

Mathematical Problem-Solving Skills of Students Based on the Kolb Learning Style through Creative Problem-Solving Learning

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This study applies creative problem-solving learning to explore problem-solving skills and learning styles, which are important skills to train students. The purpose of this study is to analyse and describe the students' mathematical problem-solving skills and Kolb learning styles. The research method used is descriptive qualitative. The research subjects are 10th grade middle-class students in Tasikmalaya, Indonesia. Data collection techniques were applied through mathematical problem-solving tests, learning style questionnaires, and interviews. Based on the data analysis, it was concluded that the type of learning style of students through creative problem-solving learning consists of divergent, assimilation, convergence, and accommodation. Students' whose learning styles were divergent or assimilation, enabled them to understand problems, plan problem-solving strategies, and perform calculations correctly. While students with convergent and accommodation type learning styles were capable of recognising problems, and planning problem-solving strategies, but were less able to perform the calculations correctly. Students of divergent, assimilation, convergence, and accommodation types, are less able to look back on the truth of the answers in a different way. Thus, divergent and assimilation-type students are better at solving mathematical problems.

Key words: *Mathematics, Learning, Problem-Solving, Education*

Introduction

The 2013 Curriculum in Indonesia requires students to be trained with problem-solving skills associated with daily life. Students learn from real-world contexts how to solve problems in everyday life (Hickendorff, 2013). The importance of problem-solving skills is trained to students supported by the National Council of Teacher of Mathematics (NCTM) (1980). Each student has the potential and their own learning style, but the problem is how to explore the potential of the students. Previous research on problem-solving skills through a variety of learning has been done by Murni et al. (2013) and Surya et al. (2017), among others. The results showed that problem-solving skills had not achieved maximum advantages, and students still had difficulty in solving problems, especially in the stage of looking back. Similarly, research on learning styles has been conducted by Muro (2007) and Cavas (2010) at various school levels, both here and abroad, but Kolb style learning research is still rarely performed in Indonesia (Muro & Terry, 2007; Cavas, 2010). One alternative to resolve these problems, is exploring the problem-solving capabilities of Creative Problem Solving (CPS) (Čančer, 2014). In addition, the CPS method also allows the establishment of learning style students (Duff, 2004). The reason to choose CPS is because of the student-based learning process for solving problems associated with daily life.

Problem-solving can be as an approach, method, learning model, or ability. In this study, problem solving is as an ability (Surya et al., 2017; Scherer & Beckmann, 2014). The ability to problem-solve is an important high-learning thinking process trained to students at every level of schooling (Murni et al., 2013). Problem-solving, according to Polya (1945), consists of four phases: understanding the problem, devising a plan, carrying out the plan, and looking back. The first phase, which is understanding the problem, is explored through several questions such as: what data is available, what is unknown or what is being asked, what is the condition of the problem, could the condition be expressed in terms of equations or other relationships, or is the condition good enough to find the question. The second phase is devising a plan, explored through several questions: has there ever been a similar problem before, has there ever been the same problem in another form. The third stage is carrying out the plan and is explored through several questions: implement the problem-solving strategy plan in point and check the truth of each step. The fourth stage is looking back, which is explored through several questions: how to check the truth of the results obtained, or can the solution be searched differently?

CPS is a problem-solving learning process that involves critical thinking and creative thinking, as well as understanding and group discussion (Treffinger & Isaksen, 2005). There are five stages in CPS: fact-finding, problem finding, idea finding, solution finding, and acceptance find (Čančer, 2014; Vidal, 2010). In the fact-finding stage, students are given the opportunity to find relevant facts about problem-solving. Problem finding is the stage of



redefining the problem, so that students better understand. Idea finding puts forward various ideas for solutions. At the Solution found stage, students find the right solution. During acceptance finding, students have another way to solve the problem. According to Treffinger (2005), CPS is a learning process that has three components: understanding the problem, generating ideas, and planning activities. In addition, the process consists of defining problems, generating ideas, choosing ideas, and implementing solutions (Treffinger & Isaksen, 2005).

Learning style is a way of learning to absorb information (Duff, 2004; Kolb, 1985). Every person has a different learning style. According to Kolb (1985), a person's learning style consists of four quadrants, namely: concrete experience; individuals learn through feelings with emphasis on concrete experience; more concerned with relationships with others; and sensitivity to other feelings (Kolb, 1985). In the learning process, individuals tend to be more open and able to adapt to the changes they face. Through reflective observation, individuals learn through observation, with emphasis on observing before judging, listening to a case from various perspectives, and always listening to the meaning of the things observed. In the learning process, the individual will use his thoughts and feelings to form opinions. In abstract conceptualisation, individuals learn through thought and are more focused on the logical analysis of ideas, systematic planning, and intellectual understanding of the situation or case at hand. In the learning process, individuals will rely on systematic planning and develop theories and ideas to solve the problems they face. During active experimentation, individuals learn by action, tend to be strong in terms of ability to carry out the task, dare to take risks, and influence others through their actions. In the learning process, the individual will appreciate his success in completing the work, his influence on others, and his accomplishments.

