Working Memory on Mathematical Problem Solving Activity: Case Study in Low Ability Students

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Abstract. Working memory has a vital role in mathematical problem-solving activities. The purpose of this investigation is to explore the working memory in mathematical problem-solving activity in students with low ability. The central question was: How does low ability students at Universitas PGRI Yogyakarta on mathematical problem-solving activity? Research questions were as follows: 1) How does long-term memory influence student's ability to problem-solving activity? 2) How does working memory influence on student's mathematical problem-solving activity? Data was gathered from 3 participants through interviews; a follow up with a written interview and a reflective journal study. Data indicated that participants experienced have not mastered the prior skills needed to solve the differential problem, which led to delay in solving the problem. Findings also indicated that long-term memory and working memory influence speed of the problem-solving.

1. Introduction

The material can be well received by students if students have sufficient initial knowledge needed, and students can make connections between the knowledge they have and the knowledge being learned. Gagne states that learning preparation includes the activities of preliminary learning activities [1]. Furthermore, Gagne states that during learning, students focus on stimuli that are relevant to the material being studied [1]. The relevant stimuli can be audiovisual, written material, or teacher behaviour. During the retrieval of relevant information from long-term memory, students activate the parts that are relevant to the topic being studied.

Long-term memory and working memory also related to problem-solving. Working memory has a vital role in mathematical problem-solving activities. Working memory refers to a system that is responsible for storing information over a short period, where the information is used to fulfil several activities that are directed towards the goal. Various studies related to working memory [2]–[10].

Previous experience, mathematical background, level of interest, motivation and problem structure are things that affect someone in solving problem-solving in mathematics[11]. A problem is a situation where an individual or group is called to do a task for which there is no easily accessible algorithm that determines the solution method completely, and problem-solving is the set of actions taken to perform the task[11]. Various studies related to problem-solving in mathematics [10]–[18].

Various studies related to low working memory capacity produce poor results in solving mathematical problems. Students with low working memory capacity cause them to become low ability students. Low ability students are the student who can be slow in the learning process so that it requires more time to learn [19].

Therefore, the author is also interested in exploring the working memory in mathematical problem-solving activity in low ability students. The central question was: How does low ability students at Universitas PGRI Yogyakarta on mathematical problem-solving activity?

Research questions were as follows:

a. How does long-term memory influence a student's ability to problem-solving activity?
b. How does memory work an influence on student's mathematical problem-solving activity?

2. Method

This research is a qualitative method. To answer the research question, we interviewed three low ability students in solving the differential equation problem. During the interview, we make notes, also follow up with a written interview. To analyze the data, we verify the interviews with the written interviews, and the reflective journals study.

3. Results and Discussions

Data from 3 participants through interviews, a follow up with a written interview, and a reflective journal study, presented as follows.

3.1. Student 1 (S1)

Errors made by the student in completing the solution of differential equation problems are illustrated in the following figure (illustrations of paper-assisted interviews).

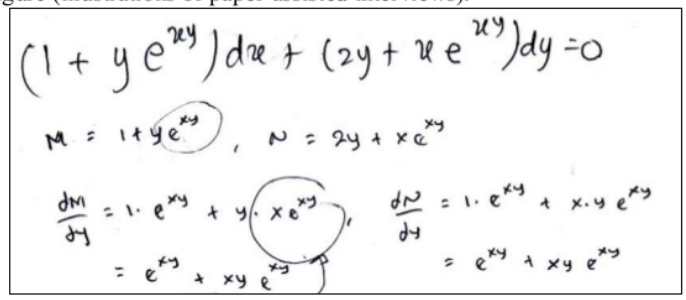

Figure 1. Student's errors in differential

Further interviews related to function derivatives. When she was asked for integrals of e^x, e^{2x}, e^{3x}, she still difficult. So, author provoked by writing on a piece of paper. However, her answer was still wrong.

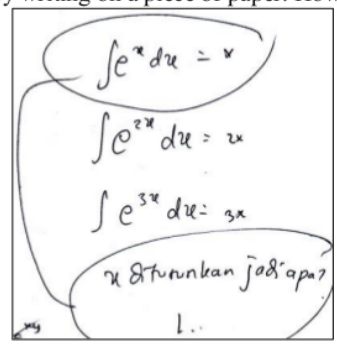

Figure 2. Student's errors in exponential

Then the interview continues with a hint: if the integral e^x is x, so $e^x = 1$?
Finally, the interview continues with a hint in the derivative of e^{xy}. It turns out that students know the derivative of the function, which finally manages to remember the integral function of e^x, e^{2x}, e^{3x}.

