

Algebra Word Problems Viewed From Secondary School Student's Self-Regulated Learning

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Abstract

The ability of junior high school students to solve algebra word problems in learning mathematics is an important part and must be mastered well. However, the results of observations carried out by researcher at one of the junior high schools in Yogyakarta showed that students had difficulty solving and understanding algebra world problems. In addition, when working on assignments given by the teacher, students tend to rely on the results of their friends' work without showing the initiative to learn independently. Therefore, this research aims to analyze students' difficulties in solving algebra word problems in terms of their self-regulated learning. This research is a descriptive qualitative research with the research subjects being all class VII students in one of the junior high schools in Yogyakarta. The data collection techniques in this research used a self-regulated learning scale and a learning difficulties test. The research results show that students with high self-regulated learning are able to solve problems in algebra word problems, but are less careful in obtaining the final results. Students in the middle self-regulated learning category are experiencing difficulties in writing descriptions and simplifying and operating algebraic multiplication and division operations. Meanwhile, students with low self-regulated learning have difficulty understanding the concept of algebraic operations and applying it in the context of algebraic word problems. Meanwhile, the average self-regulated learning of students at one of the junior high schools in Yogyakarta is in the medium category. It is hoped that the research findings will provide an idea for teachers to train students' self-regulated learning so that their ability to solve algebra word problems can be even better.

Keywords: algebra word problems, self-regulated learning, student's difficulties, learning mathematics

Abstrak

Kemampuan siswa SMP menyelesaikan soal cerita aljabar dalam pembelajaran matematika, menjadi salah satu bagian penting dan harus dikuasai dengan baik. Akan tetapi, hasil observasi yang dilakukan peneliti di salah satu sekolah menengah pertama di Yogyakarta diperoleh fakta bahwa siswa mengalami kesulitan dalam menyelesaikan dan memahami soal cerita aljabar. Selain itu, saat mengerjakan tugas yang diberikan oleh guru, siswa cenderung mengandalkan hasil pengerjaan teman tanpa menunjukkan inisiatif untuk belajar mandiri. Oleh karena itu penelitian ini bertujuan untuk

menganalisis kesulitan siswa dalam menyelesaikan soal cerita aljabar ditinjau dari kemandirian belajar mereka. Penelitian ini merupakan penelitian kualitatif deskriptif dengan subjek penelitian seluruh siswa kelas VII di salah satu sekolah menengah pertama di Yogyakarta. Adapun teknik pengumpulan data dalam penelitian ini menggunakan skala sikap kemandirian belajar dan tes kesulitan belajar. Hasil penelitian menunjukkan bahwa siswa dengan kemandirian belajar tinggi mampu menyelesaikan permasalahan pada soal cerita aljabar, namun kurang teliti dalam memperoleh hasil akhir. Siswa dengan kategori kemandirian belajar sedang mengalami kesulitan dalam menuliskan penjabaran dan menyederhanakan serta mengoperasikan operasi perkalian dan pembagian aljabar. Sementara itu, siswa dengan kemandirian belajar rendah mengalami kesulitan dalam memahami konsep operasi aljabar dan mengaplikasikannya dalam konteks soal cerita aljabar. Adapun rata-rata kemandirian belajar di salah satu sekolah menengah pertama di Yogyakarta berada pada kategori sedang. Temuan penelitian diharapkan memberikan gambaran bagi para guru untuk melatih kemandirian belajar siswa agar kemampuan mereka dalam memecahkan soal cerita aljabar dapat lebih baik lagi.

Kata kunci: Aljabar, Kemandirian belajar, Kesulitan siswa, Pembelajaran Matematika

Pendahuluan

Indonesia takes a test which is routinely held every 3 years by Trends in International Mathematics and Science Study (TIMSS), an institution tasked with measuring and comparing the mathematical abilities of students from all over the world. The results of the TIMSS test carried out in 2015 showed that Indonesia was ranked 44th out of 49 countries that took the test, this means that Indonesia's position is still low compared to the 43 countries that are above Indonesia. In 2019, Indonesia did not participate in the TIMSS test. Based on the results of TIMSS 2015 above, it proves that the quality of education in Indonesia is still relatively low and needs to be improved.