Furthermore, according to Duff (2004) and Kolb (1985), the four learning quadrants form four types of learning style combinations: divergent, assimilation, convergence and accommodation. Divergent type learning is a combination of feelings and observations. Individuals with divergent type learning excel at seeing concrete situations from many different points of view. Their approach to every situation is observing and not acting, including the behaviour of others, discussions and so on. The assimilator type, is a combination of thinking and observing. Individuals with assimilator types have an advantage in understanding the various information presentations gathered from various sources, and viewed from various perspectives, summarised in a logical, concise and clear format. The convergence type learning style is a combination of thinking and doing. Individuals with converge types excel at discovering the practical function of ideas and theories. Usually, they have good skills in problem-solving and decision making. The accommodation type learning style is a combination of feelings and actions. Individuals with an accommodating type have a good learning ability from their own experiences. They love to make plans and involve

themselves in new and challenging experiences. They tend to act on intuition or impulse, rather than on logical analysis.

According to the learning style quadrant by Kolb (1985), student learning styles are generally not dominated by one learning style, but at least a combination of two learning styles. Concrete Experience (CE) is a combination of divergent and accommodation styles. The students learn through feelings, by emphasising concrete experiences, prioritising relationships with others, and sensitivity to other emotions. In the learning process, students tend to be more open and able to adapt to the changes they experienced. Reflection Observation (RO) is a combination of divergence with assimilation types. The students learn through observation. The emphasis is observed before assessing, listening to a case from various perspectives, and always listening to the meaning of things observed. In the learning process, students will use their thoughts and feelings to form opinions. Abstract Conceptualisation (AC) combines assimilation with convergent types. The students learn through thought and focus more on logical analysis of ideas, systematical planning, and intellectual understanding of the situation or case at hand. The learning process relies more on systematic planning and developing theories and ideas to solve problems. Active Experimentation (AE) is a combination of divergence with assimilation types, students learn through action, tend to be strong in terms of the ability to carry out tasks, dare to take risks, and influence others through their actions. The learning process appreciates success in completing work, influence on others, and achievements.

Therefore, this study aims to investigate the students' problem-solving skills in terms of the Kolb learning style by using CPS. In this case, before doing the learning process, the teacher must know the student's learning style. The purpose of this study is to analyse and describe problem-solving skills in terms of the Kolb learning style. In addition, this research provides the problem-solving skills mapped with learning styles, so it can be used in everyday learning processes that students should learn.

Experimental Method

This study uses qualitative methods with the Think Out Loud approach (Olson et al., 1984; Subanji & Supratman, 2015). The research subjects were seventy-three 10th grade middle-class students in Tasikmalaya, Indonesia. The stages in this research included: developing a problem-solving skill test and modifying the Kolb learning style questionnaire; determining the validity of the problem-solving test and the questionnaire on Kolb learning style; and analysing the Creative Problem Solving (CPS) learning process, Kolb learning style questionnaire, problem-solving test, and interviews. Data collection was completed through mathematical problem-solving tests, learning style questionnaires, and interviews. Before use, the problem-solving skills test instrument was reviewed by two experts in mathematics

education, assessing face validity and content validity. Based on the considerations of both experts, the problem-solving skills test instrument was worthy of use after being revised several times. The questionnaire used in this study was a learning style questionnaire KLSI (Kolb Learning Style Inventory) that was modified. Kolb Learning Style Inventory is a list of statements consisting of four columns (Muro & Terry, 2007; Kolb, 1985): dimensions of CE, RO, AC, and AE. The KLSI's scoring guide uses the rubric: score 1: less appropriate to students when studying; score 2: somewhat according to the students when learning; score 3: according to the student when studying; score 4: very suitable for students when studying. Learning style was determined by calculating the combination score (Cavas, 2010; Kolb, 1985), AE score minus RO score (AE-RO) and AC score minus CE score (AC-CE). If the AC score minus the CE score was positive and the AE score minus the RO score was positive, then the learning style corresponds to the accommodation learning style. If the AC score minus the CE score was positive and the AE score minus the RO score was negative, then the learning style corresponds to the divergent learning style. AC score minus the CE score was negative and the AE score minus the RO score was negative, then the corresponding learning style assimilation. AC score minus the CE score was negative and the AE score minus the RO score is positive, then the corresponding learning style convergent. To find out more about students' mastery of problem-solving, learning styles were taken from each group with about 15 per cent of students randomly analysed for the answers, and then interviewed. Thus, from the divergent and accommodation types, there were two students each, while from the convergent and assimilation types there were ten students each, so there were ten students who analysed the answers.

