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Algebraic thinking ability of grade VIII students using a Problem-Based Learning (PBL)

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Abstract
Students still have limited algebraic reasoning skills, so a learning model called Problem-Based Learning (PBL) is utilized as a teaching strategy to help student develop their algebraic thinking abilities. This study uses the learning model Problem-Based Learning (PBL) to the algebraic thinking skills of class VIII students. The method of research is descriptive qualitative research. The students in class VIII students of SMPN 1 Lahat participated in this study. Problem-Based Learning (PBL) worksheet in accordance with three algebraic thinking abilities: generational activities, transformational activities, and global, meta-level, and mathematical activities. Data for the study came from observations, interviews and written exams. Data from the results of observation sheets are used to see the emergence of indicators of students' algebraic thinking during learning with a total of 2 sessions; data from the results of written tests are used to categorize students' algebraic thinking abilities after learning, taking 2 students from each category, and interviews to clarify the results of students' answers. The findings of this study show that students possess a range of low, medium, and high levels of algebraic thinking ability. The result of the implementation learning model showed that 14 students were in the medium category and 17 students were in the low category.

Keywords: algebraic thinking skill; problem-based learning, student in class VIII

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I. Introduction

Algebraic thinking is one of the most important basic skills for solving mathematical problems. For students in grades 5-8, building a foundation for high-level formal learning by explicitly exploring algebraic concepts is important (NCTM, 1989). Algebraic thinking skills allow students to generalize patterns, symbols and numbers into the form of words, tables, diagrams, pictures and mathematical expressions. When students' algebraic thinking skills are optimal, they are more competent and know more about the uses and benefits of algebraic thinking skills (Misbahuddin et al., 2019). Supported by the opinion of Persada (2013), it is claimed that one aspect that contributes to students' ability to solve mathematical problems is the ability to think algebraically.

However, algebraic thinking skills are still low in Indonesia, as indicated by the 2011 TIMSS results, where the average score of the

ability level of students in Indonesia reached a score of 386, which is far from the 500 standards of the international average in the study (Ina et al., 2012). These results indicate that students' ability in Indonesia is still low in the algebra content area in TIMSS, representing 30% of the total content tested (Zaelani et al., 2019).

This can happen because primary school students from grades I to V only focus on the arithmetic thinking process. In contrast, students in grade VIII of junior high school must change the arithmetic thinking process to algebraic thinking (Hidayanto, 2014). Transitioning from arithmetic to algebraic thinking is the most challenging stage in students' mathematical life. The transition from arithmetic thinking to algebraic thinking needs to be bridged by a mathematics learning and instructional design in the classroom that can motivate the emergence of a transition of skills (Pratiwi & Kurniadi, 2018).

Because of the need for a learning model that can bridge the transition from arithmetic reasoning to algebraic reasoning to improve students' algebraic reasoning skills, according to Harti & Agoestanto (2019), a learning model that uses learner-centred learning methods is an appropriate learning model to be given to students in order to develop algebraic thinking skills. Problem-based learning (PBL) is one of the learning approaches that focus on problems as a starting point, followed by learner-centred learning, while the teacher becomes a facilitator in the learning process (Mustaffa et al., 2018). In line with Sermatan et al.'s (2018) research, the application of the problem-based learning (PBL) learning model can significantly improve students' algebraic thinking skills compared to students who receive conventional learning.

So this study wants to see how the algebraic thinking ability of students in the problem-based learning model with algebraic material that fits this learning model is the material of the system of equations of two variables (SPLDV), where SPLDV presents simple problems related to everyday life (Syafina & Pujiastuti, 2020).

Another study on the profile algebraic thinking ability on the material algebraic form of Qur'ani's research (2015) shows that there are a number of students at the junior secondary level with various kinds of difficulties for students in learning algebra and utilizing the ability to think algebraically. Farida and Hakim's (2021) research shows that many students still need to be able to meet the Graduate Competency Standards. This indicates that students' algebraic thinking ability still needs to improve due to their lack of understanding of the concept of algebra.

