Students’ mathematical connection ability in the learning employing contextual teaching and learning

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Abstract. Mathematics consists of a variety of topics requiring students to have the mathematical connection ability to link the concepts learned for a better understanding. This study aimed to identify students’ mathematical connection ability in the mathematics learning employing Contextual Teaching and Learning (CTL). It employed a mathematical connection ability test as instrument to achieve the objective. This study was conducted in a junior high school in Aceh Besar regency, Indonesia. The participant of this study were 23 Year 9 students. Students test results were then scored and compared to the indicators of the mathematical connection ability. The results showed that 17 students have poor mathematical connection ability, while the other six students have fair ability.

1. Introduction
Mathematics topics range from a simple to advanced concept, and each topic is likely to be interconnected. The ability to connect one mathematics concepts to another will assist students to understand deeper and grasp the mathematics concepts. Moreover, a mathematical connections system enable students to understand a more advanced concepts [1]. Higher mathematical connections enable deeper understanding [2]. Connection making capability is one of the necessary skills to compete in a rapidly growing global economy [3]. Thus, promoting mathematical connections ability among students are paramount as it will benefit their deeper understanding mathematics which will ultimately improve their mathematics performance and prepare them for the ever-changing world competition.

Mathematical connections have been a major attention for decades, some previous studies examined these topics [1,4-7]. Mathematical connections are defined as “a cognitive process through which a person relates or associates two or more ideas, concepts, definitions, theorems, procedures, representations and meanings among themselves, with other disciplines or with real life” [1]. In short, mathematical connections play a role in bridging mathematical concepts, including the prior and current concepts in enhancing the understanding between mathematical ideas or topics [3]. Thus, students should see mathematics as an intertwined concept rather than separate entity.

A well designed lesson is a key in a successful learning. Regarding the mathematical connections ability, one way to promote this skills among students is through the contextual teaching and learning (CTL) method. CTL is a learning approach that assists educators in linking the topics delivered to real-life context [8]. CTL not only allows students to connect the mathematics concepts to their daily life problems but also to other mathematics topics learned before. Furthermore, it promote students learning autonomy by allowing them to handle their own learning as well as create the link between the knowledge and real-life implication [8].
There has been some studies discussing mathematical connection in the Indonesian context [9-11]. However, they have not employed CTL for fostering students’ mathematical connections and limited studies concerning this skill has been conducted in the context of Aceh, Indonesia. Therefore, this article will bridge the gap by indentifying students’ mathematical connections ability in mathematics learning employing CTL. It is expected that the findings will enrich the literature in the field and provide more insights for educators concerning this matter.

2. Method
The purpose of this study was to describe students’ mathematical connection ability (MCA) in one of junior high schools in Aceh Besar regency, Indonesia. In this study, the MCA was classified into three aspects as in [12], namely 1) connection between concepts in mathematics, 2) connection with other disciplines, and 3) connection with daily life.

The participants of this study were 23 Year 9 students of the junior high school. Some information about the students and the usual teaching-learning practice was obtained from informal interviews with the teacher and students. The students came from the school neighborhood, which were in Aceh Besar regency, Indonesia. They usually learned mathematics conventionally using direct learning. The teacher explain the subject material in the textbook, give some examples, and asking students to do exercises.

The data for this study was collected using MCA test which was given after 3 sessions of mathematics learning employing CTL. One of the authors acted as the substitute teacher. The test consisted of three essay questions about quadratic functions, each question stood for one aspect of MCA. The MCA test was in the form of essay because of some advantages namely: 1) It is easier to evaluate students thinking process and precision; and 2) The test requires students to think systematically, express their opinion and arguments, and link relevant facts [13].

The test taken by the students was scored using MCA scoring rubric (see Table 1) and then was classified into five categories, namely excellent, good, adequate, fair, and poor [14].

| Table 1. Scoring rubric for MCA test |
| Score | Criteria |
|-------|----------|
| 4     | Correct understanding of the problem, complete steps in solving problem, correct computation, and correct answer |
|       | Correct understanding of the problem, complete steps in solving problem, correct computation, but incorrect answer. |
| 3     | Correct understanding of the problem, incomplete steps in solving problem, correct computation, and correct answer. |
|       | Correct understanding of the problem, incomplete steps in solving problem, incorrect computation, and partly incorrect answer. |
| 2     | Incorrect understanding of the problem. |
| 1     | No answer |

*Source [15]*

3. Results and Discussion
The MCA test was scored using rubric in Table 1. The overall percentage of students’ mathematical connection ability is displayed in Table 2.

Based on the Table 2, most students (73.91%) got poor mathematical connection scores, 26.09% students received fair scores, and no one got average, good and excellent ability in mathematical connection.
Table 2. Number of students on each category of MCA.

| Category of MCA | Number of Students | %  |
|-----------------|--------------------|----|
| Excellent       | 0                  | 0  |
| Good            | 0                  | 0  |
| Adequate        | 0                  | 0  |
| Fair            | 6                  | 26.09 |
| Poor            | 17                 | 73.91 |

Furthermore, students’ score at each question of MCA test presented in Table 3.

