Jurnal Math Educator Nusantara
Wahana publikasi karya tulis ilmiah di bidang pendidikan matematika
p-issn: 2459-9735 e-issn: 2580-9210
http://ojs.unpkediri.ac.id/index.php/matematika

Algebraic Thinking Profile of Prospective Mathematics Teacher Students with Medium Mathematics Ability According to SOLO Taxonomy

Siti Rochana [1*], Lilia Sinta Wahyuniar[2], Niska Shofia[3] ,Umi Mahdiyah[4]
[1,2,3,4] Informatic Engineering Study Program, Universitas Nusantara PGRI Kediri. Jalan KH. Acmad Dahlan No 76 Kota Kediri, Indonesia.
E-mail: sitirochana@unpkediri.ac.id*

Article received : 23 agustus 2020,
Article revised : 12 oktober 2020,
Article Accepted : 18 oktober 2020.

Abstract: This study aims to describe the algebraic thinking profile of prospective mathematics teacher students according to the SOLO taxonomy. The research was conducted at the Nusantara University PGRI Kediri. The research subjects were students who are prospective mathematics teachers with moderate or average abilities. Subjects are selected based on course scores and information from several lecturers who are teaching the subject. Besides that, the willingness and openness of the subject is also a consideration for choosing this subject. The instrument used in this study was a matter of algebraic problems. The method used is a qualitative method which refers to the written test and interview. The questions that are done consist of tests of algebra problems for pattern components and algebra problem tests for variable components. The results showed that students of prospective mathematics teachers with moderate mathematical abilities met the indicators of algebraic thinking, namely being able to find certain terms in a given pattern but were unable to generalize the given pattern and could not understand variables as general form numbers in algebraic form.
Keywords: Algebraic Thinking Profile, Mathematics Teacher Candidates, Medium Math Ability, SOLO Taxonomy

INTRODUCTION

Algebra is a branch of mathematics. Algebra has an important role in solving problems in advanced mathematics, science, business, economics, trade, computing and other problems in everyday (Booker, 2009). Given the importance of algebraic material which is part of mathematics in schools, therefore prospective teachers who are mathematics mus master mathematics material including algebra with well (Sugiman, 2015). The ability of prospective mathematics teacher students can be seen from their responses or answers when given a problem (Irawati et al., 2006). Algebraic material has actually been known to students since they were in high school. However, in the development of student algebraic thinking becomes diverse. Based on this, this study aims to describe the algebraic thinking profile of prospective mathematics teacher students with moderate abilities in solving algebraic problems and then classified according to the SOLO taxonomy (Structure of Observed Learning Outcomes).

Solving algebraic problems cannot be separated from the algebraic thinking process (Kriegler, 2008). Thinking is something that is absolutely necessary when humans experience life.

CITATION FORMATS; Rochana, S., Wahyuniar, L. S., Shofia, N., & Mahdiyah, U. (2020). Algebraic Thinking Profile of Prospective Mathematics Teacher Students with Medium Mathematics Ability According to SOLO Taxonomy. *Jurnal Math Educator Nusantara: Wahana Publikasi Karya Tulis Ilmiah Di Bidang Pendidikan Matematika*, *6*(2), 127-137. https://doi.org/10.29407/jmen.v6i2.14742

Thinking is also a mental activity to help formulate or solve a problem, make a decision, or fulfill a curiosity (Ruggiero & Ruggerio, 2004). While thinking algebra according to (Dindyal, 2004) in general, it has three related components, which include the use of symbols and algebraic relations, the use of various forms of representation, and the use of patterns and generalizations.

Algebra is the study of symbols and the rules for manipulating these symbols (Herstein, 1964). Algebra simplifies difficult problems by using letter symbols to represent unknown numbers in calculations. However, in reality understanding algebraic material is not an easy matter. Algebra is not easy for many students to understand (Linsell et al., 2007). This is also supported by the statement (Gagnon & Maccini, 2001) that many students have difficulty solving problems related to algebra. From the preliminary study, the researcher as a linear algebra lecturer for 4 years saw the phenomenon of low student proficiency in algebra, possibly due to many factors, one of which is the teacher's unpreparedness in delivering algebraic material. This can be important for lecturers to pay attention to the development of algebraic thinking in prospective mathematics teacher students who will be prepared to teach mathematics subjects in schools.

