Pre-service mathematics teachers' reasoning ability in solving mathematical non-routine problem according to cognitive style

by Ayu Faradilah

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A Faradillah[1], W Hadi[1] and A Tsurayya[1]

[1]Universitas Muhammadiyah Prof. DR. HAMKA, Jakarta, Indonesia

E-mail: ayufaradillah@uhamka.ac.id

Abstract. This research described the level of mathematical reasoning ability of preservice teachers in solving the mathematical non-routine problem based on cognitive style. The cognitive style used was fast-accurate, reflective, impulsive and slow-less accurate cognitive style. Researchers used Matching Figure Familiar Test (MFFT) to find each cognitive styles. The total subject of this research was four mathematics education's preservice teachers. In addition, the category of research method used was explorative research with a qualitative approach where researchers tried to describe the level of preservice teachers' mathematical reasoning ability in solving the mathematical non-routine problem according to their cognitive style. Moreover, based on the result of this research, there were three of four mathematics education's preservice teachers who have mathematical reasoning ability in level 2. Meanwhile, there was one preservice teacher who got level 3 of mathematical reasoning ability. Furthermore, it related to their cognitive style. Since the preservice teacher who got level 3 of mathematical reasoning ability, she had fast-accurate cognitive style. Whereas, they who got level 2 had reflective, impulsive and slow-less accurate cognitive styles.

1. Introduction

Mathematics appears from the results of human thought related to ideas, processes, and reasoning. A mathematical material and mathematical reasoning cannot be separated, this is because mathematics is understood through reasoning and reasoning understood and trained through mathematical material [1]. So that the ability of mathematical reasoning is very important and necessary in mathematical learning. Moreover, mathematical reasoning as a part of the mathematical thinking that involves forming generalizations and drawing valid conclusions about ideas and how they are related. This identifies that a person who has mathematical reasoning ability will be able to generalize a problem to form a valid conclusion [2].

Pre-service teachers said to be capable of reasoning when they are able to use reasoning in patterns and traits, perform mathematical manipulations in generalizing, compiling evidence, or explaining mathematical ideas and statements [3]. Therefore, pre-service teachers must have good mathematical reasoning ability so that they are able to apply to the learning process in the school. This is reinforced by Baroody [3] reveals that a good reasoner should be introduced to situations of problems related to reasoning as early as possible including in mathematical learning in the school.

The mathematical reasoning ability of pre-service teachers can help them see mathematics as logical and plausible, thus it will help them to develop their beliefs that mathematics is something that they can

understand, think, justify and evaluate. Based on some of the above opinions show that the ability of mathematical reasoning is an important aspect that should get the attention of teachers.

Accordingly, the teacher must also have the ability of mathematical reasoning inhabiting to be able to assist students in improving their reasoning. In fact, teachers often only invite students to learn routine questions, so students have not honed their mathematical reasoning ability in mathematical materials. Whereas, non-routine problems that can help students in improving the ability of mathematical reasoning. Non-routine problems lead to process problems, it is requiring more than simply translating problems into mathematical sentences and using known procedures. This is the focus in learning mathematics in Education Unit Level Curriculum Non-routine questions can be used to improve reasoning and non-routine problems focus on high level of interpretation and organizing problems. Non-routine problems in mathematics can encourage logical thinking, add conceptual understanding, develop mathematical reasoning, develop abstractive thinking skills and transfer math skills to unfamiliar situations.

Based on the statement, a teacher must also have the high mathematical reasoning ability to solve non-routine problems. This indicates that before becoming a teacher, it must first be analyzed to what extent reasoning ability possessed by pre-service teachers. They are difficult in guessing the strategies that will be used to solve the problems given and also less precise in generalizing the problem. This is because they are unable to use their reasoning in solving problems [4]. Though the objects studied in mathematics are abstract so that students need to use their rational power to solve the given problem.

Besides, there are other aspects that need to be considered that is cognitive style. The cognitive style is characterized as a possible cognitive trait to express the difference in the individual's ability in the quality of his thinking. [5], cognitive style is a typical way of studying students, both related to the way of receiving and processing information, attitudes toward information, and habits related to the learning environment. This is reinforced one group of student-made decisions after briefly looking at the figures, so they were cognitively impulsive, while the other was cognitively reflective [6]. One group of children who in making decisions briefly after viewing the image, so they are impulsive cognitive style, while other groups carefully choose before making a decision, they are reflective cognitive style. Moreover, there is a cognitive style in which students are fast and correct in answering and cognitive style where students are slow an incorrect in answering.

