The Effect of Note-Taking Strategy on Complex Analysis Problem Solving Skill

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Abstract: This study aims to increase student's problem solving skills by using note-taking strategies for Complex Analysis. Students habituation to write the necessary materials at right colom of the paper work, will allow them to connect mathematics topics with the related mathematical topics, which will ultimately increase problem solving skills. This research is a classroom action research conducted in Mathematics Education Department of Widya Dharma University Klaten. The study was conducted in several cycles. At the end of the cycle, we did evaluation and reflection to determine the deficiencies and their advantages, then repaired for the next cycle. The Cycles would be stoped when the indicator of success target has reached. The study was stopped in second cycle as it already has reached the indicator of success target. The result of this research showed that by using note-taking strategy for every step of Polya's theory, the student's problem solving skill has signifantly increased. It ould be seen that the average value of problem solving skills in the first cycle was 63.26, increased to 81.28 at the end of the second cycle.

1 INTRODUCTION

Mathematics is one of the subjects that has a big share in preparing students. Mathematics is a science that cannot be separated with other sciences, such as Chemistry, Biology, Physics and Economics. Without mathematics these sciences will have difficulty in solving problems. Mathematics is needed as a tool in solving problems. No wonder that many people say that mathematics is a servant of science, as queen of science and as a language of science also (Bell, 1996).

General objectives of mathematics learning formulated in The Regulation of National Education Ministry regarding Content Standards are students have the ability, 1) to understand the concept of mathematics, explain the interconnection between concepts and apply the concept or algorithm flexibly, accurately, efficiently and appropriately in problem solving, 2) to use reasoning in patterns and traits, performing mathematical manipulations in generalizing, compiling evidence, or explaining mathematical ideas and statements; 3) to do problem solving that includes the ability to understand problems, designing mathematical models, solving models and interpreting solutions obtained; 4) to communicate ideas and symbols, tables, diagrams, or other media to clarify circumstances or problems 5) to have an appreciative attitude to the use of mathematics in life, that is to have curiosity, attention, and interest in learning mathematics and resilience and confidence in problem solving (Menteri Pendidikan Nasional Republik Indonesia, 2006).

According to the National Council of Teaching Mathematics the goals of learning mathematics in schools are: (1) problem solving; (2) mathematical reasoning and proof; (3); mathematical communication (4) mathematical connection; and (5) mathematical representation (Midget and K.Edin, 2001). Problem solving becomes an important part of mathematics learning. that have the potential to provide intellectual challenges for enhancing students' mathematical understanding and development (Bradbury, 2010). Problem solving is also needed in everyday life and at work. Referring to the purpose of learning mathematics, problem solving is the goal of learning mathematics but is also a tool for doing so. Most mathematical concepts can be introduced through problems based on experiences that come from the life of students. To achieve mathematical learning objectives well, a teacher is required to be qualified and professional in order to

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improve the quality of education. So the teachers should be able to choose and apply the right learning strategy.

Problem in mathematics is an inquiry starting from given conditions to investigate or demonstrate a fact, result, or law. According to Shadiq (2004) a question will be a problem only if the question indicates a challenge that cannot be solved by a known routine procedure. So to solve a problem is treated a relatively longer time than the process of solving regular routine problems. Meanwhile, according to (Hudoyo, 2003), a question is a problem only if a person does not have rules / laws that can immediately be used to find answers to these questions. A question is called a problem depends on the knowledge it has. Problems are subjective to everyone, it means that a question can be a problem for a person, but not a problem for others (Hudoyo, 2003). Furthermore, Herman Hudoyo also stated that for a person, the question can be answered by using a routine procedure, but for others, it could be use a non routine procedure. So a question can be a problem if the question is challenging to answer which the answer can not be done routinely. Furthermore, this challenging question becomes a problem for someone when the person accepts the challenge (Hudoyo, 2003).

The Department of Mathematics Education has an obligation to prepare students to become competent mathematics teachers who will be the spearhead of mathematics learning. So it is necessary that the students of The Department of Mathematics Education be provided complete competence in mathematics and mathematics education. Complex Analysis is one of the subjects that taught in The Department of Mathematics Education in 7th and 8th semesters. To study the subject of Complex Analysis requires previous knowledge among others set theory, logic, trigonometry, analytical geometry, algebra, calculus, advanced calculus, and topology. If the student has not mastered the previous knowledge, he/she will find difficulties in studying further complex analysis. Instead, studying Complex Analysis becomes a vehicle for revealing these previous knowledge to further strengthen the mastery of the concept. To solve the problem of Complex Analysis requires previous knowledge such as the skills of applying trigonometric functions, performing operations in the form of exponents, performing logarithmic operations, applying the properties applicable in set theory, logic, describing functions, operations applicable to limits, differential or integral.