Based on this description, the researcher will research students' algebraic thinking skills using the Problem-Based Learning (PBL) learning model on the Two-Variable Linear Equation System (SPLDV) material.

II. Research Method

The type of research used in this study is descriptive qualitative research. According to Abdussamad (2021), qualitative research studies natural object conditions where the researcher is the key instrument, data collection techniques are triangulated, data analysis is inductive, and results focus on meaning rather than generalization. This study aimed to describe the algebraic thinking skills of students in Grade VIII using the Problem-Based Learning (PBL) model.

The implementation of the research was carried out by conducting learning for 2 sessions using the Problem-Based Learning (PBL) learning model first, followed by activities for conducting written tests consisting of 2 questions with Masala-based type questions and followed by conducting interviews followed by 6 students selected from students who have high, medium and low abilities seen from the implementation of written tests. Furthermore, the data will be analyzed and described qualitatively.

The data collection techniques used in this study were observation, tests of algebraic thinking ability and interviews. Data from the

results of observation sheets are used to see the emergence of indicators of students' algebraic thinking during learning with a total of 2 sessions; data from the results of written tests are used to categorize students' algebraic thinking abilities after learning, taking 2 students from each category, and interviews to clarify the results of students' answers. According to Kieran, the analysis of algebraic thinking ability is based on tests based on indicators of algebraic thinking ability, which consist of generational activities, transformational activities, and global, meta-level, and mathematical activities. The following table 1 shows the criteria for algebraic thinking ability.

Table 1. Algebraic thinking ability criteria

category	Interval Value
High	$66{,}67 < n \leq 100$
Medium	$33{,}33 < n \leq 66{,}67$
Low	$0 \leq n \leq 33{,}33$

III. Results and Discussion

The results of the research carried out at SMP Negeri 1 Lahat were described to determine the algebraic thinking ability of students involving students from Class VIII, totalling 31 students, after analyzing the data from the algebraic thinking test results and interviews with students in each group of high, medium and low levels.

Based on the Algebraic Thinking Ability Test results, 31 students attended, 9 entered the medium-level criteria, and 21 entered the low-level criteria. The results of the algebraic thinking ability test of Class VIII students at SMPN 1 Lahat are still dominated by students in the low category.

The data on students' algebraic thinking ability is further analyzed based on students' responses to the algebraic thinking ability test and the interview results. The following table summarises the appearance of indicators of students' algebraic thinking ability when solving test questions.

Table 2.Summary of the appearance of algebraic thinking ability

Indikator	Subjek			
	NK (sedang)	AE (sedang)	AP (rendah)	FD (rendah)
aktivitas generasional (generational activities)	✓	✓	✓	✓
transformasional (transformational activities)	✓	✓	-	-
Global, meta-level, mathematical activities (aktivitas matematika, meta-level, global)	✓	✓	-	-

Keterangan:
✓ : Indikator muncul
- : indikator tidak muncul

Table 2 shows that in the medium and low criteria, the indicator of algebraic thinking ability that appears most often in students is generational activity in the form of students determining the meaning of variables and presenting problems in the form of relationships between variables.

NK Algebraic Thinking Ablitiy Analysis

According to the information from the maths teacher, NK is an active and intelligent child. During the 2 sessions, NK was always present, and in the learning process, NK also looked active. From the test results obtained, NK is a student with moderate criteria. The following are the test answers to the test given by student NK