Low quality education will have an impact on low human resources as well. Even though education is an important pillar for human survival in the nation and state (Normina, 2017). With education, it is hoped that we will be able to form creative and innovative human resources (Hasibuan & Prastowo, 2019). Education is not just teaching which is often interpreted as a process of transferring knowledge, transforming values, forming attitudes and personality with the various aspects it covers, but teaching is more oriented towards the formation of specialists or certain fields so that attention and interest are more technical in nature. (Nurkholis, 2013). Therefore, the quality of education is very important in a country,

including in Indonesia because it will be a benchmark for the nation's progress and development.

Education that is able to support progress and development in the future is education that is able to develop the potential of its students. So that later being able to apply what is learned at school can be a provision in facing problems in everyday life and in future life (Sholihah & Mahmudi, 2015). One of the subjects that is very influential in dealing with everyday life problems is mathematics (Salvia et al., 2022). Mathematics is a science that plays an important role in facing various challenges (Susanti & Syam, 2017). Therefore, mathematics has become a scientific discipline that is applied at all levels of education. Mathematics requires students to have a strong understanding of the material in structuring reasoning and decision making (Siagian, 2016). According to Cahani and Effendi (2019) Mathematics is a structured subject and requires a lot of thinking, and this is considered a difficulty in learning it. Many students are less interested and think mathematics is difficult (Amallia & Unaenah, 2018).

Students' perceptions of algebra in mathematics as something difficult are still a challenge in Indonesian education. Learning difficulties occur when students face difficulties during the learning process, for example not understanding the material being taught (Munirah, 2018). However, basic knowledge in learning algebra mathematics will influence the development of advanced concepts (Mendrofa & Mendrofa, 2022). Without mastery of basic competencies, students will experience learning difficulties in learning mathematics (Indrawati, 2019). This learning difficulty will have an impact when students solve math problems, especially when solving problems related to story problems. Mathematics story problems are questions related to contextual problems which in the process of working on them require a deeper thought process so that students can understand and determine what is known, asked questions and can find appropriate solutions (Yunia & Zanthly, 2020). Based on these problems, the role of teachers is very important in guiding students so that in the future they do not face difficulties.

Teachers have an important role in forming quality human resources with high potential. Teachers and students themselves cannot be separated, this is because teachers and students really need each other. Teachers have the responsibility to guide students to achieve

learning goals, for example, teachers encourage students to think critically and creatively in the learning process, increase enthusiasm for learning, increase students' interest and enthusiasm for learning. (Asmara & Nindianti, 2019). Apart from the teacher's role in the learning process, one other important aspect in a learning process is student's self-regulated learning (Tasaik & Tuasikal, 2018).

Student's self-regulated learning is needed so that students have a sense of responsibility in managing and disciplining themselves, as well as developing the ability to learn of their own accord. (Afiani, 2017). According to Rachmayani (2020), student's self-regulated learning is the main key in developing their ability to solve mathematical problems with individual effort and ability self-regulated learning can be said to be a student's learning activities and their continuity is driven by their own will, their own choice and their own responsibility (Handayani & Hidayat, 2019). Students are said to be able to learn independently when they are able to complete assignments without relying on the help of others (Nahdi, 2017). By self-regulated learning, students are expected to be able to solve various kinds of mathematical problems with the effort and ability of each individual.

