The Mathematics Connection of Teacher Candidates to Solve Mathematics Problems of Primary School Teacher Candidates

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Education encourages the teacher candidates to connect the taught concepts and to instill a more comprehensive understanding. The researchers comprehended the mathematics connections made by the moderate mathematics students in solving mathematics problems. The researchers applied a qualitative approach to identify the connections in the problem-solving process. The researchers collected the data from 35 students of primary school education enlisted at Universitas Negeri Semarang. The researchers collected the data with the mathematics connection evaluation, strategy, and interview. The researchers collected the data with the screened interview process, taken with purposive sampling. The researchers developed the questions based on the mathematics connection characteristics proposed by NCTM. The connection included inter-mathematics topic connection, interdisciplinary connection, and daily life connection. The researchers revealed three connection types established by the students while solving the problems. They were comprehension, reasoning, representation, and procedure.

Keywords: mathematics connection, problem solving, teacher candidate

INTRODUCTION

The development of a community requires an education system to provide the learning process in the new era with skills and competencies. Thus, the development could significantly contribute to the economic development of the community. The initiative about the globalized 21st-century world deals with the belief that this century demands different competence from various people to properly perform (C. Dede, 2007). The competencies include critical thinking skills, connectivity, problem-solving skill, and innovation (J.A. Eli, 2013).

The characteristic of mathematics is a non-partitioned feature from various separated topics but an integrated matter. Mathematics is inseparable from other disciplines and daily life problems. Without mathematics connectivity, learning requires various memorization and separated mathematics procedure (NCTM, 2000:275).

Besides mathematics connectivity, a learner must also have other important skills, such as problem-solving skills. Polya (1985) explains that problem-solving is an effort to find a solution to a difficulty or to reach a complicated objective immediately. Polya mentions four stages in solving problems. They are understanding problems, planning the solution, implementing the problem solution, and checking all the applied stages. Aydoğdu & Ayaz (2008) explain that mathematics problem-solving facilitates an individual to understand the problem-solving strategy and to realize the possibility of various problem-solving methods.

At the International level, mathematics connectivity positively influenced problem-solving skills (Suharto et al, 2019). Students with excellent mathematics connectivity skills could successfully solve mathematics problems and vice versa (D. S. Pambudi,2020).

A lack of understanding of the relevant functional concepts of mathematics made the students ineffectively involve the senior high school learners in making the mathematics connectivity, reasoning, problem-solving, and finding a solution (J. A. Eli, 2009). Checking the understanding of mathematics requires connectivity checking of an individual to realize the idea (P. Bamby et al., 2009). Thus, effective teaching demands the skills to make inter-topic connectivity (D. L. Ball,2005). Therefore, the holistic developments of learners require future mathematics teachers to have the knowledge and make a connection in all contents.

According to the National Council of Teacher Mathematics (2000, 274), mathematics connectivity is an important part that must receive emphasis at each educational level. Mathematics connectivity refers to the inter-connected mathematics topics, the inter-connected mathematics and other disciplines, and inter-connected mathematics and the real world in daily activities. The mathematics connectivity skill refers to an important skill to understand the mathematics concept. With the mathematic connectivity, the studied mathematics concepts become inseparable matters for basic understanding to comprehend other new concepts.

The students of Primary School Teacher Education of Universitas Negeri Semarang are studying to be real primary school teachers. Thus, they must have all capabilities of education, especially for preliminary school education levels. The learners must have excellent competencies and skills to make their future better. One of the crucial and required skills is developing the learning to promote innovative, interactive, interesting, meaningful, and joyful learning. Therefore, the teacher candidates of preliminary schools must train in their skills.

Lailiyah (2015) explains the importance of problem-solving to find a solution from the cognitive process. This process manipulates the knowledge, called a thinking process. Muttaqien (2016) explains that teachers while teaching mathematics lessons to learners, could elicit problem-solving representation. Isroil, Budayasa & Masriyah (2017) explain that learners require conceptual mastery to solve problems in a lesson. Kurnila et al. (2018) explain that learners with a problem-solving approach could solve their problems independently. From the explanations, learners with excellent concepts could promote the question-solution representation with problem-solving skills and manipulate their knowledge to solve the problem autonomously.

Many researchers have been studying mathematics connectivity and problem-solving skills. Son, Darhim & Fatimah (2019) found low levels of learners' mathematics problem-solving skills. Garcia-Garcia & Dolores-Flores (2019) found that mathematics problem-solving skill refers to complex cognitive activities in various cases. Pradika, Amin & Khabibah (2019) found that learners with mathematics connectivity skills could solve complex mathematics problems. Arjudin et al. (2016) found mathematics connectivity should receive attention because many learners committed mistakes in solving problems. Thus, mathematics connectivity should be characterized. From all previous studies, the researchers did not find any studies about the correlation between mathematics connectivity skills and problem-solving. Therefore, the researchers deemed this topic important to study.