Mathematical problem solving steps were first introduced by Polya and are still used today (Polya, 1973) are: 1). Understand the problem, What is known and what is unknown, and what conditions are known; 2). Devise a plan, Choose the theorems or concepts that have been studied to be combined, so they can be used to solve the problem; 3). Carry out the plan, Fixed the problem as planned. Check each step. Prove that the steps are true; 4).Look back: Re-examine the results obtained, by matching the answers with the problem and writing the conclusions. In mathematical problem solving, note-taking can help students to solve the problem by taking the note of required previous knowledge, note the associated formulas,

The note-taking strategy was first examined by Di Vesta and Gray (1972), who found that making notes contained two activities at once namely, processes and products. Taking notes (note-taking) can help improve students' understanding and retention of the material being studied. (Kirkgoz, 2010) stressed that the main purpose of making notes is to capture important points from textbooks or lessons and save them, with the aim of being able to be used later in the framework of revisions, especially for the purpose of facing exams or writing summaries or reports that need notes (Kirkgoz, 2010). Making notes requires high-level skills. Note-taking can be useful when students re-learn the subject matter. (Cardetti, Khamsemanan and M. Carolina Orgnero, 2010) confirmed that partial notes in mathematical assignments are related strongly to high academic performance.

It is believed that students' notes which are written in class during the lesson or while reviewing a course material or comprehending a text are essential tool for learning. Good note-taking practices can lead to efficient study practices, better course outcomes, and improve retention of content beyond a course's conclusion. It is because learning can occur during both the production and review of notes by allowing learners to make connections between the idea units and engage in deep processing of course content (Bohay *et al.*, 2011)

Note-taking in solving mathematics problem, is a strategy to improve learning of both oral and written materials. It is a beneficial technique for studying the content, developing language skills, and learning task in general (White, 1996). Hebert, Graham, & Ganson (2014) prove that note-taking is useful tool for improving students' reading comprehension. The beneficial effect of note-taking covers two major functions as process and product (Boch & Piolat, 2005), First, the process of taking notes facilitates

learning. It works well to increase students' attention, to raise awareness of text organization, and to store the information into memory. Second, the notes, as product serve as an external storage of information that is useful to retrieve the content in delayed recalls or answering some exam questions.

Although note-taking is not a substitute for attendance, practice, instruction, or tutoring, it is one of many ingredients that can lead student to success in developmental math courses and is cited as an important, common student practice impacting student behaviour and performance (Bauer and Koedinger, 2006, 2008). Note-taking is believed to simulate the generative process in which students encode connections between prior knowledge and learning content. Note-taking strategy provides students with a method for increasing their short-term and long-term memory (Boyle, 2010). Although there are many new methods of teaching and learning have been developed, Boyle (2011) believes that note-taking is still an important learning skill for students. Note-taking remains an essential study skill for students. Note taking can be done in various activities such as lectures, reading, or when making simple observations. In the classroom, students who used notes can improve their learning experience. As students move on to post secondary education, note-taking will become even more essential as it is reported that 98% of college-level classes are in the form of lectures (Eades, Carol; Moore, 2007) (Boyle, 2011). In making notes, students have to write notes that are organized, can distinguish between important and unimportant points, connect to prior knowledge, and make a re-statement (Boyle, 2011).

This study will develop a note-taking strategy in solving complex analysis problems for Mathematics Education students, through classroom action research. To solve mathematical problems, students need to develop strategies, such as making appropriate diagrams, choosing the right formula, connecting with previous knowledge, finding suitable patterns, trying out values or special cases. These strategies can be applied by using note-taking strategies at each problem-solving step, This strategies need to be taught to students so that students can practice to monitor their thinking as they solve problems. Thus, it is expected to improve student problem solving skills.

In this study, making notes while solving the Complex Analysis problem is by writing down the essential contents of the text on the right-hand side of work paper. Things to note include prior knowledge, necessary formulas and other important things. By keeping in mind the prior knowledge and taking the notes on the right side of the worksheet, will make it easier for students to solve problems. According to opinions of Shrager & Mayer (1989) that note-taking activities will also improve students' problem solving skills and recall ability.

The purpose of this study is to increase students' problem solving skills by using note-taking strategies for Complex Analysis problem solving.

2 METHOD

This research is a Classroom Action Research which is conducted in several cycles. Each cycle has four main activities: a) planning, b) implementation, c) observation, and d) reflection. An advanced cycle will be implemented if success indicators have not been achieved, by correcting the weaknesses of the previous cycle. The cycle will be stopped if the success indicator is reached. The indicator of success in this study is if more than 70% of students obtain a score of problem solving skills Complex Analysis at least 70.