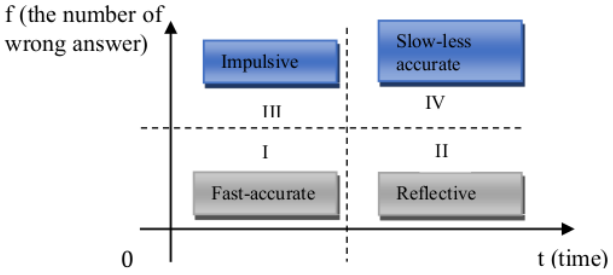

Figure 1. Fast-accurate, Reflective, Impulsive and Slow-less accurate Cognitive Style

According to figure 1, some definitions of cognitive style put forward by the experts, hence the cognitive style in this research is a person's way of processing, thinking and solving that is consistent where the type of cognitive style is a cognitive style fast-accurate, reflective, impulsive and slow-less accurate. Cognitive style associated with the use of time used by students to answer the problem and the number of errors made by students in solving problems given.

Methods

This research aims to describe the level of mathematical reasoning ability of pre-service teachers in solving non-routine mathematical problems according to their cognitive style. This research is

categorized as explorative research with a qualitative approach. Before testing the ability of mathematical reasoning, the researcher will be selected subject of research. The subjects of research were selected by using MFFT to categorize subjects based on the four cognitive styles that were focused on this study. After obtaining the subjects, the subject was asked to solve a non-routine mathematical problem in writing first. Furthermore, the written results are stored by researchers and researchers conducted interviews related to non-routine mathematical problems that have been completed in writing. After obtaining the required data the researcher analyzed the data obtained in accordance with the purpose of this study. The level of mathematical reasoning ability that is measured in this research is level 4 (Superior), level 3 (satisfying with a few shortcomings): Level 2 (Quite Satisfying), level 1 (Satisfactory).

The analysis of qualitative data is done in a process, means that data analysis can be done since the data collection in the field and ended at the time of preparation of research report [7]. Suggests the analysis during data collection provides an opportunity for researchers to re-examine existing data and develop strategies for obtaining quality data [8]. Furthermore suggested there are three stages of analyzing qualitative data that is data reduction, data presentation, and conclusion [9]. Data analysis techniques in this study refers to the stages of data analysis proposed [9].

2.1. Data Reduction

Data reduction is intended to select, refocus, abstract, and transform raw data. In this research, the raw data obtained from field research is reduced to get the data that is really needed in analyzing the mathematical reasoning ability of the prospective teacher in solving the non-routine mathematics problem based on the cognitive style.

2.2. Presentation of data

The presentation of research data includes classification and identification. This is intended to make it easier to draw conclusions from the data. Thus, the written data has been well organized and categorized.

2.3. Conclusions

The conclusion is to give meaning and explanation to result in data presentation. Furthermore, the conclusion of this study is aimed to reveal the mathematical reasoning ability of prospective teachers in solving non-routine mathematical problems based on cognitive style.

3. Findings and Discussion

The selection of research subjects started with the Matching Familiar Figure Test (MFFT) which was held on June 2, 2017. Researchers conducted MFFT in the 2F class of pre-service teachers Mathematics Education Study Program of University of Muhammadiyah Prof. DR. HAMKA (UHAMKA), where the number of pre-service teachers in the class is 26 students. The result of MFFT class 2F can be seen in Table 1.

Table 1. The Result of MFFT

Cognitive style	Total Pre-service Teachers
Fast-accurate	10
Reflective	5
Impulsive	10
Slow-less accurate	1
Total	**26**

According to the results of MFFT class 2F students of UHAMKA mathematics education program in Table 1. above, it is known that from 26 pre-service teachers attending MFFT there are 10 pre-service teachers who have fast-accurate cognitive style, 5 pre-service teachers who have reflective cognitive

style, 10 pre-service teachers cognitive impulsive style and 1 pre-service teachers who have slow-less accurate cognitive style. The selected research subjects can be seen in Table 2. as follows.