The results of the interview indicate that she is still having difficulties, confusion about the initial material related to the derivative function.
At the end of the interview, she succeeds to solve the problem of differential equations proposed, even though the time needed to complete was longer than the time it should have been.

3.2. Student 2 (S2)

This student is wrong in determining which method is easier to solve the differential problems proposed. The problems presented should be more easily solved by linear differential equations, but these students do it with an inexact differential equation. Although this is not a problem, completing it will be longer, because the sequence of steps of the process becomes longer.
Also, this second student also experienced difficulties and finally made a mistake when changing the exponential value $e^{\ln|4y-3|^{-\frac{1}{2}}}$. Students mistakenly change $e^{\ln|4y-3|^{-\frac{1}{2}}}$ to $\ln|4y-3|^{-\frac{1}{2}}$, as shown in the figure below.

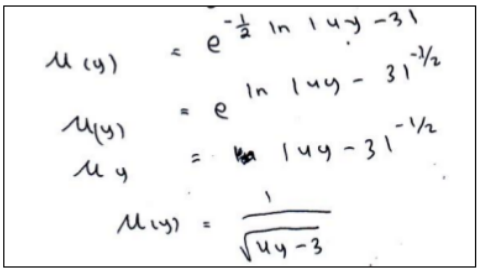

Figure 3. Student's errors in exponential value

After the student was being confirmed with a simpler exponential (in the figure below), students can remember the operation error.

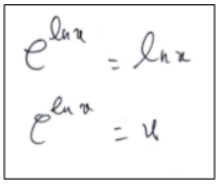

Figure 4. The simpler exponential

Finally, this student succeeds to solve the problem of differential equations proposed, even though the time needed to complete was longer than the time it should have been.

3.3. Student 3 (S3)

S3 is far worse than the first and second students. In this third student, there are still difficulties in simple operations of algebraic addition and algebraic division. Even at a more advanced level, this can happen. Based on the results of the interviews conducted, the following results were obtained.

At the interview by writing on a piece of paper, arrived at solving differential equations, $x\frac{dy}{dx} + \frac{2x+1}{x+1}y = x - 1$, students try to divide the two segments with x, as shown in the following figure.

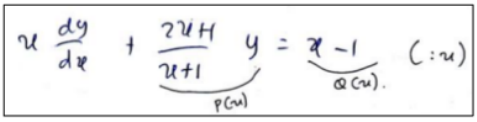

Figure 5. Student try to divide two segments with $\boldsymbol{x}$

However, a student mistakenly conducts division operations, so the results presented appear as follows.

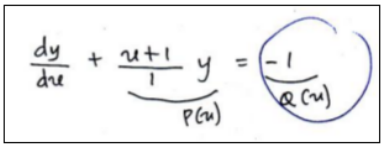

Figure 6. Student's errors in conduct division operations

After being confirmed, it turned out that the student had difficulty doing the division operation. Then the student is provoked, is $x - 1$ divided by x equal to (-1)?

Moreover, students answered that $x - 1$ divided by x does not equal (-1). The students began to get confused, and finally a,fter a rather long time ago, new students were able to successfully perform the distribution operation properly.

Furthermore, like the first and second students, third students also have difficulty completing the integrals presented. The solution to the differential problem is also stalled at the completion of the integral. These fundamental settlement errors include the selection of integrated integration techniques for solving integrals. However, after a variety of inducements were carried out, students succeeded in solving the differential equations proposed. Of course, the time needed is much longer than it should.

Data indicated that participants experienced have not mastered the prior skills needed to solve the differential problem, which led to delay in solving the problem. Findings also indicated that long-term memory and working memory influence speed of the problem-solving. These findings is by the theory that the learning preparation activities of preliminary learning activities [1] and previous experience affect someone in solving problem-solving in mathematics [11].

4. Conclusion

Working memory influences the speed of students in mathematical problem-solving activity. Long-term memory not only affects the speed of work but also affects the difficulty in doing it.

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