At Universitas Nusantara PGRI Kediri, mathematics education students are not only high school students majoring in science but all majors can enter the mathematics education department. In addition, the selection system that can be said to be soft cannot detect how much algebraic understanding of the prospective mathematics teacher is. So that it is important for researchers to conduct this research to find out how the algebraic thinking of prospective mathematics teachers will be before plunging into a mathematics teacher. In addition, most of the average ability according to data on course scores and information from fellow lecturers is intermediate ability or moderate ability.

Algebraic thinking is related to the SOLO taxonomy because the SOLO taxonomy can be used as a tool to categorize student or student algebraic thinking (Lim & Noraini Idris, 2006). Like the resulting research (Kamol, 2005) namely regarding the algebraic thinking framework of students characterized by SOLO taxonomy which consists of (1) unistructural, (2) multistructural, (3) relational, and (4) extended abstract. In addition, similar research has also been conducted on high school students (Napfiah, 2016) and has also been done at Madrasah Tsanawiyah (Wahyuniar et al., 2018).

From a series of reasons, the researcher wants to know how the algebraic thinking profile of prospective mathematics teachers with mathematical skills is in solving algebraic problems. Before students who are prospective mathematics teachers enter the world of education to educate students at school, they must first have a measurable algebraic thinking profile. This research is important to do because this research will greatly support the quality of mathematics education by prospective mathematics teachers who will educate students at school.

ISSN 2459-9735 (print), ISSN 2580-9210 (online)

METODE

This research is included in the type of qualitative research, namely research that uses qualitative data which is then described to produce an exposure to the Algebraic Thinking Profile of Prospective Mathematics Teacher Students.

Prospective subjects consist of second-level students who have or are currently taking algebra courses. The determination of the subject of this study is one student with moderate math ability. Selection of students is based on the value of the algebra course test, math ability test, and information from the course supervisor. In choosing this subject, it is necessary to pay attention to the fluency of communication and the ability of students to express opinions because an interview process will be carried out with the selected subject.

In this research, the main instrument in data collection is the researcher himself. according to the opinion of (Moleong, 2007) only researchers are able to understand the relationship between the realities in the field through observation and interviews, and cannot be represented by others. In addition, there are supporting instruments which include the Mathematics Ability Test and Algebra Problem Test and interview guidelines.

Data collection in this study was carried out using two techniques, namely written tests and interviews. The written tests conducted in this study were tests of mathematical abilities and tests of algebraic problems. Mathematical ability tests are carried out to determine subject selection and algebra problem tests are used to describe the algebraic thinking profile of the selected subject. Besides that, task-based interview techniques are used. Task-based interviewing techniques are interviews conducted simultaneously when the subject is working on a test of algebra problems. Interviews were conducted to obtain clearer data about the algebraic thinking profile of students. Opinion (Moleong, 2007) revealed that triangulation is a data validity checking technique that utilizes something other than the data for checking purposes or as a comparison to the data. In this study, time triangulation was used. The data collected through written tests and interviews were then tested for their validity by triangulation of time in an effort to obtain valid data which in the end could be analyzed as a conclusion or the result of this study. Time triangulation means that the subject is given the same test but at a different time.

Data analysis to reveal the algebraic thinking profile of students in solving problems is to analyze the results of interviews by transcribing all recorded conversations to determine algebraic thinking activities in solving problems orally. The results of this interview analysis are used to complete and explore further information on student answers to the problem solving test and reveal things that have not been fully seen in problem solving. The research procedure carried out in this study includes three stages, namely the preparation stage, the implementation stage and the completion stage.

