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The Analysis Of Students' Difficulties In Solving Systems Of Linear Equations in Two Variables

Puspita Dwi Widyastuti[a)], Mardiyana [b)] and Dewi Retno Sari Saputro[c)]

Department of Magister Mathematics Education
Faculty of Teacher Training and Education, Sebelas Maret University
Surakarta, Indonesia

[a)] Corresponding author: widya.puspita9@gmail.com
[b)] mardiyana@staff.uns.ac.id
[c)] dewiretnoss@staff.uns.ac.id

Abstract. This research aims to analyze students' difficulties in solving systems of linear equantions of two variables and the solutions. The research was conducted based on the students' low value in national exam from PAMER data. The research method was conducted by analyzed students' written test and interviewed with the students. The analysis involved high ability student, average ability student, and low ability student. Based on the result, it was concluded that : (1) high ability student had difficulties in performed mathematical procedures (the operation of mathematical models) and solving the varies tests; (2) average ability student had difficulties in mathematical modeling, determined the problem-solving strategies (student didn't use elimination method, subtitution method, or mix method), and performed mathematical procedures (student wasn't correct in mathematical operation, performed the process, and determined the final answers); (3) low ability student had difficulties in mathematical modeling, determined the problem-solving strategies, performed mathematical procedures (student dind't operated all of the data were known in the questions because of the confusion), and solved the varies tests. Those results showed that mathematical modeling and the operations are very important in learning process. Comic was selected as the learning media because the characteristic of SPLDV is relevant with mathematical comic. SPLDV can be brought into real life through conversations between the characters in the comic so it can make the student eassier to understand.

INTRODUCTION

Mathematics is one of the most important thing in the world of education. Mathematics has become a required subject for primary education, general secondary education, vocational secondary education, and even for the university. At the national education curriculum, algebra is one of the materials which studied in junior high school, one of them is system of linear equations in two variables. Algebra in national education curriculum aims to equip students to think logical, analytical, systematic, critical and creative. Algebra is also one of the materials which tested at the National Exam besides the numbers, statistics and opportunities, as well as geometry and measurement.

Based on tha data from the 2016th PAMER about the percentage of junior high school's National Exam of math year 2015/2016 is known that in Surakarta, Batik junior high school is one of the schools that got the low absorptive capacity for categories of indicators. This amount is relatively low compare to other junior high school which mostly above 50%. There are two indicators which tested in national exam, such as : a) Given the price of the *n* first item n times the price of the second item. If a the price of first item and b is the price of second item, students determine the sum of p of first item and q of second item (n, a, p, b, q are a natural numbers more than 1 and b) Learners can solve word problems using the concepts of SPLDV. The first indicator got 50% and the second got 44,08%. It means that student couldn't reach the target of the indicators.

Low educational achievement is one of the proves that students have difficulties in solving mathematical problems. Students' difficulties be marked by errors in workmanship matter. Errors in the workmanship matter

indicate that students are not really optimal in absorbing information which related to the learning material. Widdiharto[7] stated that learning difficulties can be experienced by a group of high ability students, average ability students, and low ability students. Widdiharto's opinion confirmed that not only a low ability students who have difficulties in understanding the material, but the average ability students and high ability students can also have the learning difficulties which marked by the inability to solve problems correctly.

Based on these, the reasearcher will analyze students' difficulties on the system of linear equations of two variables to know the extent of students' understanding and what difficulties are often encountered in the material. This study refers to the results of previous studies which conducted by Yeo[8], which also discussed the issue of students' learning difficulties. The explanation about students' difficulties are described as follows.

1) Difficulties to Understand the Problems

In this stage, students are said to be having learning difficulties to understand the problems if : a) they haven't been able to understand what is known about the questions ; b) they haven't been able to understand what is asked about the questions.

2) Difficulties to Change the Problems Into Mathematical Models

Students have learning difficulties to change the problems into mathematical models if : a) they haven't been able to determine the correct mathematical symbols; b) they haven't been able to determine the mathematical symbols from what is known; and c) they haven't been able to determine the mathematical symbols from what is asked.

3) Difficulties to Determine Problem Solving Strategies

Students have learning difficulties to change the problems into mathematical models if : a) they don't determine the problem solving strategies completely; b) they don't determine the problem solving strategies correctly.

4) Difficulties to Do Mathematical Procedures

Students are said to be having learning difficulties to do mathematical procedures if: a) they don't operate the equations correctly; b) they don't do the workmanship correctly; c) they don't answer correctly; and d) they don't determine the conclusion correctly.

The researcher choose this theory because the researcher can identify the students' difficulties easily by looking at the characteristics that have been presented in Yeo's theory. For example if student has problems in operates the equations and determines the conclusion, it can be assumed that student has difficulties to do mathematical procedures. This kind of analysis will direct the reasearcher to conclude the difficulties and find the solutions.