Table 2. The List of Research Subjects According to MFFT

Subject	M/F	Cognitive style	*f*	*t*
S1	F	Fast-accurate	11	15.55
S2	M	Reflective	9	26.57
S3	F	Impulsive	3	14.03
S4	F	Slow-less accurate	3	16,14

Note:
f : Number of incorrect answers
t : Time students use to answer the given questions

After getting the research subject, the researcher did the validation of the problem-solving problem of non-routine mathematics. Researchers asked one lecturer of mathematics education at the State University of Surabaya, East Java, Indonesia to validate the question. The result of the validation stated that the test question to analyze the mathematical reasoning ability of the pre-service teacher is feasible to be used with the improvement in the sentence used by the problem.

Mathematical reasoning test is used to measure the level of reasoning ability possessed by students of mathematics teacher candidates. There are four levels of mathematical reasoning abilities, namely level 4 (superior), level 3 (satisfactory with a few shortcomings), level 2 (quite satisfactory) and level 1 (satisfactory). The following is the presentation of the results of the analysis of the level of mathematical reasoning ability of prospective teachers based on their cognitive style.

3.1. Analysis of The Level of Mathematical Reasoning Ability of Pre-Service Teachers' Who has Fast-Accurate Cognitive Style (S1)

S1 who has a cognitive style quickly-able to solve the problem non-routine given by researchers for approximately 70 minutes. Based on the result of the completion of S1 on the problem of mathematical reasoning test, the level of mathematical reasoning ability possessed by S1 is at level 3. This is because S1 is able to show understanding of mathematical concepts, using appropriate solutions in analyzing most mathematical situations, Indirectly most of it is true by using the volume formula and using the ribs that have been obtained, using the appropriate strategy that is correct in searching the ribs for the cube with the expanded cubical surface area, able to make the image most appropriate, calculate (computation) mostly true And meet the desired demand.

3.2. Analysis of The Level of Mathematical Reasoning Ability of Pre-Service Teachers' Who has Reflective Cognitive Style (S2)

S2 who has a reflective cognitive style to solve non-routine problems provided by researchers for approximately 60 minutes. Based on the results of completion of S2 in solving non-routine mathematical problems given, the level of mathematical reasoning capabilities possessed by S2 is at level 2. This is because S2 is satisfactory even though the results are less precise. S2 demonstrates an understanding of some mathematical concepts, using improper solutions that result in imprecise results, making indirect proofs largely wrong and using less appropriate, less systematic and organized strategies to solve the problem.

3.3. Analysis of The Level of Mathematical Reasoning Ability of Pre-Service Teachers' Who has Impulsive Cognitive Style (S3)

S3 who has a reflective cognitive style solve non-routine problems provided by researchers for approximately 60 minutes. Based on the result of the completion of S3 in solving the non-routine mathematical problem given, the level of mathematical reasoning ability possessed by S3 is at level 2. This is because S3 is satisfactory even though the result is less precise. S3 demonstrates an understanding

of some mathematical concepts, using improper solutions that result in imprecise results, making indirect proofs largely wrong and using less appropriate, less systematic and organized strategies to solve the problem.

3.4. Analysis of The Level of Mathematical Reasoning Ability of Pre-Service Teachers' Who has Slow-Less Accurate Cognitive Style (S4)

S4 who has a reflective cognitive style resolves non-routine problems given by researchers for approximately 60 minutes. Based on the result of the completion of S4 in solving the nonroutine mathematical problem given, hence level of mathematical reasoning ability possessed by S4 is in level 2. This is because S4 is satisfactory even though the result is less precise. S4 demonstrates an understanding of some mathematical concepts, using improper solutions that result in imprecise results, making indirect proofs largely wrong and using less appropriate, less systematic and organized strategies to solve the problem.

In this part will describe the discussion of research results based on data obtained related to the ability of reasoning of pre-service teachers in solving non-routine mathematical problems based on cognitive style fast-accurate, reflective, impulsive and slow-less accurate. S1 who has a fast-accurate cognitive style and level 3 mathematical reasoning ability in accordance with the definition of cognitive style stated [10]. A pre-service teacher with fast-accurate cognitive style has fast characteristics in answering the problem and accurate so the answer is always right [10]. This is seen from the level of reasoning that S1 is the highest among other subjects. Although the timing of the test S1 does not match the characteristics it should have based on its cognitive style.