ISSN 2459-9735 (print), ISSN 2580-9210 (online)

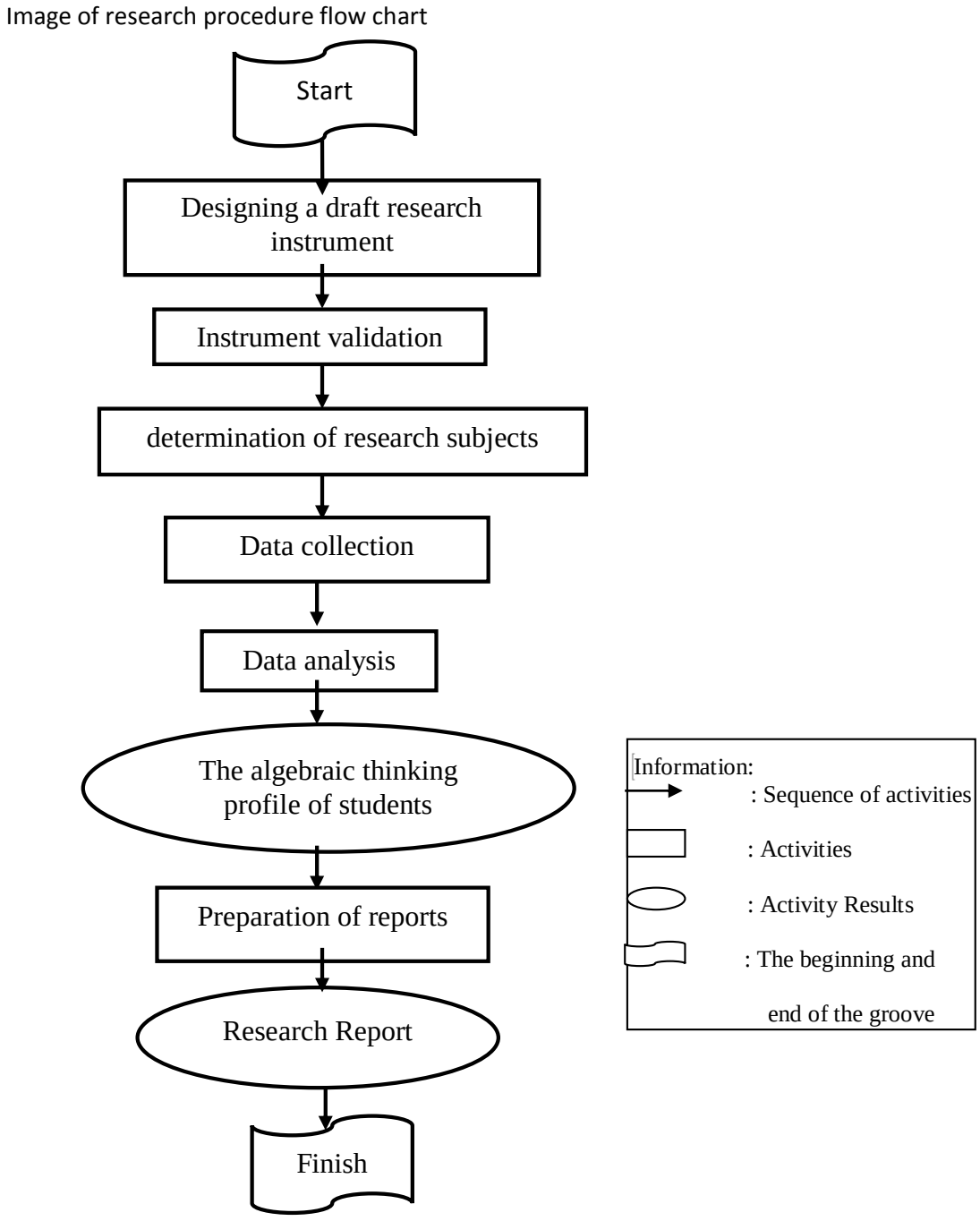

Figure 1. Research Flowchart

In this study, the SOLO taxonomy regarding student responses was adapted from Kamol's opinion (Kamol, 2005) namely the five levels of student response based on the SOLO taxonomy as follows.

1. *Prestructural*
   Students are confused or unable to participate in assignments. Students do not understand the problem or the response given is irrelevant.

