------|----------|
| 1      | 90 – 100 | Very Good |
| 2      | 80 – 89  | Good     |
| 3      | 70 – 79  | Good enough |
| 4      | 60 – 69  | Not Good |
| 5      | < 59     | Very Poor |

**Figure A1.** Results of students answers to *Stage Understanding Problems (SA)*

**Figure A2.** The results of student’s answer to devise and carry out the plan (SA)
Figure A3. The results of student’s answers to looking back (SA)

Figure B1. Results of students answers to Stage Understanding Problems (SB; SB2)

Figure B2. The results of student’s answer to devise and carry out the plan (SB)

Figure B3. The results of student’s answers to looking back (SB)