RESEARCH METHOD

This mixed-method research used concurrent triangulation to check the pre-arranged mathematics connectivity of the teacher candidates while solving problems in geometry. The researchers took the research sample from the teacher candidates of the Primary School Teacher Education Program at Universitas Negeri Semarang.

Data Collection

The researchers collected the data with the mathematics connection evaluation, strategy, and interview. The designed mathematics connectivity evaluation measured the students' mathematics connectivity in the problem-solving activity. Then, the researchers scored the mathematics connectivity of the students based on the rubric. The given maximum scores are 2 points for a correct connection, 1 point for a partially correct connection, and 0 for an incorrect connection. The researchers examined the instruments for the second-semester grade students of the program.

The research orientation was based on a research nature. The researchers provided the option for the students to quit participating at any time without any responsibility to explain the reason. The researchers guaranteed their identity in secrecy. In the beginning, the researchers asked the students to answer the first and second problems autonomously. Then, the researchers interviewed the participants for 20 minutes each after solving the problems. After collecting the data, the researchers validated the obtained interview results.

The Data Analyses

This research applied a qualitative approach to identify the connections found in the problem-solving process. The researchers used the semi-structured interview to describe the specific occurring connectivity process. The objectives of the interview were to reveal the observed phenomenon (Esterberg, 2002). The researchers also established the complex description; checked the descriptive words; considered the respondents' perspectives; and promoted a comprehensive study within the experience context while observing the phenomenon (Cresswell, 2012). Therefore, the researchers proposed questions for the students to obtain descriptions of the occurring connections while solving the language problems. The researchers provided some moments for the students before answering the interview questions.

The researchers provided the language tasks for the students. Then, they developed the tasks based on the three connectivity characteristics explained by NCTM. They were the inter-connected mathematics topics, the inter-connected mathematics and other disciplines, and the inter-connected daily life problems. The researchers prepared three questions:

1) Cubic cardboard has laterals with 72 cm for each lateral. The cardboard could contain 648 uniform beams. The length of each beam is 12 cm with a width of 6 cm. How many piles of beams are inside the cardboard?
2) The cardboard has an 8 cm lateral. Then, the lateral is shrunk to ¾ of the original size. How are the volumes before and after being shrunk?
3) A prism has a rectangular area with a ratio of 3:2, between the length and the width. Given the height of the prism is 30 cm and the volume is 2880 cm^3, determine the length and the width of the prism!

RESULTS AND DISCUSSIONS

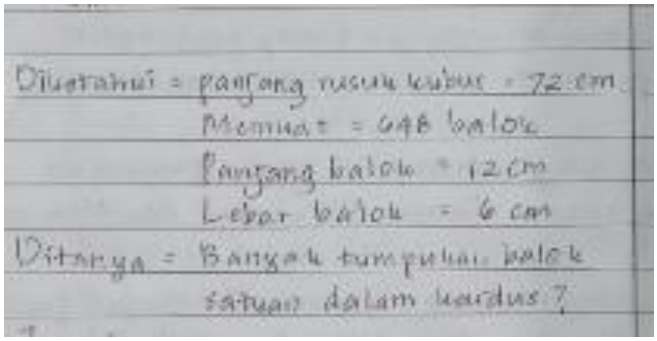
For the first question, the subjects applied the linked understanding. The linked understanding refers to connectivity based on the subject's skills to identify the given elements and the questioned elements in determining the applicable concepts and procedures for solution strategy. The subject's identifying skill was useful to connect all given and questioned elements. Then, the subjects combined the elements in a strategy to obtain a solution. The researchers illustrated this process based on the cited interview results, shown in Figure 1.

P : What did you understand after reading the first numbered questions?(Apa yang anda pahami setelah membaca soal nomor satu?)

CA : I wrote the given and questioned elements from the question. (Saya menuliskan dulu unsur-unsur yang diketahui dan ditanyakan dalam soal bu.)

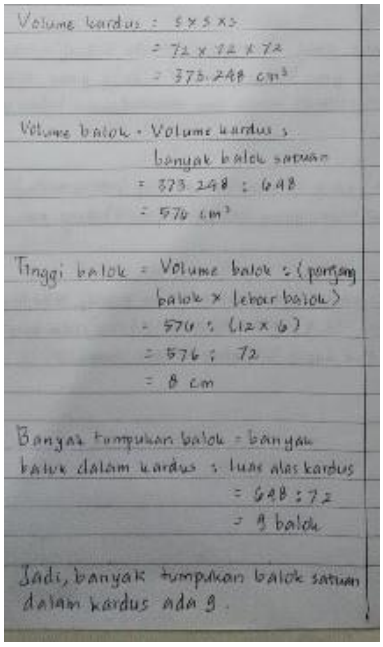
P : What were they? (Seperti Apa itu?)