ISSN 2459-9735 (print), ISSN 2580-9210 (online)

2. *Unistructural*
   Students focus on the problem but only use one piece of relevant data. Students use one piece of data in responding to problems.
3. *Multistructural*
   Students use several pieces of data but cannot make connections between them. Students use some data to solve problems but cannot provide a relationship between the data obtained.
4. *Relational*
   Now students can use all the data as appropriate and are able to appreciate the meaning of the parts in relation to the whole. Students can provide a relationship between the data obtained.
5. *Extended abstract*
   Students make connections not only within a specific subject area, but also beyond it, able to generalize and transfer the principles and ideas that underlie specific examples. The response given is almost the same as the response at the relational level but the data or concepts and processes are drawn from outside the assumed knowledge of the question.

HASIL DAN PEMBAHASAN

The purpose of this study was to describe the algebraic thinking profile of prospective mathematics teachers who have moderate math abilities. The subject's initials were KN. The research results will be presented as follows:

1. Tests for Pattern Component Algebra Problems
   a. Point pattern component a

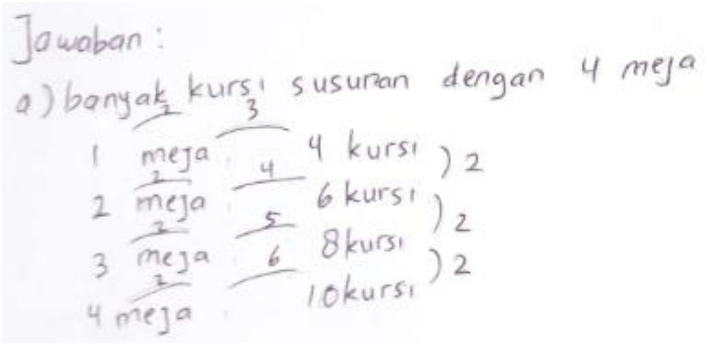

Figure 2. Results of TMA 1 Workmanship Pattern Components points a

KN's answer to point a is by making a pattern like the description in the question. KN looks for answers by using annotation patterns and connecting one pattern to another (Figure 2). At this point the KN reaches a multistructural level.

ISSN 2459-9735 (print), ISSN 2580-9210 (online)

a. Point pattern component b

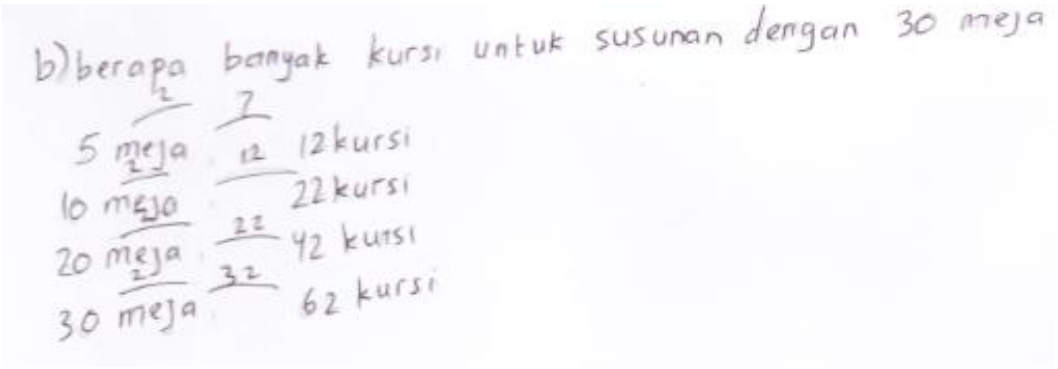

Figure 3. Results of TMA 1 Component of Point Pattern b

KN's answer to point b is by making a pattern like the description in the question. KN looks for answers by using annotation patterns and connecting one pattern to another (Figure 3). At this point students reach the multistructural level.

