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METACOGNITIVE SKILLS ANALYSIS OF STUDENTS IN INTEGRAL CALCULUS PROBLEM SOLVING

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Abstract

This study aims to describe the profile of students' metacognitive skills in solving integral calculus problems seen from the aspects of planning, monitoring and evaluation metacognitive skills. The research method used is descriptive qualitative research methods. The subjects in this study were 3rd semester students who had taken courses or were taking calculus II courses for the 2020/2021 academic year which were carried out using purposive sampling technique. In this study, the instrument used was a test to measure the ability in solving integral calculus problems in the form of essay questions, unstructured interview guidelines, documentation and observation. Data were analyzed in three stages, namely reduction, presentation, and conclusion or verification. The results in this study were students with high problem solving abilities had met the indicators of metacognitive skills, namely the planning, monitoring and evaluation stages. Students with moderate problem-solving abilities have only reached indicators of metacognitive skills, namely the planning and monitoring stages, but have not reached the evaluation stage, while students with low problem-solving abilities have not measured metacognitive skills indicators both at the planning, monitoring and evaluation stages. So that students with high problem solving abilities are more likely to have good metacognitive skills, because students with high problem solving abilities are well organized from planning, monitoring to the evaluation stage.

Key words: Integral Calculus, Metacognitive Skills, Problem Solving Ability

INTRODUCTION

Mathematics is a supporting science for other sciences (Ningsih,





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arithmetic, statistics and probability. Mathematics Education students are required to take integral calculus courses in higher education, this is in line with the opinion Bergwall&Hemmi (2017)that Integral calculus is the main subject in the transition from secondary to tertiary education.Integral calculus is included in basic courses which must mastered particularly by Mathematics Education students in order to learn more complex material at a higher level. However in reality, there are still many students whom do not fully understand the integral concept. This also happens to STKIP Kusuma Negara students based on observations and interviews with students whom have or are studying integral calculus.Based on the results interviews. students of often experience misconceptions when faced with integral calculus problems, especially problem of integral application, partial integral problems, integral rational functions, the area under the curve and the volume of rotating objects using the tube shell method and the disc method. It is resulted in the learning outcomes obtained were still not as expected. This is proven by the results of the UAS (Final Semester Examination) of the Mathematics Education students of STKIP Kusuma Negara Jakarta in and the 2018/2019 2019/2020 where in academic vears the 2019/2020 has decreased from the previous year, with details in 2018/2019 the value of A 31 %, B 63%, C 6% and in 2019 // 2020 the values of A are 18%, B 45%, C 27% and D 10%.

This means that student learning outcomes in calculus courses

are still low. This is in accordance with the results of preliminary observations and interviews that have been conducted, namely that most are still confused students in determining the steps to solve that must be taken when faced with integral questions. The ability of students to solve integral calculus problems could be improved by providing frequently practice questions from basic ones to those require deeper solution analysis. Problem solving is one of important aspects in learning mathematics. However, several studies have shown that the problem-solving abilities of students in Indonesia are still low (Nahdi et al., 2020).Problem solving is a valid experimental test for studying innovation, proposing a conceptual model of problem solving in which motor diversity plays a more central role than has been considered and providing to date. recommendations for future research using problem solving to investigate innovation (Lau, 2017). Mathematical problem solving is an increasingly important skill in today's mathematics curricula. Success in math problem solving is highly correlated with overall mathematics achievement (Bryant, Bryant, & Hammill, 2000; Krawec et al., 2013), and the need to develop proficiency in this domain is relevant to student success in school and so on. To overcome the need for problem-solving skills, major steps have been made to reform the mathematics curricula from emphasis on memorization skills and procedural knowledge of problem analysis, interpretation, and conceptual understanding (National Council of Mathematics Teachers, 2000: Krawec et al., 2013). Another opinion states that problem solving as the heart of mathematics learning, and all creative mathematical activities require problem solving (Pinta, actions Tayruakham&Nuangchalerm, 2009; Yazgan, 2015), may increase students' imagination (Wibowo et al., 2017), to develop student creativity (Suastika, 2017), and may support students' understanding skills (Mulyati et al., 2017; Cockcroft, 1982; Barham. 2020).

In addition to problem solving abilities, metacognitive skills also influence contribute to student learning outcomes. One of the factors supporting cognitive abilities is metacognition (Panggayuh, 2017). Metacognitive strategies are a series of regular activities used to control cognitive activity and ensure that cognitive goals have been achieved (Amin et al., 2017). Metacognitive strategies help students learn more effective as they become more aware of their own self-regulation (Colthorpe et al., 2018).Research in all academic domains consistently demonstrated the inability of students with LD to successfully complete academic tasks which require the use of cognitive and metacognitive skills (Krawec et al., 2013). Metacognitive strategies are "executive" activities such as planning, monitoring, and evaluation used to control and regulate cognitive a person's processes (Gourgey, 2001: Livingston, 2003; Clarebout et al., 2013).

METHODS

This research is case study qualitative research, which is a type of qualitative approach that explores a particular "case" in a real life context in accordance with the current situation. This study focused on students' metacognitive skills in solving Integral calculus problems. The main object is STKIP Kusuma Negara students who have or are currently taking integral calculus courses in the 2020/2021 academic year. The subjective of research consisted of 3 students with initials AFJN, MI, and AE..