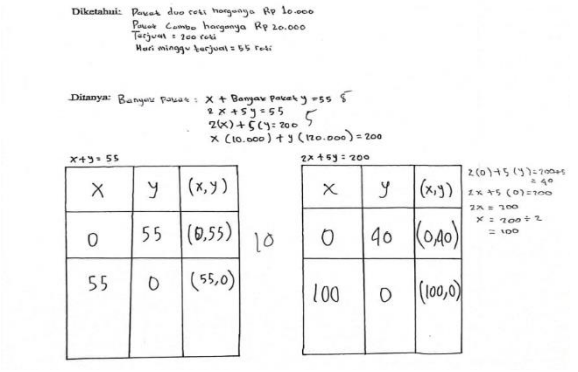

Figure 1. NK test result

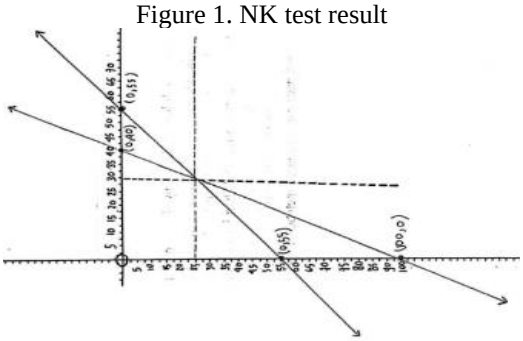

Figure 2. Graphical result form NK students

In the answers NK wrote above, NK raised indicators of generational activities, transformational activities, and global, meta-level, and mathematical activities. In the indicators of generational activities and global, meta-level, mathematical activities, NK could use the information obtained to express it in an equation. It's just that when determining the variables, NK forgot to write down what the x-variable is and what the y-variable is, and NK also needed to remember the main problem of the given problem. However, when interviewed, NK's answer was correct, and NK knew where the error was on the answer sheet, which is supported by the following interview extract.

Teacher : *Darimana NK mendapatkan variabel x dan y?*

Student : *dari paket roti duo dan paket combo, paket roti dua adalah x dan paket roti combo adalah y.*

Teacher : *Apakah NK tahu permaslahan pada soal?*

Student : *permasalahannya adalah berapa total pendapatan toko roti pada hari itu dengan metode grafik..*

Teacher : *apakah NK tahu bahwa nilai x pada persamaan 1 akan mempengaruhi nilai x pada persamaan 2?*

Student : *tahu, karena nilai x adalah banyak roti duo dan kedua persamaan sama-sama ada banyak roti duo.*

Teacher : *Apakaj NK tahu makna dari titik potong grafik yang dibuat NK?*

Student : *tahu, 30 dan 25 merupakan banyak paket yang terjual saat itu 30 itu nilai dari y dan 25 nilai dari x.*

From the interview results, NK was able to explain and give the right reasons why NK could sell a lot of bread packets at that time.

For the transformational indicators (transformational activities), NK was able to operate the algebraic form in the form of 2 equations that NK gets from the problem, NK is also able to make tables and draw graphs of the 2 equations that NK gets. The following interview extract supports this.

Teacher : *Bagaimana NK mendapatkan nilai y=55 pada tabel persamaan 1?*

Student : *Dengan memasukan nilai x = 0 ke x+y=55 sehingga didapatkan nilai y=55.*

Teacher : *Bagaimana NK mendapatkan nilai x=55 pada tabel persamaan 1?*

Student : *sama seperti mencari nilai y dengan memasuka y = 0 ke x+y=55*

Teacher : *Bagaimana NK mendapatkan nilai x=100 dari tabel persamaan 2?*

Student : *dengan memasukan nilai y=0 ke 2x+5y=200, terus didapatkan 2x = 200 maka didapatkan x=100 hasil dari 200 dibagi 2.*

According to the interview results, NK also understood the problem; it's just that at the time, after working on the graph, NK did not write the conclusion of the problem. However, during the interview, NK was able to write the conclusion very well. Below is an extract from NK's interview.

Teacher : *Apakah NK tahu kesimpulan atau inti dari permasalahan tersebut?*

Student : *pada soal 1 mencari total pendapatan toko roti dengan metodegrafik namun NK belum menuliskan kesimpulannya, dan pada soal 2 mencari total berat kaleng minyak pertiga dengan metode grafik*

One of the mistakes students make when writing conclusions is that they need to remember the problem or what the problem asks and do not need to do it carefully.