Subjects in this study are students who studied Complex Analysis in the 7th semester on Mathematics Education Department of Universitas Widya Dharma Klaten, with 23 students consisting of 15 female students and 8 male students.

The learning instrument was validated by 3 validators before being used in the study. As a validators are 3 lecturers on Mathematics Education Department. If it is less valid, the learning instrument should be revised according to the suggestion of the validator.

To see the effectiveness of this strategy, the results of post-test in the first cycle and the last cycle are compared using the difference mean test. If the value of problem solving skills has increased significantly then the cycle is stopped.

3 RESULT AND DISCUSSION

3.1 Validation for Learning Instrument

An instrument is said to be valid if it is able to measure what should be measured. To determine valid or not an instrument is, we need validation action. In this study, we employed expert's judgment, i.e. the instrument validated by validators who are experts in mathematics, mathematics education, and educational psychology.

3.1.1 The Validation Result of Lesson Plan

Lesson plan is validated by three validators, the average value given by the three validators is 3.7. All three validators conclude that Lesson Plan can be used as a guide in the implementation of learning.

3.1.2 The Validation Result of Student's Worksheet

The validation of student's worksheet by three validators obtained an average value of 3.6. As per the criteria of the scoring scale, each aspect obtained a good category. All three validators conclude that the Student's worksheet can be used with a few revisions.

3.1.3 The Validation Result of the Post-test of Each Cycle

Based on the validation result of each post-test by three validators, the average score of the post-test of each cycles can be categorized as valid, understandable and can be used without revision. Thus the post test of each cycles can be used without revision.

3.2 Result from the First Cycle

Based on observations in the first cycle we obtained the following results.

3.2.1 Result of Lecturer Observation

From the results of learning observation, it have found that the learning was begun by direct learning, the lecturer explained the problem solving steps. To explain the definition, lecturer used expository method. In proving the theorem or solving complex analysis problems, the lecturer has involved students to actively participate in thinking. Lecturers solved the problems by Polya's problem solving steps. At each problem solving step, the lecturer wrote down everything needed based on the students' opinions. The lecturer conditioned students to express the initial knowledge needed. In the next activity, students solve the Complex Analysis problem by using Student Worksheets that have been provided by the lecturer, as a guide to solving problems using note-taking strategies.

3.2.2 Result of Student Activity Observation

From the results of students' activity observation, it have found that the students who participate actively in the learning process were not much. Many students were just silent, did not dare to express his opinion. This is because of students forgot the prior knowledge that needed. Likewise in working on worksheets, many students who had not been able to write the prior knowledge or the things needed in problem solving, so not many students got good results.

The average score on the post test of the first cycle is 63.26. The students who reached a score more than 70 are only 52.17%. It means that the success indicator has not reached, so it should be continued to second cycle.

Based on that description it can be concluded that the study should be continued in second cycle, by eliminating the weaknesses and utilizing the advantages. The improvements should be do in second cycle are:

1. Lecturers must remind students how to make notes when solving problems. In solving problem of Complex Analysis, students are accustomed to work on using problem solving steps according to Polya and write down everything needed to solve the problem. In understanding the problem, students need to be accustomed to: 1) write down what is known and what is being asked, 2) write down prior knowledge, 3) write down the goals, 4) sketch or draw that can help solve the problem. When doing device a plan, students need to be accustomed to: 1) write down the relationship between the data and the question, 2) write down something useful from the data, 3) write down the necessary prior knowledge, 4) write down a related problem, 5) write down the tool if the relationship cannot be found, 6) write down the plan of the solution, 7) write down the formula that used at each step. When carrying out the plan, students need to be accustomed to: 1) write down the formula that used, 2) write down the steps of solving problem, 3) write down the important information. When doing look back, students need to be accustomed to: 1) check the truth of the step, 2) convince that the evaluation is correct, 3) evaluate goal achievement.
2. In demonstrating note-taking strategies at front of the class, lecturer are required to be smarter in expressing student opinions.
3. The lecturer gives task to strengthen the prior knowledge that needed to solve The Complex Analysis problem.
4. The lecturer requires students to write down the necessary prior knowledge, and matters that related to the existing problems on the right side of the worksheet.
5. Lecturers should give intensive guidance and motivation.

3.3 Result from the Second Cycle

Based on observations in the second cycle we obtained the following results.

3.3.1 Result of Lecturer Observation

In addition to using direct learning, the lecturer added a cooperative method of think-pair-share type. In this cooperative type, students discussed with their peers to solve the problem and write down what is needed in the space that provided on the worksheet.