b. Point pattern components c

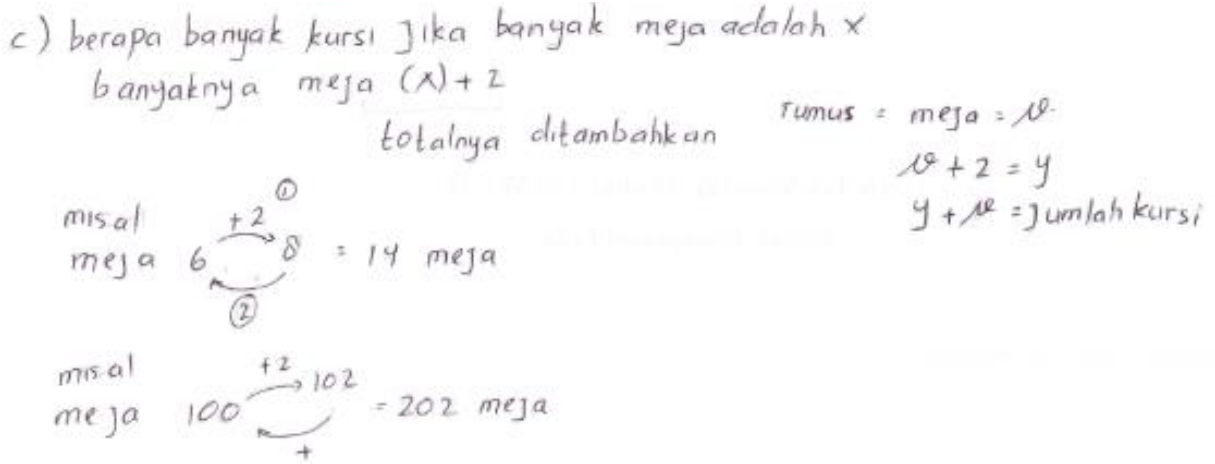

Figure 4. Results of TMA 1 Workmanship Components of the points pattern c

KN's answer to point c only uses two pieces of information, namely an example of 6 tables and 100 tables. KN can make relationships between known patterns but KN fails to make generalizations even though the pattern calculation is correct (Figure 4). In the question of point c, the thinking profile of students is at the multistuctural level.

ISSN 2459-9735 (print), ISSN 2580-9210 (online)