One of the difficulties referred to is that students cannot determine what is known and asked from the word problem given, so when solving the problems the teacher has to explain by rewriting what is known and asked about the questions. When students do assignments given by the teacher, they prefer to see the answers their friends have done rather than doing and studying themselves. Students also do not have the initiative to study independently, look for other learning sources and work on questions other than those given by the teacher. This is supported by research conducted by Rofi'ah et al. (2019) regarding the analysis of student errors in solving algebra word problems. Based on the background explanation described above, this research was conducted to determine the factors that cause students to experience learning difficulties and to determine the description of students' learning difficulties in algebra word problems in terms of student's self-regulated learning.

Method

The method used in this research is a descriptive qualitative research method. This research was carried out at a junior high school in Yogyakarta in the 2023/2024 academic year. In this research, researcher used instruments in the form of self-regulated learning attitude

scale sheets and learning difficulty test questions. The subjects used in this research were class VII B which consisted of 33 students. This research was carried out in four stages of research procedures which include: 1) Preparation stage; 2) Implementation stage; 3) Data analysis stage; and 4) Conclusion stage.

Student's self-regulated learning attitude scale provided consists of 15 statement items with four different answer choices. The test questions consist of 2 algebra word problem in description form. The scale used in this attitude scale is the Likert scale. The Likert scale is used to measure attitudes, opinions, perceptions of a person or group of people about something (Sugiyono, 2015). The alternative Likert scale answer scores used in this research are Very Often (V), Often (O), Sometimes (S) and Never (N).

Meanwhile, grouping categories of student's self-regulated learning uses self-regulated learning grouping criteria adapted from research (Isroah & Sumarsih, 2013). The grouping of student's self-regulated learning categories can be seen in the table below.

Table 1. Student's Self-Regulated Learning Categories

Student's self-regulated learning categories	Categories
$Mi + SDi < x \leq Mi + 3SDi$	High
$Mi - 1 SDi < x \leq Mi + 1SDi$	Medium
$Mi - 3 SDi < x \leq Mi - 1SDi$	Low

Mi = Mean; SDi = Standard Deviation; x = self-regulated learning score

From Table 1, students who have self-regulated learning scores between the mean and mean + 3 times the standard deviation are in the high category. Students who have self-regulated learning scores between the mean - 1 time the standard deviation and mean +1 time the standard deviation are in the medium category. Meanwhile, students who have self-regulated learning scores between the mean - 3 times the standard deviation and mean -1 time the standard deviation are in the low category.

Data from the results of the self-regulated learning attitude scale are analyzed according to the scores obtained. These results will be used as a reference for selecting research subjects who will be grouped into three self-regulated learning categories, namely the high self-regulated learning category, the medium self-regulated learning category and the low self-regulated learning category. After grouping them based on self-regulated learning category,

the researcher chose 3 students to take the algebra story questions test, namely 1 student with the high self-regulated learning category, 1 student with the medium self-regulated learning category and 1 student with the low self-regulated learning category. The subject selection is relevant to the research conducted by Purwanti & Pujiastuti (2020) namely, the subjects taken included 1 student in the high category, 1 student in the medium category and 1 student in the low category. After selecting three research subjects, the results of completing the learning difficulties test for the three students were then analyzed based on the students' work in understanding the problems in the questions, namely looking at the students' answer sheets whether the students were able to write down or determine what was known and asked as well as the resolution of the problems presented. .

Results and Discussion

The research results were analyzed to determine students' difficulties in solving algebra story problems in terms of self-regulated learning. The data used to analyze student's self-regulated learning uses the acquisition of attitude scale scores. Meanwhile, data to analyze students' difficulties in solving algebra word problems uses test results.

The following is a grouping of self-regulated learning categories after being entered into the formula.

Tabel 2. Results of grouping self-regulated learning categories

self-regulated learning	categories
$45 < x \leq 60$	High
$30 < x \leq 45$	Medium
$15 < x \leq 30$	Low

From Table 2, students who have self-regulated learning scores between over 45 and 60 are in the high category. Students who have self-regulated learning scores between over 30 and 45 are in the medium category. Meanwhile, students who have self-regulated learning scores between 15 and 30 are in are in the low category.

