# Analysis of student difficulties on algebra problem solving in junior high school

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**L Sugiarti[1] and H Retnawati[2]**

[1]Graduate Program of Mathematics Education, Universitas Negeri Yogyakarta, Yogyakarta, Indonesia
Jl. Colombo No.1, Sleman, Yogyakarta, Indonesia
[2]Mathematics Department, Faculty of Mathematics and Science, Universitas Negeri Yogyakarta, Yogyakarta, Indonesia
Jl. Colombo No.1, Sleman, Yogyakarta, Indonesia

lanasugiarti09@gmail.com

**Abstract.** Algebra is one of the mathematical sciences studied in junior high school. Some students may have difficulty learning algebra. This study aims to determine the difficulties experienced by students in solving the problem of algebraic operations. The type of this research is qualitative research with case study approach. Subjects in this study are students of grade 8D 1 Salam Magelang junior high scchool, Central Java in the semester of the year 2016/2017 academic year. Methods of data collection used include algebraic operations tests, open questionnaires, and documentation. Data analysis techniques through data reduction, data presentation, and conclusions. The result of the research that there are students' difficulties in doing algebraic problems related to concept and principle. Students difficulties experienced related to the concept of difficulty in determining variables and constants including but not understanding the definitions of variables and constants, and difficulties in applying the concept of division in algebra. The difficulty experienced in terms of principle is the application of the principle of addition to the algebraic form, the reduction in algebraic form, multiplication on the algebraic form, simplifying algebraic fractions, factoring, and solving algebra-related stories.

## 1. Introduction

Mathematics is a subject that is always there in every level of education. Ranging from elementary education to higher education is always something to do with learning mathematics. Mathematics is a part of science that applied aspect and its reasoning is widely utilized in various fields especially technology [1]. Mathematics is a science that is close to everyday life. In daily activities, not separated from the role of mathematics. For example in the sale and purchase transactions in the market, in the rules of taking medicine from doctors, in measuring buildings, and so forth. That means that math is the thing we need in everyday life. Mathematics also deals with geometry, algebra, trigonometry, arithmetic, and so on. Mathematics is very important in the face of scientific and technological progress [2]. Thus the improvement of high-level thinking skills in mathematics is necessary.

In junior high school students for example there are still many students who find difficulty in doing math problems. Many of them argue that there are certain materials in mathematics that are difficult to understand. Based on the results of middle examination and ask questions with mathematics teachers in

grade 8 Salam 1 junior high school, obtained information that in grade 8D most of them complain of having difficulty in doing mathematical problems on algebraic factorization.

Algebra is a material that is often used in everyday life. Learning algebra material in school is necessary because it can help students to think critically, systematically, logically, analytically, creatively, and cooperation. It is also because of the algebraic material encountered in everyday life. Because algebra is one part of mathematics, the understanding of the concept of algebra is one of the goals to be achieved in mathematics learning in junior high school. The difficulty of learning mathematics experienced by students means also a difficulty learning the parts - the mathematics section. This study was conducted with the aim of obtaining information about the difficulties experienced by students of Salam 1 junior high shool in solving algebra problems. So that after the difficulty can be solved so that students do not feel difficult anymore in learning algebra material, for example by using the right method of teaching or guidance to students who have difficulty. This is to answer from the student's need for mathematical understanding as delivered by Lahinda [3] that the need for understanding and the use of mathematics in everyday life as well as in the working world is getting bigger and growing This is in accordance with the opinion stating that mathematics disorders or dyscalculia idiom is one of the learning disabilities which influences learning and application of mathematical skills and conceptions [4].

The purpose of learning mathematics in junior high school one of them is understanding the concept. Because algebra is one part of mathematics, the understanding of the concept of algebra is one of the goals to be achieved in mathematics learning for junior high and equal. According to Gagne [5], in learning mathematics there are two objects that can be obtained students, namely direct objects and indirect objects. The direct object consists of facts, concepts, skills, and principles. Meanwhile, according to Bagle [6] states that the object or object of mathematical study is facts, concepts, operations, and principles. Facts usually include terms (names), notations (symbols / symbols), and so on. While the concept is an abstract idea that makes it possible to group objects into instances and non examples. Skill relates to the student's ability to provide answers. While the principle can be a combination of concepts and some facts.