c. Point pattern components d

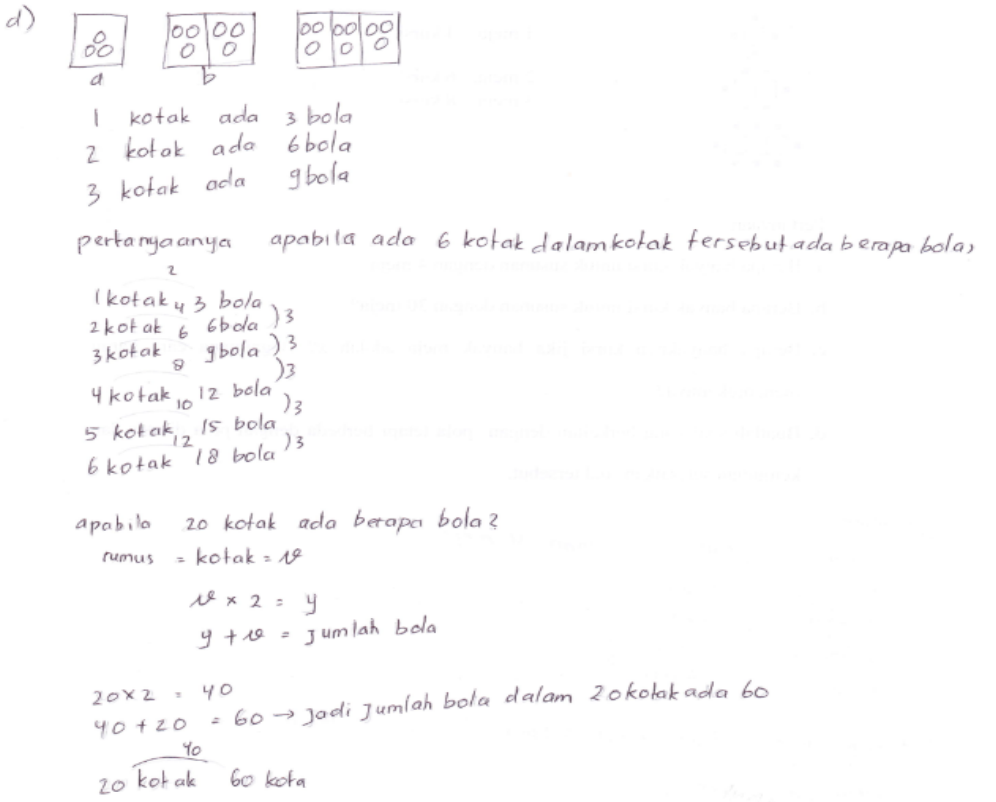

Figure 5. Results of TMA 1 Workmanship Pattern Component points d

Similar to points a, b, c, this student can make pattern problems that are still similar to the pattern questions above. However, KN failed to generalize about the problems he had made (Figure 5). This is in line with research (Ni'mah, 2016) that most children cannot express generalized patterns. At point d, the KN thinking profile is at the multisructural level where KN can use all known data and can provide a known pattern relationship. However, in generalization, KN cannot make generalization patterns.

2. Test Problems with Algebra 1 Component Variable

a. Variable Component points a

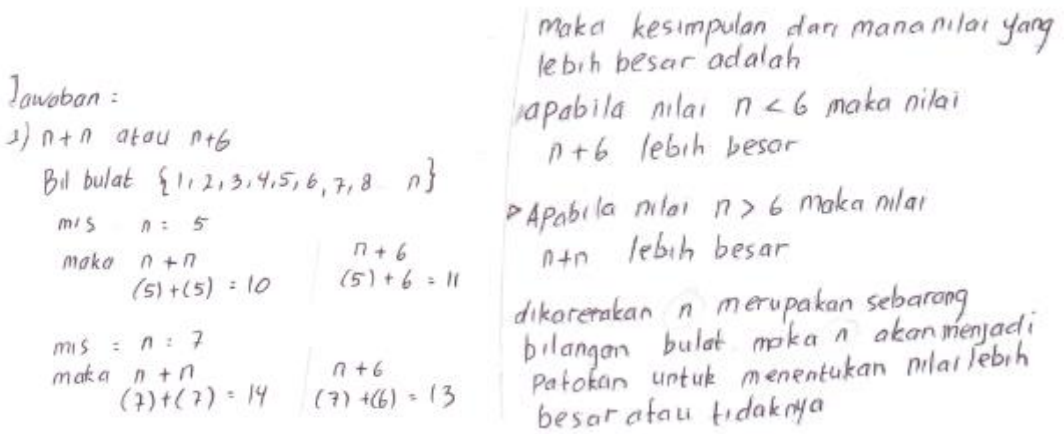

Figure 6. Results of TMA 1 Variable Component Component point a

ISSN 2459-9735 (print), ISSN 2580-9210 (online)

The answer to TMA 1 point a, KN is able to use all available data to find the data relationship. At this point the profile of KN thinking is at the relational stage (Figure 6).

b. Variable Component points b

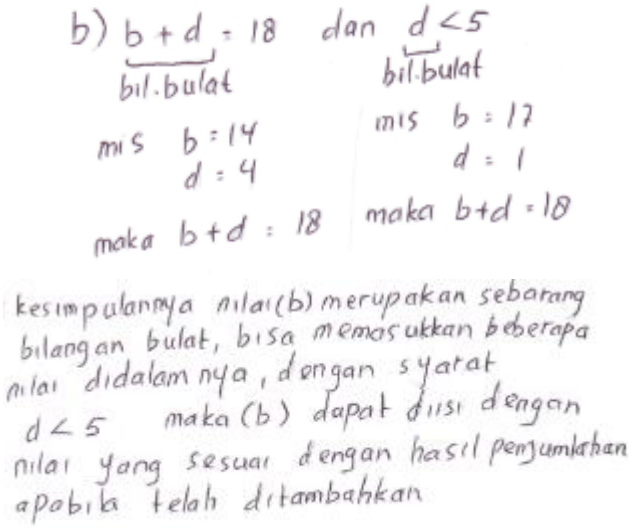

Figure 7. Results of TMA 1 Variable Components point b

The answer to TMA 1 component of the variable point b is that KN can assume the value of b into numbers, but KN cannot read the conclusions from the sample numbers that have been taken and cannot relate these numbers to the b variable (Figure 7). At this point, the KN thinking profile reaches a multistructural stage.