Based on filling in the attitude scale, the results obtained from the attitude scale for student's self-regulated learning are shown in Table 3.

Table 3. Results of filling in the self-regulated learning attitude scale

No	Students' Name	Score	Category
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1	DDS	53	High
2	KAG	47	High
3	VDK	46	High
4	CVA	45	High
5	LSP	44	Medium
6	NBQ	43	Medium
7	ALS	41	Medium
8	HOH	41	Medium
9	TLL	40	Medium
10	APNP	38	Medium
11	HRA	38	Medium
12	CRY	37	Medium
13	DMNS	37	Medium
14	IM	37	Medium
15	NXD	37	Medium
16	KYK	36	Medium
17	PAF	36	Medium
18	SRM	36	Medium
19	MJH	35	Medium
20	GNN	34	Medium
21	HDS	34	Medium
22	KR	33	Medium
23	COF	32	Medium
24	OAN	32	Medium
25	AGH	31	Medium
26	ZMK	30	Medium
27	NA	29	Low
28	NAW	27	Low
29	NDT	26	Low
30	FAD	25	Low
31	NJP	25	Low
32	ZKR	22	Low

Based on the table obtained, it can be seen that there are 4 students with high self-regulated learning, 22 students with medium self-regulated learning and 6 students with low self-regulated learning. The percentage of students' self-regulated learning can be seen in [Table 4](#).

Tabel 4. Percentage of students' self-regulated learning

No	Self-Regulated Learning Category	Percentage (%)
1	High	12.50
2	Medium	68.75
3	Low	18.75

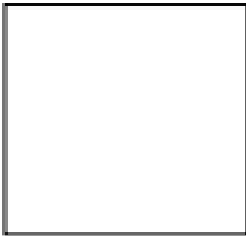
From [Table 4](#), it can be seen that 12.50% of students have a high level of self-regulated learning, while 68.75% of students have a medium level of self-regulated learning and 18.75% of students have a low level of self-regulated learning. Based on the results of the percentage of self-regulated learning attitude scale obtained, it can be seen that student's self-regulated learning needs to be increased. This is supported by research conducted by Rahayu and Aini (2021) which states that student's mathematical self-regulated learning needs to be increased so that every indicator of self-regulated learning is achieved well, one of which is by creating learning conditions that are conducive to growing and increasing student's self-regulated learning, so that mathematics learning goals can be achieved.

The learning difficulties test was distributed to three research subjects, namely VDK is a student in the high self-regulated learning category, OAN is a student in the medium self-regulated learning category and NJP is student in the low self-regulated learning category. The test questions given are algebra word problems form which contain problems that exist in everyday life problems. The learning difficulties test instrument used in this research is shown in [Figure 1](#).

Penilaian Harian Individu

Kerjakan soal-soal di bawah ini dengan tepat beserta langkah penyelesaiannya!

1. Pak Yono memiliki sebidang tanah dengan bentuk dan ukuran sebagai berikut:



$(x+5) \text{ m}$

$(x+8) \text{ m}$

Tentukan keliling dan luas tanah Pak Yono tersebut !

2. Pada saat mati listrik suhu kulkas adalah $(10x+20)^{\circ}\text{C}$. Setelah listrik nyala, suhu kulkas tersebut turun $(5x+5)^{\circ}\text{C}$.

Berapa derajatkah suhu kulkas saat ini (saat listrik nyala) dalam Reamur?

Figure 1. Learning difficulties test instrument

Of the 2nd instrument items tested, after being analyzed based on the results of the work, the subjects consisting of students with high, medium and low self-regulated learning showed that they experienced difficulty in solving the algebra story problems. The difficulties experienced by students in working on this test questions are as follows:

1. Student with the High Self-Regulated Learning Category

Students with high self-regulated learning experienced little difficulty in solving question number 1.