In this research will be discussed about students' difficulties in applying the concepts and principles on algebra material. The material of grade 8 junior high school algebra discusses variables, constants, coefficients, similar and unlike tribes, as well as count operations on algebraic shapes using the principles of counting operations on integers. This indicates that every material in the learning of mathematics can not be separated from facts, concepts and principles. Lessons learned in the early or basic stages must be very steady, because the learning difficulties experienced by students in the early stages will affect the transfer of learning at a later stage. The things that happened in this research were almost the same as those found by Tambychick & Meerah, this study concludes that students faces difficulties in mathematics problem solving due to incompetency in acquiring many mathematics skills and lacking in cognitive abilities of learning [7].

Soedjadi [8] said that the difficulties experienced by students will allow a mistake when answering test questions. Errors that students do in answering algebraic issues are evidence of the difficulties experienced by students on the material. It confirms that difficulty is the cause of error. From the various efforts that have been done by teachers, it is still happened learning difficulties faced by students. Cooney states that students' difficulties in learning mathematics to focus on two important types of knowledge of mathematics are knowledge of concepts and knowledge of principles [9]. Thus to know students 'learning difficulties in learning algebra can be reviewed from the students' knowledge of the concepts and principles in algebra. Like other fields of mathematics, algebra consists of several concepts and principles in which an algebraic concept is needed as a basis for subsequent algebraic learning concepts, and the use of interrelated principles will be the capital for students to be able to solve algebraic problems well and correctly. Difficulties in solving algebraic problems are also related to

errors in working on the problem. This is in accordance with the opinion of the Hansen, Drews, & Dudgeon stating that an error could be made for many reasons. It could be the result of carrelesness, misinterpretation of symbol of text, lack or relevant experience or knowledge related the mathematical topic/learning objective/concept, a lack awareness or inability to check the answer given, or the result of a misconception [10].

In terms of the spirit of learning, each student is also different. Sometimes high spirits, but sometimes also difficult to concentrate. That fact is often encountered in every student when learning in the classroom. Differences between individuals is what causes differences in learning behavior among learners. The situation in seeing where the principle of algebra is done is to look at the errors - students' errors related to the concept and principles. And based on the description, this study is entitled "Analysis of Student Difficulties on Algebra Problem Solving in Junior High School". Analysis in this case is the investigation of an event (essays, deeds and so on) to know the real situation (causal, sit case and so on). Less than optimal student achievement of learning achievement is possible because there is difficulty learning in student.The analysis intended in this study is an attempt to review students' difficulties in solving algebra problems relating to concepts and principles.

Azis mentions there is a kind of difficulty in the cognitive and affective aspects [11]. But in understanding the concept of algebra in students can be viewed from the students' knowledge of mathematical concepts in accordance with the subject that is in algebra material. Students' knowledge of algebraic concepts can be reviewed, and in this study students who have no difficulty using concepts if students can: (1) mark, express in words, and define concepts; (2) using the concept of what has been learned about algebra to solve the problem correctly. The difficulty in understanding the principles of algebra in students can be seen from students' knowledge of mathematical principles related to algebra. Knowledge of the principles of algebra can also be reviewed, and in this study students who have no difficulty using principles, among others, if the student can: (1) recognize when a principle is required; (2) using the principle correctly. There are many things that cause students to experience difficulties in solving algebraic problems. Maybe one of them is a disruption as expressed by Lerner & Kline that dyscalculia is described as a specific disturbance in learning mathematical concept and computation associated with a neurological, central nervous system dysfunction. Which means that dyscalculia is a specific disorder in learn mathematical concepts related to neurology, dysfunction central nerve system [12].

Based on the above description, the problems that arise related to learning algebra is that students have difficulty in learning algebra, so students make mistakes when solving algebra problems. The learning difficulties of the students studied in this study are through the analysis of student errors in solving algebra related to the mastery of concepts and principles. Student mistakes that included errors in algebraic notation as expressed by Jones & Pratt that students make a mistake notation as a result of a combination of operations called error "walking" statements [13]. Therefore, the purpose of this study is to describe the difficulties experienced by students of grade 8 Salam 1 junior high school in solving algebra problems related to the concept and principles, and describe the things causes of student learning difficulties in solving problems related to algebra. The difficulties experienced by students are different, therefore the assessment used is not only a judgment that is reminiscent and summarizes just as expressed by Jones that assessment that is only oriented to recall and summarization cannot distinguish students who have levels different knowledge, therefore need a capable assessment shows the development of student knowledge [14]. The difficulties experienced by students are expected to make teachers eager to motivate students to be diligent in learning so that students do not experience fear of mathematics as expressed by Peker & Mirasyedioglu [15]. Benefits in this study are expected to provide benefits in describing students 'errors in solving algebra problems related to algebraic concepts and principles, encouraging teachers to seek alternative action in overcoming students' difficulties in learning mathematics especially on algebra materials, improving the quality of learning mathematics,

especially on algebra materials, improve the quality of learning algebra in particular and mathematics in general, and provide information and experience for those who do this study on the problems that occurred in the real class.