METHOD

The research design used a descriptive approach. The method was done by analyzing students' written test and interview with students. The analysis was conducted on the high-ability students, average–ability student, and low-ability student. The classification was based on the values of the previous semester, the daily activities, and consultation with the teachers. Students must first be given to the UN 2015-2016 school year which contained the system of linear equations of two variables, then researchers confirm the results of the written test by conducting interviews. Based on the results of written test and interview, researchers can conclude the students' difficulties from each ability. The study was followed up by giving the solution.

RESULTS AND DISCUSSION

The difficulties are based on students' mistakes in written test and interview regarding to systems of linear equantions of two variables.

Table 2. Difficulties of High Ability Student

Difficulties	Characteristic Features	Interview with Student	Possible Reasons
Understand the Problems	a) Students haven't been able to understand what is known about the questions. b) Student haven't been able to understand what is asked	Student mentioned what were known and what was asked from both questions.	Student understands the problems.

Difficulties	Characteristic Features	Interview with Student	Possible Reasons
	about the questions		
Change the Problems Into Mathematical Models	a) Students haven't been able to determine the correct mathematical symbols b) Students haven't been able to determine the mathematical models from what is known c) Students haven't been able to determine the mathematical models from what is asked.	a) Student wrote the mathematical symbols from both numbers correctly. b) Student wrote the mathematical models from both what were known, even on the second number was not really clear but the student explained about it correctly. c) Student wrote the mathematical models from both what was asked.	Student can change the problems into mathematical models.
Determine the Problem Solving Strategies	a) Students don't determine the problem solving strategies completely. b) Students don't determine the problem solving strategies correctly	a) Student explained how to get the value of each item first, and after that he explained how to operate the mathematical models to get the final answer. b) Student mentioned that he used the elimination and substitution methods in order to solve the problems.	Student can determine the problem solving strategies.
Do the Mathematical Procedures	c) Students don't operate the equations correctly d) Students don't do the work-manship correctly e) Students don't answer correctly f) Students don't determine the conclusion correctly	Student didn't operate the equations correctly. He didn't know how to eliminate a variable to get the value of each item. So the final answers from both numbers were false.	Student had difficulties to do mathematical procedures.

Table 3. Difficulties of Average Ability Student

Difficulties	Characteristic Features	Written Test and Interview	Possible Reasons
Understand the Problems	a) Students haven't been able to understand what is known about the questions. b) Student haven't been able to understand what is asked about the questions	Student mentioned what were known and what was asked from both questions. The wtitten test were not really clear but from the interview, he explained it correctly.	Student understands the problems.
Change the Problems Into Mathematical Models	a) Students haven't been able to determine the correct mathematical symbols b) Students haven't been able to determine the mathematical models from what is known c) Students haven't been able to determine the mathematical models from what is asked.	a) Student didn't write the mathematical symbols from the both numbers. b) Student didn't write the mathematical models from both what were known. c) Student didn't write the mathematical models from both what was asked.	Student can't change the problems into mathematical models.
Determine the Problem Solving Strategies	a) Students don't determine the problem solving strategies completely. b) Students don't determine the problem solving strategies correctly	a) Student explained how to get the final answer, but the written test was confusing because he didn't write it step by step. Most of the answers were obtained by estimating. b) Student mentioned that he didn't use the elimination or	Student can't determine the problem solving strategies.

Difficulties	Characteristic Features	Written Test and Interview	Possible Reasons
		substitution methods.	
Do the Mathematical Procedures	a) Students don't operate the equations correctly b) Students don't do the work-manship correctly c) Students don't answer correctly d) Students don't determine the conclusion correctly	Student didn't use all of the datas from the both numbers and it influenced the final anwers. Student was not careful in calculating the numbers from the both questions.	Student had difficulties to do mathematical proce-dures.

Table 4. Difficulties of Low Ability Student

Difficulties	Characteristic Features	Interview with Student	Possible Reasons
Understand the Problems	a) Students haven't been able to understand what is known about the questions. b) Student haven't been able to understand what is asked about the questions	Student mentioned what were known and what was asked from both questions.	Student understands the problems.
Change the Problems Into Mathematical Models	a) Students haven't been able to determine the correct mathematical symbols b) Students haven't been able to determine the mathematical models from what is known c) Students haven't been able to determine the mathematical models from what is asked.	a) Student didn't write the mathematical symbols from the both numbers. b) Student didn't write the mathematical models from both what were known. c) Student didn't write the mathematical models from both what was asked.	Student can't change the problems into mathematical models.
Determine the Problem Solving Strategies	a) Students don't determine the problem solving strategies completely. b) Students don't determine the problem solving strategies correctly	a) Student couldn't explain how to get the final answer, but from the written, he found the value of each item first. After that he operated both values to get the final answer. b) Student didn't use the elimination and substitution methods in order to solve the problems, and the final anwers were wrong.	Student can't determine the problem solving strategies.
Do the Mathematical Procedures	a) Students don't operate the equations correctly b) Students don't do the work-manship correctly c) Students don't answer correctly d) Students don't determine the conclusion correctly	Student didn't know how to operate the equations correctly. He didn't understand how to solve the equations at all, and he couldn't explain his own anwers.	Student had difficulties to do mathematical procedures.