FD Algebraic Thinking Ablitiy Analysis

According to the maths teacher, FD is an active child but lacks understanding in maths subjects. Based on the algebraic thinking test results, FD is included in the low-criteria pupils. During 2 sessions, FD was always present but could not cooperate with his group mates. Below are the test results of the FD students.

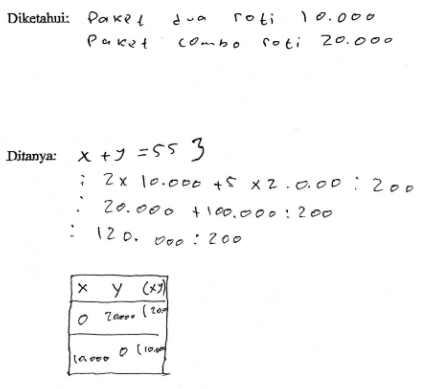

Figure 3. FD Test result

Based on the answers of FD learners, only indicators of generational activities are raised. FD can already express the information in the problem in the form of an equation, but the answer written by FD needs to show whether FD understands the given problem. When interviewed, FD learners admit to difficulties in answering problems, which is supported by the following interview results:

Teacher : *Apakah FD paham mengenai permasalahan yang diberikan?*
Student : *tidak paham pak*
Teacher : *Apakah permasalahan ini sulit?*
Student : *sulit*
Teacher : *Apakah FD tahu inti permasalahan yang diberikan?*
Student : *mengenai keuntungan roti-roti*
Teacher : *Bagaimana FD menuliskan persamaan ini?*
Student : *dapat dari soal pada kalimat total paket roti yang terjual 55 paket*
Teacher : *Kenapa tidak melanjutkan untuk menjawab?*
Student : *tidak tahu apa yang mau ditulis*

The results and interviews show that FD needs help understanding the meaning of the given problems. FD knows that the given problem is to find the profit of the problem, but FD only focuses on the numbers in the problem. So FD found it difficult to solve the given problem, so FD did not use the solution that had been taught in the previous 2 sessions.

Observation

Observations were carried out for 2 meetings during learning activities. Observations were made to determine students' activities during the implementation of learning on PBL-based SPLDV material. The observation sheet used contains 10 statements related to the learning process. The following are the results of observations for two meetings. shows the criteria for algebraic thinking ability.

Table 3. Percentage result of observation sheet

Indikator	Persentase	
	Pertemuan 1	Pertemuan 2
Generational activities (aktivitas generasional)	68,96% Tinggi	78,49% Tinggi
Transformational activities (aktivitas transformasional)	77,01% Tinggi	73,38% Tinggi
Global meta-level activities (aktivitas meta-level global)	31,03% Rendah	56,98% Sedang

Based on the table above, at the first meeting, the percentage obtained averaged 59%, which means that the activity towards implementing learning is categorized as good. At the first meeting, it can be seen that the indicators that often appear are transformational activities; this shows that 77.01% of students or almost all students have raised transformational indicators (transformational activities). The indicators that rarely appear in learners are Global, meta-level, mathematical activities (mathematical activities, meta-level, global), where 31.03% or almost half of the learners have not raised indicators of Global, meta-level, mathematical activities (mathematical activities, meta-level, global).

Even though in the first session the students need time to get used to different activities and ways of learning, which are different from the usual sessions in the students' class. One of them is when forming groups and discussing with groups in solving problems on LKPD. However, in the second meeting, the students started to get used to the learning activities.

Discussion

Based on the results of data analysis, it is found that the algebraic thinking ability of students increases and is dominated by students in the low category. This study's results align with the results of Qur'ani's research (2015), which states that there are a number of students at the junior secondary level who do not master

algebra material. This research shows that there are various kinds of difficulties for students in learning algebra and in utilizing the ability to think algebra. This is in line with the result of Farida and Hakim's (2021) research, which states that many students still need to meet the Graduate Competency Standards, which indicates that students' algebraic thinking ability still needs to improve.