## 2. Methods

### *2.1. Research type*

In its implementation, this research uses a qualitative research type with case study approach. The type of qualitative research is chosen in order to clearly describe student difficulties. How to determine the participants is to ask the teacher, which grade has the lowest average algebra exam results. Grade 8 Salam 1 junior high school consists of 6 classes, from class 8A to class 8F. From the information provided by the teacher, class 8D has the results of midterm semester which is the lowest on algebra material. So the researchers chose class 8D to be a participant in doing this study.

Data collection was done during the math class. The data collection is done by permission from the teacher of mathematics subjects who have been willing to use their classes for research place. In conducting data collection, researchers used an algebraic form test instrument to find out the type of student difficulty associated with algebra and open questionnaires to find out the difficult part of the algebraic material and the factors that caused the difficulty.

The algebra test is done together without opening the book (close book). The expected data is the result of the student's work on the answer sheets accompanied by the steps in solving the problem. This algebra test result data is used as a basis for analyzing students' difficulties on mastery of concepts and principles. Student mismanagement is analyzed and then grouped into types - difficulties related to concepts and principles. The questionnaire used in this study is an open questionnaire consisting of questions. The question items in the open questionnaire were used to find out the difficult problem section and the factors that caused the students difficulties in solving the problem. This open questionnaire is presented in a simple form so that the respondent can give the field according to the will and the circumstances he experienced at the time.

Data analysis techniques used include data reduction, data presentation, and conclusions. Data obtained in this study are data of algebra test result and open questionnaire filling result data. After the data collected, conducted data reduction that aims to focus on things - things to be studied is the analysis of student answers from the subject that has been determined. Data analysis is done with the following criteria:

1. If students make mistakes related to the concept of each step in solving algebraic problems, then the student is expressed having difficulty in understanding the concept of algebra.
2. If the student makes mistakes relating to the principle of each step in solving algebraic problems, then the student is otherwise experiencing difficulties in understanding the principle of algebra.

Stages of data analysis in this study are as follows:

a. Data Reduction

Data reduction is a form of analysis that sharpens, classifies, directs, discards unnecessary data, and organizes data in such a way that conclusions can be drawn and verified.

The data reduction steps in this study include:

1) Correcting student work results to be analyzed into conceptual or principle difficulties.
2) Reading open questionnaire results that have been written by the students and simplified into good language as support to reinforce the test answers of students who have difficulty in concept and principle.

b. Presentation of data

The presentation of data is a set of arranged information that gives the possibility of drawing conclusions and taking action. In this stage the data in the form of student work results are arranged according to the

sequence of mistakes made and grouped who have difficulty in the concept and who have difficulty in principle. This activity shows information that enables a conclusion or action.

Stages of data presentation in this research include:

1) Present the results of the student's work that has been selected for analysis.
2) Presenting an open questionnaire results in accordance with the difficulties experienced by the students.

c. Draw conclusions or verification

Verification is part of an activity of a complete configuration so as to answer research questions and research objectives. This is done by comparing the results of student work and open questionnaire results, then from it can be drawn conclusions.

## 3. Result and Discussion

### *3.1. The implementation of the worked example*

The test was held on Wednesday, November 23, 2016 in grade 8D Salam 1 junior high school. The test was performed on the 32 students. Each student worked on algebra test questions and proceeded to do an open questionnaire to find out the difficulty of concepts and principles in algebra material. The open question and questionnaire used in this algebra test is in the appendix. Of the 32 students who were given questions, students were selected to have difficulty in working on problems related to algebra. The complete result of the analysis of each error causes the difficulties carried out in the concept of algebra are analyzed as follows:

1) Determine variables and constants

Problem: $6x^3 - 5x^2 + x + 2$ algebraic forms, variables and constants are ....

a. Student A

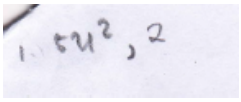

**Figure 1.** Student A answer algebraic problem

From the answers of students who in working on problems related to these variables and constants, students seem to lack understanding of the definitions of variables and constants. The student replied that the variable is $5x^2$ and the constant is 2. That means that the student does not really understand what is a variable and what is a constant.