Suggestions to The Systems of Linear Equantions of Two Variables Problems Activities

Based on the analysis of the difficulties and causes difficulties in the systems of linear equantions of two variables, the authors provide alternative solutions to the problem as follows.

The results showed that mathematical modeling and operations are important in learning. The 58th of Permendikbud Year 2014 stated that mathematical learning should depart from the things that are concrete to the

abstract. In the implementation of teaching and learning activities, teachers are required to optimize the use of equipment, media, visual aids, and other learning resources which interesting and useful in accordance with the demands of competence. One of the goals of learning mathematics based on the 58th of Permendikbud year 2014 is that the students can use the simple props or the results of the technology to perform mathematics activities.

In response to this, we need a media which can facilitate the learners in learning the system of linear in two variables. One of the media that can deliver things from the concrete to the abstract is comic. All this time, we only know comics as a entertain facilities for children, teenagers, and adults. Most of people like the literature which contained in the comics because the events and background which presented are clear, dynamic and alive. Comics emphasizes to the strory telling picture. This is what gives inspiration that comics can be a guidelines learning which is designed and arranged systematically to achieve a goal the learning goals.

Comics was chosen as learning media because the characteristic of the system of linear equations in two variables is relevant with mathematical comics, that is the element of of the system of linear equations in two variables can be brought into real life through conversations between the characters in the comics. Comics are expected to help students to translate daily languange into mathematical models with more interesting ways dan easy to understand. The other solution is the teacher have to give more varied exercises to the students. It is intended that students can think more critical in order to solve the non-routine matters.

The researcher hopes that students who previously were not interested to read will be more interested because of the comic. In addition, there are pictures in the comics that attract the attention of students, there is also a storyline that leads learners to keep reading.

The previous research by Tin Lam Toh [6] showed that comics was the good advice for algebra because it was the effective in communicating with the general public. The feedback from the teachers also showed that this approach of solving linear equations helps their students more than the traditional approach of introducing the section on solving algebraic equations, move beyond the guess-and-check processes, and transcends the process of solely focusing on algebraic procedures. Comics also helps students to visualize the solving a linear equation by balancing both sides of beam balance through a visual context.

CONCLUSION

Based on the research result, it can be concluded that: (1) The high ability student had difficulties to do mathematical procedures (mathematical models operation) and the difficulties to solve varied matters; (2) the average ability student had difficulties in mathematical modeling, determined problem solving strategies (student didn't use elimination, subtituion, graph or mix methods), and do the mathematical procedures (student didn't operate the equations correctly, carried out the process, and determined the final answers); (3) low ability student had difficulties in mathematical modeling, determined problem solving strategies, do the mathematical procedure (student didn't operate all of the datas which known in the questions because he felt confused) and difficulties to solve varied matters. Those results showed that mathematical modeling and the operation are the most important thing in the system of linear equations of two variables.

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REFERENCES

1. A, Mulyono, *Pendidikan Bagi Anak Berkesulitan Belajar*, (Jakarta: Rineka Cipta, 2009).
2. B. C. Gary, *Connecting Through Comics: Expanding Opportunities for Teaching and Learning*. (*David Publishing* : 2012). (http://files.eric.ed.gov/fulltext/ED533545.pdf).
3. H. P. Chazan, D. Chen, C. L. Chieu, V. M., and Weiss, M. *Using Comics- Based Representations Of Teaching, And Technology, To Bring Practice To Teacher Education Courses*, 1- 22.
4. M, Yudhi, *Media Pembelajaran: Sebuah Pendekatan Baru*. (Jakarta: Referensi, 2013).
5. P, Leif. and O, Frank, *Comics With Attitude*, (New York, 2005).
6. T. T. Lam, *Use Of Cartoons And Comics To Teach Algebra In Mathematics Classrooms*. *(Nanyang Technological University: Singapore).*
7. Widdiharto, *Diagnosis Kesulitan Belajar Matematika SMP dan Alternatif Proses Remidinya*, (2008). (http://p4tkmatematika.org/fasilitasi/22-diagnosis-kesulitan-belajar-matematika-smp-Rachmad.pdf).
8. J. Yeo, *Secondary 2 Student's Difficulties in Solving Non-Routine Problem*. *International Education Journal For Mathematics Teaching and Learning, 10(1), 1-30*, (2009).