3.3.2 Result of Student Activity Observation

Students who actively participate in the learning process has increased. By discussions with their friend, students become more dare to express their opinions and be able to write down what is needed in problem solving. Because students often using the initial knowledge, they become more understand the mathematics mater that required. Thus, students' ability to solve problems has increased, the mastery of other mathematical material related to Complex Analysis has increased too.

Recapitulation of student's ability in solving Complex Analysis problem at each cycle can be seen in Table 1.

From the Table 1 it can be seen that the lowest value increased from 25 to 45, the highest score increased from 85 to 95, the average value increased from 63.26 to 81.28.the average score on the final test of the second cycle is 81.28, and who reaches a score of more than 70 to 86,97%, it means that the success indicators have been reached, so the cycle can be stopped.

To be more strengthening, we did the mean differences test between the average post test score of students' problem solving skill in the first cycle and the second cycle. Calculations were done by using the Minitab program. The results shown at Table 2.

Table 1: Score of student's ability in solving complex analysis problem.

Score	Cycle		Information
	I	II	
The Highest score	85	95	Increased
Average score	63,26	81,28	Increased
The Lowest score	25	40	Increased
Percentage earned a score of ≥ 70	52,17%	86,97%	Indicator of success has been achieved

Table 2: Calculation of mean differences test.

Two sample T for first vs second				
	N	Mean	StDev	SE Mean
First cycle	23	63.26	8.94	0.59
Second cycle	23	81.36	9.97	0.96
95% CI for mu First - mu Second (-23.57, -12.63)				
T-Test mu First = mu Second (vs <): T= -6.49 P=0.0000 DF= 44				

From these results, we obtain a t-test value of -6,49 with a probability of 0,000. It mean that there is a significant difference between the average score in the first cycle and the second cycle. From the results it can be concluded that there is a significant increase between the average post test scores in the first cycle to the second cycle. So, the cycle can be stopped.

The results of this study are that note-taking strategies can improve the problem-solving skills of Complex Analysis. While (Senkowski, 2016) also conducted research about structured note-taking techniques to improve the mathematics performance of K 12 students. In his research he divided subjects into two groups, one group was given a structured note-taking strategy treatment, the other one was not given treatment. The result showed there is no significant difference between students' mathematics performance in treatment and non-treatment groups. However, this study will continue for different schools. Although, student perceptions of note-taking showed growth based on student survey responses.

Meanwhile, (Riyadi, Hersulastuti and Theresia Kriswianti N., 2017) developed metacognitive learning strategy that consisting of highlighting, note-taking, summarizing and concept maps for reading comprehension. It was concluded that note-taking helps someone to carry out a range of intellectual processes, especially in making judgment, resolving issues, and further making decisions. This is not much different from our research. By noting important things when solving the problems, students become actively thinking in constructing their own knowledge. It will make students' knowledge more meaningful. Every time doing an action, they should have a logical reason. This will keep students accountable for what they do. By writing down the necessary formulas, the mastery of mathematical material related to Complex Analysis will increase and integrated one and other. This is in accordance with the opinion of (Bohay *et al.*, 2011) that active engagement with material, such as note-taking, appears to have the greatest benefit at the deeper

levels of understanding. (Hartley, 2002) claims that note-taking as an effective information-processing tool that is commonly used both in daily life and in many professions. Note- taking helps someone to carry out of a range of intellectual processes, especially in making judgments, resolving issues, and making decisions. Teachers should develop a problem-solving culture in classroom to make problem solving as a regular and consistent part of one's classroom practice. The strength of the note-taking strategy are:

1. Students become more active, more critical and have high motivation because students are actively involved in the problem-solving process.
2. By applying note-taking strategies on solving complex analysis problems, students can be trained to construct their own knowledge with teacher scaffolding.
3. Mastery of mathematics materials increased and integrated one and other
4. Student problem solving skill has increased

While the weakness of the implementation of this strategy are:

1. For students who have not mastered the initial knowledge yet, such as number operations, trigonometric formulas, logic, functional graph, limit, differential, integral, they will find difficulty to solve the problem.
2. Many students lazy to write down the things needed on the right side of the worksheet, because they are still confused what to write.

4 CONCLUSIONS

This study shows that by using note-taking strategy in learning Complex Analysis can improve problem solving skills of mathematics education students. In addition, by using note-taking strategy, can improve the mastery of mathematical material. Students who are accustomed solve problems by using note-taking strategies on every step of Polya problem solving, can improve metacognitive ability and metacognitive awareness. Furthermore, students have self-confidence, thorough, critical, systematic, and skilled in making decisions. Students can master mathematical material such as Set Theory, Logic, Trigonometry, Algebra, Analytical Geometry, and Calculus as a whole and integrated, so there are not easy to be forgotten. As a math teacher candidate, this mastery is needed, as a provision to become a competent teacher.

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