The data in this study are primary data and secondary data. Documentation of student work and the results of interviews with several students to explore the information needed in the study are the primary data. Meanwhile, the secondary data in this study are the results of previous studies have been published. The technique of collecting data in this study was data triangulation, namely observation. interviews and documentation. Several stages of the problem-solving method, Polya (1973) states four stages, namely (1) understanding the problem, (2) planning, (3) implementing the plan, and (4) looking back. The indicators are (1) identifying known, requested, required elements; and (2)formulating mathematical problems or compiling mathematical models; applying strategies to solve (3) problems or mathematical models; (4) explaining or interpreting the results according to the original problem; (5) using mathematics in a meaningful 1989; Tambunan, way (NCTM, 2019). Data were analyzed using the triangulation method, namely the of analyzing data process by comparing information or data obtained through observation,

interviews, and problem-solving test results.

RESULTS AND DISCUSSION

Data in this study include: profile data of students' skills in solving integral calculus problems and data from interviews. Then 3 students were taken with high, medium and low problem solving abilities. The following will discuss the work results of several students, with different categories. The data from the answers of students with high problem solving abilities with value of 100 can be seen in the figure 1.

In the planning stage, MI has been able to formulate which part is u and which part is dv. It means MI has been able to determine the first step must be taken in solving the problem correctly. MI could also determine which formula is needed and what knowledge is needed to solve the problem. Therefore it could be said that MI has met the planning indicators in metacognitive skills.



Figure 1. Result of MI's answer

In the evaluation phase, MI is able to perform calculations that are planned to solve the problem. In this case MI performed an integral operation, but because the integral is being worked on is still in the form of partial integral, MI outlined the second equation in the form of partial integral by determining u and dv, until the correct calculation results and the correct answer are obtained. MI has rechecked the answer. So it could be said that MI has met the evaluation indicators in metacognitive skills.

Data from the answers of students with moderate problemsolving abilities with a value of 65 are shown in the figure 2.

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Figure. 2 Result of AFJN's answer

In the planning stage AFJN has been able to formulate what is known and is asked in this problem. It means AFJN has been able to interpret information of problem and could determine or plan to solve the problem. AFJN understands the first step that must be taken in solving the problem correctly. AFJN also be able to understand which formulas are needed and what knowledge is needed to solve the problem. So it could be said that AFJN has met the planning indicators in metacognitive skills.

In the monitoring stage, AFJN could interpret the relationship between problem parts to apply the formula in problem solving mathematically in this case it can determine the value of dy / dx = 3x,

which is obtained from the information in the problem that the curve gradient at each point is three times its absences. could also interpret the AFJN relationship between problems using important information in problem solving mathematically, in this case AFJN could determine the important variables in applying integral everyday techniques related to problems. AFJN is able to determine which operations will be used and the order in which they are used in solving integral problems, in this case AFJN applies the integral formula to determine the curve equation being asked in the problem, namely by integrating the gradient equation it has formulated. So it can be said that AFJN

has met the monitoring indicators in metacognitive skills.

In the evaluation phase, AFJN made a mistake in operating the integral on the gradient equation that it had formulated, the calculation planned to solve the problem in this case MI performed an integral operation but the results were not correct, which resulted in incorrect operation of the balagan and obtained incorrect answers about the constant value, so the answer is not completely correct. AFJN has not re-checked the answer, which resulted in AFJN did not know if the answer is still wrong. So it could be said that the AFJN has not met the evaluation indicators in metacognitive skills.

Data on the answers of students with low problem-solving abilities with value of 35 are shown in the figure 3.

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Figure 3. Result of AE's answer

In the planning stage, AE has been able to formulate what is known and is asked in this problem, meaning that AE could interpret the information in the problem and could determine or plan to solve the problem of question. AE understands the first step that must be taken in solving the problem correctly, but AE does not fully understand which formula is needed and what knowledge is needed to solve the problem, because this problem should be solved using integration. So it could be said that AE has not met the planning indicators in metacognitive skills.

In the monitoring stage, AE has not been able to interpret the relationship between the problem parts to apply the formula in problem solving mathematically, in this case AE has not been able to determine the problemsolving method with the relationship between acceleration. speed and distance. In which three variables are related to time. AE has not been able to receive information on questions about the relationship between known variables. AE also could not interpret the relationship between problems in using important problem information in solving mathematically, in this case AE could not determine the variables that are important in applying integral techniques related everyday to problems. AE has not been able to determine which operation will be used and the sequence of its use in solving the integral problem, in this case AE does not do integral to determine the velocity and distance equations as asked in the question, namely by integrating the acceleration equation. So it can be said that AE has not fulfilled the monitoring indicators in metacognitive skills.

In the evaluation stage, AE has not fulfilled the standard, because the technique or completion strategy used is still not correct, resulting in the result of the answer that is written down as it should be. So it could be said that AE has not met the evaluation indicators in metacognitive skills.

The results of this study are in accordance with the research conducted by (Amin &Sukestiyarno, 2015; Atmojo&Masduki, 2016), namely that students' metacognitive skills are more dominant in students with high and medium mathematics abilities. Students with low mathematical abilities tend to not meet the skill indicators of metacognitive.

CONCLUSION

The conclusion in this study is students with high problem solving abilities meet all the indicators of metacognitive skills, namely planning, monitoring and evaluation stages. Students with moderate problem solving abilities have only fulfilled two indicators of metacognitive skills, namely planning and monitoring. students While with low problemsolving abilities have not yet meet the indicators of metacognitive skills. So it can be conclude that students with high problem solving abilities are more likely to have good metacognitive skills, because students with high problem solving abilities are organized well from planning, monitoring to the evaluation stage.

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