IV. Conclusion

Based on the research conducted, the researcher concludes that the thinking ability of the students of Class VIII with the Problem-Based Learning (PBL) model on SPDLV material at SMPN 1 Lahat is still at a moderate level. This may be because from the Algebraic Thinking Ability Test results, 9 students are medium criteria and 21 students are low criteria. In learning, it is good where indicators that appear frequently are generational activities and transformational activities. Meanwhile, indicators that rarely appear are global, meta-level, and mathematical activities (mathematical activities, meta-level, global). In the observation results, the indicator of generational activities is good, which indicates that the appearance of these indicators is in the high category and some students are able to express important information in the form of algebraic equations. The indicator of transformational activities is very good, indicating that the occurrence of these indicators is included in the high category and that some students can transform algebraic forms into tables and graphs to find the point of intersection on the graph. Meanwhile, the indicator of global, meta-level, and mathematical activities could be higher, which shows that the indicator is still in the moderate category, and only a few students were able to model the given problems.

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Reference

Angriani. (2017.). *Kemampuan berpikir aljabar dan self-efficacy matematis siswa SMP melalui pendekatan concrete-pictorial-abstract (CPA)*. (S2 Thesis, Universitas Indonesia,2017) Diakses dari http://repository.upi.edu/30401/

Farida, I., & Hakim, D. L. (2021). Kemampuan berpikir aljabar siswa SMP pada materi sistem persamaan linear dua variabel (SPLDV). *JPMI (Jurnal Pembelajaran Matematika Inovatif)*, 4(5), 1123-1136.

Harti, L. S., & Agoestanto, A. (2019). Analysis of algebraic thinking ability viewed from junior high school students' mathematical critical thinking ability on problem-based learning A R T I C L E I N F O. *Unnes Journal of Mathematics Education*, *8*(2), 119–127. https://doi.org/10.15294/ujme.v8i2.32060

Hidayanto, E. (2014). *Transisi dari berpikir aritmetis ke berpikir aljabaris.* (Disertasi. Malang: PPS Universitas Negeri Malang, 2014).

Ina V.S. Mullis, Michael O. Martin, Pierre Foy, and A. A. (2012). Timss 2011 international results in mathematics. *In TIMSS & PIRLS International Study Center* (Vol. 2012, Issue 136).

Kementerian Pendidikan dan Kebudayaan. (2016). Peraturan menteri pendidikan dan kebudayaan republik indonesia nomor 24 tahun 2016 tentang kompetensi inti dan kompetensi dasar.

Mustaffa, N., Haruzuan, N., Said, M., Ismail, Z., & Tasir, Z. (2018.). The effect of integrating algebraic thinking in problem-based learning via virtual environment among secondary school students.

Nacional Council of Teacher of Mathematics (NCTM). 2000. *Principles and standars for school mathematics.* USA: NCTM

Pratiwi, V., Herman, T., & Lidinillah, A. M. (2017). Upper elementary grades students' algebraic thinking ability in Indonesia. In *IJAEDU-International E-Journal of Advances in Education: Vol. III*. http://ijaedu.ocerintjournals.org

Qur'ani, Z. M. W. (2015). Analisis kemampuan

berpikir aljabar siswa pada materi sistem persamaan dan pertidaksamaan linier. Surabaya: UIN Sunan Ampel Surabaya

Sermatan, E., Fahinu, & Zamsir. (2018). Peningkatan kemampuan penalaran aljabar siswa melalui problem-based learning dan konvensional pada siswa madrasah tsanawiah. *Jurnal Pendidikan Matematika*.

Sugiyono. (2019). Metode penelitian kualitatif kuantitatif dan R&D (Sutopo (ed.); Kedua). ALFABETA

Syafina, V., & Pujiastuti, H. (2020). Analisis kemampuan matematis siswa pada materi SPLDV. *Majum* 7 (2).

Zaelani, M., K., Attin Warmi., & Redo M.R. (2019). Berpikir aljabar siswa SMP dalam menyelesaikan masalah aljabar berbasis TIMSS. *Prosiding Seminar Nasional Matematika dan Pendidikan Matematika Sesiomadika.*