2) Understand the concept of division in algebra

Problem: Results for $(8x^3 - 27) : (2x - 3)$ is ....

a. Student C

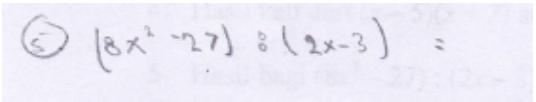

**Figure 2.** Student C answer algebraic problem

From the problem given, it appears that student C does not answer the question at all. From this it can be seen that student C has not understood the concept of division on algebra, but the time given to do this problem is enough time. This can also be seen from the open questionnaire responses done by students C. From the answer result in the open questionnaire, student C replied that he had difficulty in working on the number 5. He said that he forgot how to work on the division of algebra. In addition, he also answered that the problem of algebra is a material that is not easy to understand. This is evident in the answer to the second question. He says that algebraic material is a difficult matter.

From the results obtained in the analysis of the difficulty in the work of algebraic problems related to the above algebraic material, it can be concluded that the causes of difficulty in working on algebraic problems related to the concept are two things, namely difficulties in: (1) determining the variables and constants ; and (2) have not understood the concept of distribution of algebraic material.

Furthermore, will be discussed about the analysis of each - each cause of difficulty that is done in the principle of algebra is as follows:

1) The principle of addition to algebra

Problem : The sum of (x - 5y) + (3x - 4y) is ....

a. Student G

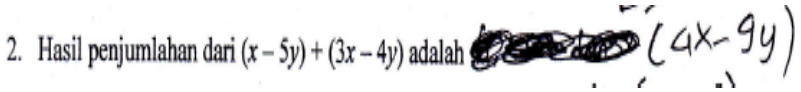


**Figure 3.** Student G answer algebraic problem

From the result of student G it appears that he did the given problem by directly providing the answer without any steps - the settlement step because. This is probably because he has not understood how to work on problems related to addition operations in algebra. The result of G student's answer in doing the summing operation on algebra states that he finds it difficult to work on the problem. The reason he felt the difficulty because he forgot the formula in the process. So the conclusion that students G feel difficult in doing the problem because he forgot the formula in the process.

2) The principle of substraction on algebra

Problem : the result of reduction of 8 $(1 – 2a^2)$ from 5 $(2 – 3a^2)$ is ....

a. Student I

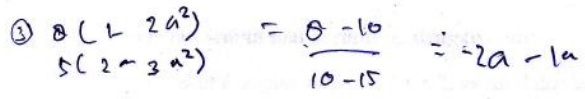


**Figure 4.** Student I answer algebraic problem

From the results of the student's answer I can see that he has not been able to solve problems related to the principle of reduction in algebra. From the results of his calculations, he calculates directly without including the variable, while in the results, it includes with the variable. From the explanation of student answer I, he felt difficult in doing the problem because felt that the problem is difficult to understand. But he did not have problems in working on the problem. But he explains that the reason is because he has not really understood the problem.

3) The principle of multiplication on algebra

Problem: The product times of (x - 5) (x + 2) are ....

a. Student K

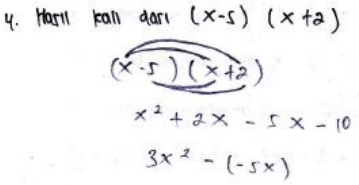


**Figure 5.** Student K answer algebraic problem

From the results of student K work above shows that students K have difficulty in working out the problems related to the principle of multiplication on algebra. This can be shown from the error in the count and the student did not complete the answer until it was completed. From the

results of open questionnaire answers written by students K showed that he found it difficult in doing a proven question of the answer that wrote a decent word. The reason is because sometimes he is still confused with the negative and positive layout in his calculations.

4) Simplifying algebraic fractions

Problem: The simplest form of $\frac{x^2-5xy+6y^2}{x^2-4y^2}$ = ....

a. Student Q

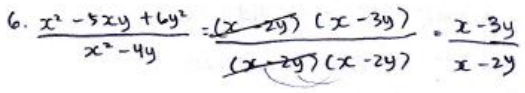

**Figure 6.** Student Q answer algebraic problem

The result of the student's answer above shows that the students are less careful in doing the question. Step workmanship of the problem is correct but the student's answer is still less precise. This can be seen from the workmanship of students in the denominator who is still not right. From the student's answer in the open questionnaire it shows the student's answer that he will find it difficult to work on the problem of simplifying the fraction in algebraic form if he remembers the formula.