Table 3. Number of students achieved scores for each question

| Score | Number of students |
|-------|--------------------|
|       | Question 1 | Question 2 | Question 3 |
| 0     | 3          | 1          | 5          |
| 1     | 12         | 5          | 18         |
| 2     | 3          | 3          | 0          |
| 3     | 5          | 6          | 0          |
| 4     | 0          | 8          | 0          |
| Average | 1.43 | 2.65 | 0.78 |

| %  | 35.87 | 66.30 | 19.57 |
| Category | Poor | Adequate | Poor |

As stated previously, each question of the test represented one aspect of MCA. The following is further description about the students’ MCA test result.

3.1. Question 1. Connection between mathematical concepts
The first question was about finding the length and width of rectangular fabric so that it has maximum area as follows.

“A student cuts a fabric into rectangular shape with the perimeter of 80cm. If the student expects the fabric to have maximum area, find it length and width.”

In order to solve this question, the student should be able to examine the connection between one procedure to another in an equivalent representation and the relationship of various concept representations. Students need to connect the concept of rectangular perimeter, system of two variable linear equation, and maximum value of function.

Table 3 shows that the students’ ability to connect various concepts in mathematics met the poor category. Based on the table, the highest score obtained by the students for the first problem was 3, and only five students got the score. They showed correct understanding of the problem, gave complete steps in solving problem and did correct computation. However their final answer was incorrect.

Figure 1 shows one of the students’ answer to the first problem. As shown in the figure 1, the student wrote correct steps but failed to give a complete solution. The student is able to connect the topics of rectangular perimeter, linear equation, and the maximum value of the given function. However, the student did not answer all the questions asked. After finding the value of rectangle width, that is \( l = 20 \text{cm} \), she substituted it to the equation \( L = 40l - l^2 \) rather than substituted it to \( p = 40 \text{cm} - l \). So, she only get the value of the maximum area and length of the rectangle and did not obtain the length of rectangle.
3.2. Question 2. Connection between mathematical concepts with other sciences

The second indicator of MCA was assessed through question about maximum height of an air balloon if given the function of time as follows.

“The height of air balloon can be modelled by \( f(t) = 16t^2 + 112t - 91 \). Find the maximum height of the balloon.”

Based on the data presented in Table 3, the students ability to connect mathematical concepts with other sciences was inadequate category. Eight students achieved the maximum score, which is 4. Furthermore, six got the score of 3 because of incomplete step in solving problem. Informal interview with some of the students who got the score of 3 revealed that they did not write the first step of problem solving and directly solve the problem because they think what is known from the problem was already clear written in the question.

Three students obtained the score of 2 for the second question. An example of the answer is presented in Figure 2. Based on the figure, it can be seen that the student made mistake in writing the formula, he wrote \( \frac{-b^2 - 4ac}{4a} \) rather than \( \frac{-b^2 + 4ac}{4a} \). Furthermore, he also wrong in compute the result.

**Figure 1.** Example of student’s answer of the first question.

**Figure 2.** Example of student’s answer of the second question.
3.3. Question 3. Connection between mathematical concept with daily life
The last question was intended to assess students’ ability in connecting mathematical concept with daily life. The question is as follows.

“A shot put athlete has height of 160cm. He releases a bullet right above his head. Evidently his throwing has the maximum height of 4.5m and the horizontal distance is 2.5m from him. If the throwing forms parabola, how far the shot put travel?”

Based on the analysis of the third question of MCA test, as presented in Table 3, 18 students got the score of 1 and the other 5 students did not answer the question and got the score of 0.

The main objective of this study was to assess students’ mathematical connection ability in the mathematics learning employing contextual teaching and learning. During the experiment, the teacher who is one of the authors conducted the learning process by considering all the seven components of CTL. In order to perform a successful CTL, the teacher paid attention to the suggestion by Selvianiresa & Prabawanto [16]. The teacher tried to facilitate a learning process that uses a high level of activity and collaborative interaction with students, connect the mathematics to the real-world context and integrate the science content into the mathematics. It was expected that the learning employing CTL can improve students’ MCA as suggested by some studies [16,17].

However, the result of this study was not as expected. It was found that most of the students were in the poor category and no one met the average level of the mathematical connection ability. The teacher argued that it was because of the limited teaching-learning time. Usually the students were given problems that were similar to what have been solved by their teacher. Therefore the students need more time to be familiar with the CTL approach and solving contextual problem. Many students asked for individual guidance.

If we look at each aspect of MCA, the students met the average category for the connection between mathematical concept with other sciences, whereas for the other two aspects they were in the poor category. In contrast, the study by Rahmawati, Budiyono and Saputro [18] found that the students were in the very low category for each aspects of the MCA, and the lowest achievement was in the second aspect, that is the connection between mathematical concept with other sciences.

One of the reasons most students could solved the second question probably because of the type of question given. Comparing to the first and the third questions, the second question was shorter and simpler. However, the researchers did not have enough data to support this reason.

4. Conclusion
This study describes students mathematical connection ability after joining mathematics learning employing contextual teaching and learning. The findings showed that, in general, 17 students in one junior high school in Aceh Besar regency, Indonesia, could only met the poor mathematical connection criteria whereas the other 6 students met the fair criteria of mathematical connection ability. Among the three aspects of the MCA, the students achieved the poor category for both connection between mathematical concepts and between mathematics and daily life, and achieved the
average category for the connection between mathematics and other sciences. Considering the limitation of this study, further research should be conducted by paying attention to the time allocation of teaching-learning practice, and the compatibility of the questions.

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