Diketahui =	$P = (x + 8)$ cm
	$L = (x + 5)$ cm
Ditanya =	a. Keliling
	b. Luas
Jawab:	
$K = 2(P + L)$	
	$= 2((x + 8) + (x + 5))$
	$= 2(x + x) + (8 + 5)$
	$= 2(2x + 13)$ cm
$L = (P \times L)$	
	$= (x + 8)(x + 5)$
	$= x^2 + 5x + 8x + 40$
	$= x^2 + 13x + 40$ cm ²

Figure 2. High level self-regulated learning student's answer of number 1

Based on Figure 2, it can be seen that VDK, namely student with a high level of self-regulated learning, are quite capable of fulfilling and solving problems in the questions, but when calculating the final results, VDK didn't complete them until the algebraic multiplication stage.

Diketahui =	lampu mati suhu kulkas = $(10x + 20)$ °C
	lampu dinyalakan suhu kulkas = $(5x + 5)$ °C
Ditanya =	Berapa derajat suhu kulkas saat ini dalam reamur?
Jawab:	
S. kulkas =	$(10x + 20) - (5x + 5)$
	$= (10x + 20) + (-5x - 5)$
	$= 10x - 5x + 20 - 5$
	$= 5x + 15$ °C
Reamur =	$\frac{4}{5}(5x + 15)$
	$= (\frac{4}{5} \cdot 5x) + (\frac{4}{5} \cdot 15)$
	$= 4x + 12$ °R

Figure 3. High level self-regulated learning student's answer of number 2

Based on figure 3 of the VDK s answer, it can be seen that when solving question number 2, VDK did not experience difficulty in writing explanations and simplifying the algebraic forms of addition and subtraction. It's just that VDK didn't write down the units of results required in the questions and didn't write enough conclusions from the answers they get.

2. Student with the Medium Self-Regulated Learning Category

Student with a medium level of self-regulated learning, experienced little difficulty in solving questions number 1 and 2.

<input type="checkbox"/>	Panjang = $(x+8)$	$= 2(p+l) = 2(x+8+x+5)$
<input type="checkbox"/>	Lebar = $(x+5)$	$= 2(x+x) + (8+5)$
<input type="checkbox"/>		$= 2(2x) + (13)$
<input type="checkbox"/>	Ditanya = keliling	$= 4x + 26$
<input type="checkbox"/>	luas	$= (p \times l) = (x+8 \times x+5)$
<input type="checkbox"/>	Jawab: keliling = $4x+26$	$= (x+x) \times (8+5)$
<input type="checkbox"/>	luas = $26x$	$= 2x \times 13$
<input type="checkbox"/>		$= 26x$

Figure 4. Medium level self-regulated learning student's answer of number 1

Based on Figure 4, it can be seen that OAN student did not understand the concept of algebraic multiplication operations. This was reflected when OAN answered the problem of determining the area of square land by knowing the length and width in algebraic form. In solving this problem, OAN directly added and multiplied variables and constants without paying attention to the position and brackets in the problem.

<input type="checkbox"/>	2	Diketahui = $(10x+20) \text{ cm} - (5x+5) \text{ cm}$
<input type="checkbox"/>		$= (10x-5x) - (20+5)$
<input type="checkbox"/>		$= (5x - 25) \times \frac{4}{5}$
<input type="checkbox"/>		$= 5x - 12$

Figure 5. Medium level self-regulated learning student's answer of number 2

Based on Figure 5 of OAN's answer of number 2, it can be observed that the student had difficulty understanding how to write explanations and simplify algebraic forms in the form of addition and subtraction. From the answers above it can also be seen that OAN had difficulty operating the algebraic forms of division and multiplication. This can be seen from the answers of OAN where when carrying out multiplication and

division operations he only do the numbers next to the multiplier subject. In fact, when an algebraic form is in the same bracket, the same treatment must be done to each number in the bracket.

3. Student with the Low Self-Regulated Learning Category

Student with low level of self-regulated learning, experienced difficulty in solving questions number 1 and 2.