c. Component Variable Points c

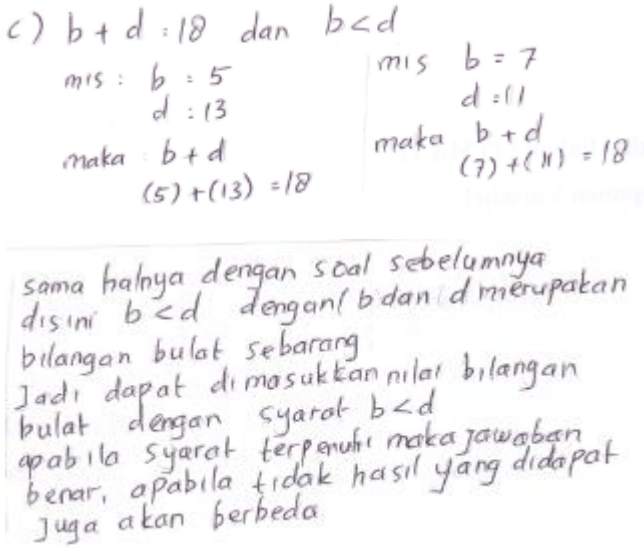

Figure 8. Results of TMA 1 Component Variable points c

The answer to TMA 1 component of the variable point c is broadly the same as point b, where KN can take the value of b into numbers, but KN cannot read the

ISSN 2459-9735 (print), ISSN 2580-9210 (online)

conclusions from the examples of numbers that have been taken and cannot connect these numbers with variable b (Figure 8). At this point, the KN thinking profile reaches a multistructural stage.

From the results of the first study, within two weeks the researchers returned to conduct research to match the data called triangulation. The results obtained are broadly the same as the results obtained in the Algebra Problem One Test. The following describes the results of TMA 1 and TMA 2 results in the table.

Table 1.Thinking Profile on Algebra Problem Test 1

Algebra Problem Test 1	**Thinking Profile according to SOLO Taxonomy**	**Highest Achievement of Bepikir Profile**
Pattern Components 1. a	*Multistructural*	
Pattern Components 1. b	*Multistructural*	*Multistructural*
Pattern Components 1. c	*Multistructural*	
Pattern Components 1. d	*Multistructural*	
Variable Components a	*Relational*	*Multistructural*
Variable Components b	*Multistructural*	*Relational*
Variable Components c	*Multistructural*	

Table 2.Thinking Profiles on an Algebra Problem Test 2

Algebra Problem Test 2	**Thinking Profile according to SOLO Taxonomy**	**Highest Achievement of Bepikir Profile**
Pattern Components 2. a	*Multistructural*	
Pattern Components 2. b	*Multistructural*	*Multistructural*
Pattern Components 2. c	*Multistructural*	
Pattern Components 2. d	*Multistructural*	
Variable Components a	*Relational*	*Multistructural*
Variable Components b	*Multistructural*	*Relational*
Variable Components c	*Multistructural*	

Students who have moderate mathematical abilities have a tendency to solve algebraic problems at the Multistructural and Relational level (table 1). This is in accordance with the results of the research conducted (Wahyuniar et al., 2018) in madrasah tsanawiyah students that students with moderate ability to solve algebra problem tests with a tendency to relational level. The same thing was also expressed (Jamil, 2017) that students with a level of relational thinking can take all the information provided into a coherent structure. Table 2 is the result of triangulation at another time with the same subject.