While the S2 who has reflective cognitive style and level 2 of mathematical reasoning ability. At the beginning of the test, S2 had difficulty in determining the way to solve the given problem. In line with the opinion subjects with reflective cognitive style experience confusion when determining the strategy that will be used to solve the problem because the subject needs to remember and match some problem solving previously used to find a way to solve the given problem [11]. S2 spends his time thinking at the beginning of work but is not able to solve the problem in the end. Furthermore, S3 has an impulsive cognitive style and level 2 of mathematical reasoning ability. At the beginning of the test, S3 looks confident in working on the given problem. She was able to solve problems earlier than other subjects although in the end waiting for other subjects to collect the results of the first answer to the new S3 participate collect. In accordance with that expressed by impulsive subject is more concerned with the speed of answering than the fear of answers [12]. And the last S4 who has a slow-less accurate cognitive style and level 2 of mathematical reasoning ability. At the beginning of the test, the S4 looks tense when the problem is given. She also did not directly do the question but instead draw other things that are not related to the problem. As expressed in the definition of cognitive style slow-less careful that students who have slow characteristics in answering problems and less accurate so often wrong answers.

4. Conclusion

According to the results of the research that has been described above, the conclusions that researchers can reveal in this study is the exposure level analysis of mathematical reasoning ability of students prospective teachers based on cognitive style, there is one pre-service teacher who obtains level of mathematical reasoning ability at level 3 (satisfactory with a few shortcomings) where pre-service teacher's cognitive style is fast-accurate. While 3 other pre-service teachers get the level of mathematical reasoning ability at level 2 (quite satisfactory) where each cognitive style it has is reflective, impulsive and slow-less accurate.

References

[1] Sa'adah W N 2010 *Peningkatan Kemampuan Penalaran Matematis Siswa Kelas VIII SMP Negeri 3 Banguntapan dalam Pembelajaran Matematika Melalui Pendekatan Pendidikan Matematika Realistik Indonesia (PMRI)* (Yogyakarta: Thesis Universitas Negeri Yogyakarta)

[2] Castro 2004 *Journal of Asia Pacific Education* **5** 2
[3] Widyasari N 2013 *Meningkatkan Kemampuan Penalaran dan Disposisi Matematis Siswa SMP Melalui Pendekatan Metaphorical Thinking* (Bandung: Tesis Sekolah Pascasarjana, Universitas Pendidikan Indonesia)
[4] Faradillah, Ayu 2014 *Profil Penalaran Matematis Siswa SMP dalam Memecahkan Masalah Matematika Berdasarkan Gaya Kognitif Reflektif-Impulsif* (Surabaya: Tesis Universitas Negeri Surabaya)
[5] Uno H B 2006 *Orientasi Baru dalam Psikologi Pembelajaran*s (Jakarta: PT. Bumi Aksara)
[6] Froehlich 2003 *Cognitive Styles: A Review of the Major Theories and Their Application to Information Seeking in Virtual Environments* (Online) http://www.personal.kent.edu/~plucasst/Cognitive%20Styles.pdf (8 Maret 2017)
[7] Moleong, Lexy J 2010 *Metodologi Penelitian Kualitatif (edisi revisi*) (Bandung: Remaja Rosdakarya)
[8] Rohendi, Tjetjep 1993 *Analisis Data Kualitatif* (Jakarta: Universitas Indonesia Press)
[9] Miles B M and Huberman 1992 *Analisis Data Kualitatif (terjemahan)* (Jakarta: Universitas Indonesia Press)
[10] Warly 2010 *Profil Kreativitas Siwa yang Bergaya Kognitif Reflektif dan Siswa Begaya Kognitif Impulsive dalam Memecahkan Masalah Geometri* (Surabaya: Dissertation Universitas Negeri Surabaya)
[11] Sulisawati 2013 *Pengaturan Diri Siswa SMP dengan Gaya Kognitif Reflektif-Impulsif dalam Menyelesaikan Masalah Aljabar* (Surabaya: Thesis Universitas Negeri Surabaya)
[12] Kenny, Robert F 2007 *International Jurnal of Social Sciences* **2** 3

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