	Panjang = $(x + 5)$
	Lebar = $(x + 8)$
	= $5(p + l)$
	= $(p \times l)$
	Ditanya = 'ceiling
	= lebar = <u>$x + 13$</u>

Figure 6. Low level self-regulated learning student's answer of number 1

Based on Figure 6 of NJP's answers above, it can be seen that NJP, one of the students in the low level self-regulated learning category, experienced difficulty in solving the problem in question number 1. NJP was able to determine what was known and asked in the question, but at the completion stage, he was confused and immediately wrote the final answer without there are clear solution steps. The final results written by NJP was also not correct. From these answers it can be analyzed that NJP did not yet understand the concepts in algebraic operations.

	Suhu malam adalah $(10x + 20)^{\circ}\text{C}$ lampu lampu yang
	Diyakinkan adalah turun $(5x + 5)^{\circ}\text{C}$
	Suhu yang tinggi = $(10x + 20)^{\circ}\text{C}$
	Suhu yang turun = $(5x + 5)^{\circ}\text{C}$
	tinggi = $(10x + 20)^{\circ}\text{C}$
	turun = $(5x + 5)^{\circ}\text{C}$
	Jadi berartinya dalam fitur
	= $(15x + 25)^{\circ}\text{C}$

Figure 7. Low level self-regulated learning student's answer of number 2

Based on Figure 7, it can be seen that NJP could understand the meaning of the question, could determine what is known and be asked to answer the problem in the question. However, NJP experienced the same difficulty when answering this question.

When determining the solution to question number two, he also immediately wrote the final answer without any clear solution process and the answer he wrote was not correct. So that the same conclusion is obtained, NJP still did not understand the concepts of arithmetic operations, including addition, subtraction, multiplication and algebraic division.

Based on the analysis of students' difficulties in solving algebra word problems in terms of student's self-regulated learning, it shows that the majority of students have self-regulated learning in the medium category (68.75%). Students with high self-regulated learning experienced little difficulty in algebra word problems, while students with medium and low self-regulated learning showed more significant difficulties. Common difficulties faced include understanding the concept of algebraic operations, elaborating and simplifying algebraic forms, as well as applying algebraic concepts in the context of real problems. This is supported by research conducted by Haniah and Senjayawati (2023) which states that students with high abilities have difficulty understanding concepts, reading accuracy, and understanding the meaning of questions. Students with medium abilities have difficulty understanding algebra concepts, especially mathematical modeling. Students with low abilities have difficulty designing mathematical examples and planning problem solutions, so they cannot solve problems.

Obstacles faced by researcher in this research include limited time in collecting and analyzing data which affects the depth of analysis. Additionally, differences in abilities between students make it difficult to draw the same conclusions for all students. It is hoped that these findings can help in designing more effective learning strategies to increase students' understanding of algebra word problems and increase their self-regulated learning.

Conclusion

From the research that has been carried out, it can be seen that the average self-regulated learning of students at one of the junior high schools in Yogyakarta is in the medium category. Based on the analysis of students' difficulties in solving algebra word problems in terms of student's self-regulated learning, the following conclusions are obtained: (1) Students with high self-regulated learning do not experience many difficulties, only the final solution

is not completed completely when answering questions and students are less careful in answering questions; (2) Students in the moderate independence category have difficulty explaining, simplifying and operating algebraic multiplication; (3) Students with a low level of independence experience difficulties in understanding algebra concepts and understanding the meaning of questions so they cannot solve the problems given. Therefore, in the future, it is hoped that teachers can foster independent learning in students so that students can be interested and interested in learning together or independently so that students do not find it difficult to solve mathematical problems. Student's self-regulated learning can be improved in many ways, one of which is based on research Damayanti & Anando (2021) which shows that student learning independence can be increased by inquiry learning. Ainun Syah et al. (2023) Research also shows that student's self-regulated learning can be increased by learning based on discovery learning.

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