ISSN 2459-9735 (print), ISSN 2580-9210 (online)

SIMPULAN

The conclusion that can be drawn from this research is that the algebraic thinking profile of student mathematics teacher candidates with moderate ability is multistructural and relational based on the SOLO taxonomy. Referring to this, the treatment that can be done is that lecturers can choose teaching strategies so that the algebraic thinking profile of prospective mathematics teacher students with moderate math abilities can be improved. This is very important considering that these prospective teacher students will go directly to guiding students at school in the future.

DAFTAR PUSTAKA

Booker, G. (2009). Algebraic Thinking: Generalising Number and Geometry to Express Patterns And Properties Succinctly. *Algebraic Thinking: Generalising Number and Geometry to Express Patterns and Properties Succinctly*, 10–21.

Dindyal, J. (2004). Algebraic thinking in geometry at high school level: Students ' use of variables and unknowns. *27th Annual Conference of the Mathematics Education Research Group of Australasia*, *June 2004*, 183–190. http://hdl.handle.net/10497/14365

Gagnon, J. C., & Maccini, P. (2001). Preparing Students with Disabilities for Algebra. *TEACHING Exceptional Children*, *34*(1), 8–15. https://doi.org/10.1177/004005990103400101

Herstein, I. N. (1964). Topics in algebra "An algebraic system can be described as a set of object together with some operations for combining them." *Ginn and Company*.

Irawati, S., Studi, P., Matematika, P., Madura, U., & Madura, U. (2006). *Analisis Kesalahan Mahasiswa Calon Guru Matematika Dalam*.

Jamil, A. F. (2017). Peningkatan Level Berpikir Aljabar Siswa Berdasarkan Taksonomi SOLO Pada Materi Persamaan Linier Melalui Pemberian Scaffolding. *JURNAL ILMIAH MANDALA EDUCATION (JIME)*, *3*(1), 175–181.

Kamol, N. (2005). A Framework in Characterizing Lower Secondary School Students' Algebraic Thinking. *Unpublished Doctoral Dissertation). Srinakharinwirot University, Bangkok*.

Kriegler, S. (2008). Just what is algebraic thinking. *Retrieved September*, *10*, 2008.

Lim, H. L., & Noraini Idris. (2006). Assessing algebraic solving ability of form four students. *International Electronic Journal of Mathematics Education*, *1*(1), 55–76.

Linsell, C., Savell, J., Johnston, N., Bell, M., Mcauslan, E., & Bell, J. (2007). *Early algebraic thinking : links to numeracy*.

Moleong, L. J. (2007). Metodologi penelitian kualitatif edisi revisi. *Bandung: PT Remaja Rosdakarya*, *103*.

Napfiah, S. (2016). Berpikir Aljabar Mahasiswa Dalam Menyelesaikan Masalah Berdasarkan Taksonomi Solo Ditinjau Dari Kemampuan Matematika. *KALAMATIKA Jurnal Pendidikan Matematika*, *1*(2), 171. https://doi.org/10.22236/kalamatika.vol1no2.2016pp171-182

Ni'mah, K. (2016). Kesadaran struktur matematis anak pra sekolah pada aktivitas pola. *Jurnal Math Educator Nusantara: Wahana Publikasi Karya Tulis Ilmiah Di Bidang Pendidikan Matematika*, *2*(1).

ISSN 2459-9735 (print), ISSN 2580-9210 (online)

Ruggiero, V. R., & Ruggerio, V. R. (2004). *The art of thinking: A guide to critical and creative thought*. Pearson/Longman.

Sugiman. (2015). Peran Guru Matematika dalam Mewujudkan Siswa yang Konstruktif melalui Pemecahan Masalah. *Seminar Nasional Matematika Dan Pendidikan Matematika UNY*, 9–18.

Wahyuniar, L. S., Shofia, N., & Rochana, S. (2018). Proses Berpikir Aljabar Siswa Mts Kelas VIII Menurut Taksonomi Solo Ditinjau Dari Perbedaan Gender. *Jurnal AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, *7*(2), 275–282.

ISSN 2459-9735 (print), ISSN 2580-9210 (online)