## 4. Conclusion

Based on the results of the analysis and discussion, it can be concluded that students' difficulties in solving various problems. There are difficulties in solving problems related to the principle, and some are difficult in solving problems related to the concept. Student difficulties associated with the concept of algebra is the difficulty of students in determining variables and constants. Students do not know the definitions of variables and constants. The next conceptual difficulty is regarding the concept of algebraic sharing. Students do not understand the concept of division in algebra so that students have difficulty working on problems related to the concept of division in algebra. While the difficulty in principle there are six, namely the principle of addition to algebra, algebra reduction, multiplication on algebra, simplifying algebraic shapes, algebraic facts, and solving algebraic story problems.

From the analysis and discussion about the students 'difficulties related to the concept and principle, it is found that students' difficulties in working on algebraic problems vary widely. There are difficulties in working on problems related to the concept, and there are also difficulties working on problems relating to the principle. Each student has their own difficulties. Based on this conclusion it can be learned that object of mathematical study is very important to students in junior high school.

## 5. Recommendation

The results of this study can be used by the teacher as a reference of the use of learning methods to improve students' learning algebra in grade 8, and can be used by students and readers to increase knowledge about learning fo algebra in grade 8.

## 6. Acknowledgments

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## References

[1] Mahmud A D 2014 Keefektifan Model Pembelajaran ISK dan Ditinjau dari Motivasi, Sikap, dan Kemampuan Komunikasi Matematis (UNY: *Jurnal Riset Pendidikan Matematika*)

[2] Wahyuni A 2014 Perbandingan Keefektifan Pembelajaran Cooperative Learning Type STAD dan Type TPS pada Pembelajaran Bangun Ruang Siswa SMP (UNY: *Jurnal Riset Pendidikan Matematika*)
[3] Lahinda Y 2015 Analisis Proses Pemecahan Masalah Matematika Siswa Sekolah Menengah Pertama (UNY: *Jurnal Riset Pendidikan Matematika*)
[4] Sahebjamei S and Mokhles H M 2012 Educational designing based on assignment-process approach and investigation of its role on reduction learning disabilities of student having mathematics disorder *Procedia-Sosial Behav. Sci.* **46** 790-4
[5] Suherman E 2001 *Strategi Belajar Mengajar Kontemporer* (Bandung: Depdikbud)
[6] Hudojo and Herman 2005 *Teori Dasar Belajar Mengajar Matematika* (Jakarta: Depdikbud)
[7] Tambychick T and Meerah T S M 2010 Student Difficulties in Mathematics Problem Solving: What Do They Say? *Procedia-Sosial Behav. Sci.* **8** 142-51
[8] Soedjadi 1996 Diagnosis Kesulitan Siswa Sekolah Dasar dalam Belajar Matematika (Surabaya: *Jurnal Jurusan Matematika FMIPA IKIP*)
[9] Novferma N 2016 Analisis Kesulitan dan Self-Efficacy Siswa SMP dalam Pemecahan Masalah Matematika Berbentuk Soal Cerita (UNY: *Jurnal Riset Pendidikan Matematika*)
[10] Hansen A, Drews D and Dudgeon J 2011 *Children Errors in Mathematics:Understanding Common Misconseptions in Primary School* (Los Angeles: Sage Publication, Inc)
[11] Azis 2015 Analisis Kesulitan Kognitif dan Masalah Afektif Siswa SMA dalam Belajar Matematika Menghadapi Ujian Nasional (UNY: *Jurnal Riset Pendidikan Matematika*)
[12] Lerner J W and Kline W F 2006 *Learning Disabilities and Related Disorder: Characteristic and Teaching Strategies (*Boston: Houghton Mifflin Company)
[13] Jones I and Pratt D 2012 A Substituting Meaning for The Equal Sign in Arithmetic Notating Tasks *J. Res. Math. Educ.* **43** 2-33
[14] Jones S M 2014 Assessing The Science Knowledge of University Student: Perils, Pitfalls and Possibilities *J. Learn. Des.* **7** 16-27
[15] Peker M and Mirasyedioglu S 2008 Pre-service Elementary School Teachers Learning Styles and Attitudes Towards Mathematics *Eurasia J. Math. Sci. Teach. Educ.* **4** 21-6