FIGURE 1
THE SUBJECTS IDENTIFIED THE GIVEN AND THE QUESTIONED ELEMENTS



The other connectivity types were from the evidence-verification process by observing and inferring (Toulmin, 2008). This connectivity occurs when the subject solved a problem by applying direct linguistic analysis based on the drawn conclusion of the given information. This information was established based on the subject's assumption. In learning mathematics, deductive reasoning or logical reasoning refers to a reasoning technique with leading conclusions based on the given facts. Toulmin explains if the premises are correct, the conclusion must be correct. The researchers illustrate this process in Figure 2.

FIGURE 2
THE PROCESS OF PROBLEM-SOLVING BY THE SUBJECT



The observed connectivity type was represented as shown during the evaluation stage. The equivalent representation refers to a represented concept with the same method, a different method, the representable concept, or different symbols (Suominen, 2015). The indication of this matter was the subject's skill to prove the correctness of the accepted responses with various expressions, both verbally and symbolically. The researchers present the process as shown in the following cited interview result.

P : What did you do to prove the correctness of your obtained answer? (Apa yang kamu lakukan untuk membuktikan kebenaran jawaban yang kamu peroleh?)

CA : hmmm.....(the subject was thinking for a moment) I usually made the mathematics model first Mam. (Saya bisa membuat model matematikanya dulu bu)

P : After that, what did you do? (Lalu setelah itu apa yang kamu lakukan?)

CA : I worked on the task by applying the substitution-elimination model. (Saya akan menyelesaikannya dengan metode eliminasi substitusi bu...)

In the second question, the subject collected the component from other concepts [14]. The subject used a concept or an idea from other concepts. Thus, the concepts had a hierarchal correlation. The researchers identified this matter on the subject and could determine the accurate concept to solve the problems. This finding indicated that the subject promoted a conceptualization as the component of other concepts. This process is observable in the following interview.

P : After that, what did you do to complete it? (Selanjutnya, apa yang akan kamu lakukan untuk menyelesaikannya?)

CA : hmmmm..... (The subject was thinking for a moment) I determined the area of the cardboard surface with the beam shape and determined the area of a package with a rectangular shape. (Saya akan menentukan luas permukaan kado keseluruhan yang berbentuk balok dan menentukan luas satu buah pembungkus yang berbentuk persegi panjang.)

In solving the third question, the subject stretched the cube and determined the volume. However, the subject did a mistake when the subject decided to add the cubic volume. The subject connected the cubic volume and worked on it. Unfortunately, the subject did not realize the committed mistake. However, the obtained answer was incorrect because the subject did a mistake when working on the cubic volume. The subject realized the mistakes when the subject did the evaluation stage. Then, the subject corrected the mistake. The researchers present the process as shown in the following cited interview result.

P : Were you sure of your answer's correctness?(Apakah anda yakin dengan kebenaran jawaban anda?)

CA : Hmmm..... Let me think Mam. (Hmmm.....saya perhatikan dulu bu ...) (The subject checked the work). I guess I found the mistake on the diagonal Mam. (Sepertinya ada kesalahan pada panjang diagonalnya bu.)

P : How did you correct it? (lalu seperti apa anda akan memperbaikinya?)

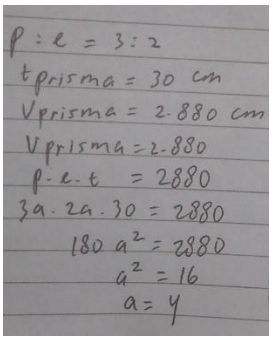
CA : By determining the cubic volume, isn't it? (Saya akan menentukan volume kubus ?)

P : Why do you think so?(Mengapa anda berpikir seperti itu?)

CA : Because I need the cubic volume to increase and shrink the volume. (Karena saya membutuhkan volume kubus untuk mempesar serta memperkecil volume.) ..... (The subject explained the work by revising the incorrect steps)

In solving the third question, the subject stretched the cube and determined the volume. However, the subject did a mistake when the subject decided to add the cubic volume. The subject connected the cubic volume and worked on it. Unfortunately, the subject did not realize the committed mistake. However, the obtained answer was incorrect because the subject did a mistake when working on the cubic volume. The subject realized the mistakes when the subject did the evaluation stage. Then, the subject corrected the mistake. The researchers illustrate the process in the following interview result.

FIGURE 3
THE PROCESS OF COMPLETING THE THIRD QUESTION



From figure 3, the subject identified the applicable concept to determine another concept. This concept became the procedure or method to correct the concept while working on the other concept. The researchers found representative connectivity on the third question. This process was observable from the subject's skill to evaluate the answer's correctness and the applied procedure.

CONCLUSION

From the results, the researchers concluded the connectivity types of the problem-solving process. They were: Comprehension connectivity - the established connection from the subject's skills to identify the given and the questioned elements in the questions to determine the applicable concepts and procedures in solving problems; Reasoning connectivity - the established connection from the verification process by observing and promoting logical reasoning; and the equal representation connectivity - the established connection based on the presented concepts with different method and formulation but with the same value. In this research, the researchers found the equality of the verbal-to-symbolic representations. The last connectivity was procedural - the established connection based on the implementation of a concept while working on certain methods or procedures.

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