Results and Discussion

This study applied creative problem-solving learning on seventy-three 10th grade middle-class students in Tasikmalaya, Indonesia, to explore the ability of problem-solving and learning style according to the Kolb theory. Based on the results of the questionnaire grouped into four, Table 1 presents the Kolb learning styles and the average problem-solving skills.

Table 1. Learning styles and problem-solving.

Learning Style	Number of Student (%)	Mean Problem-Solving
Divergent	13 (17.81)	17.79
Accommodation	13 (17.81)	17.53
Convergent	20 (27.40)	17.01
Assimilation	27 (36.98)	15.20

Table 1 illustrates that the results of the learning style questionnaire are divided into four groups: divergent, accommodation, convergent, and assimilation. Student learning styles are

mostly in the assimilation type and are followed closely by convergent type. Meanwhile, divergent and accommodation types are the same. Thus, based on the learning styles, students are more likely to learn through observation, doing, and thinking with various presentations from various sources. Based on problem-solving achievement, divergent, accommodation, and convergent learning type students were superior compared to learning type assimilation students. This is because, students in the divergent, accommodation and convergent types of learning style are more self-digging than students in the assimilation type. Overall students' problem-solving skills through CPS have not received satisfactory results. Table 2 presents the results of the analysis of the answers of ten students in problem-solving.

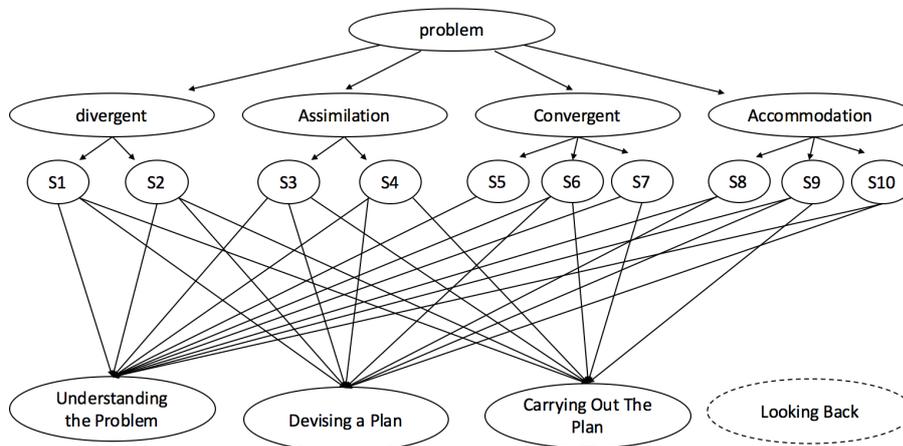
Table 2. Mathematical problem-solving analysis based on student learning styles

Learning Style	Subject	Understanding the Problem	Devising a Plan	Carrying Out The Plan	Looking Back
Divergent	S1	Capable of understanding the problem	Capable of plan problem-solving	Capable of performing calculations	Answer but wrong
	S2	Capable of understanding the problem	Capable of plan problem-solving	Capable of performing calculations	No answer
Assimilation	S3	Capable of understanding the problem	Capable of plan problem-solving	Capable of performing calculations	Answering the other way but wrong
	S4	Capable of understanding the problem	Capable of plan problem-solving	Capable of performing calculations	Answering the other way but wrong
Convergent	S5	Capable of understanding the problem	Write down the plan but not complete solutions	Do the calculation but there was an error	No answer
	S6	Capable of understanding the problem	Capable of plan problem-solving	Capable of performing calculations	Answer but wrong
	S7	Capable of understanding the problem	Planning a solution but not quite right	Capable of performing calculations	Answering the other way but wrong
Accommodation	S8	Capable of understanding the problem	Capable of plan problem-solving	Do the calculation but there was an error	No answer

	S9	Capable of understanding the problem	Capable of plan problem-solving	Capable of performing calculations	Answer but wrong
	S10	Capable of understanding the problem	Capable of plan problem-solving	Do the calculation, but there was an error	No answer

Table 2 provides an overview of the problem-solving process of each subject, in each type of learning style, and taken at random. The result of a linkage analysis between Kolb learning styles with mathematical problem-solving skills can be seen in Figure 1.

Figure 1. The link between Kolb learning styles with mathematical problem-solving ability



Considering the table, students who had divergent, assimilation, convergent, and accommodation learning styles were capable of understanding the problem and devising a plan, although there was still lack of ability to design a plan. In the Kolb convergent and accommodation learning styles, students are still working on the calculations but there are errors. In all Kolb type learning styles, students are not able to look back to solve problems in different ways, but the results are the same.

Conclusion

It was concluded that in student learning through creative problem-solving learning, the student learning style of the accommodation type is more than the convergent, divergent or assimilation type. Students with divergent and assimilation type learning styles could solve problems and understand the problems, whereas, students with convergent and accommodation style were capable of reaching an understanding of the problem stage.



Students with divergent and assimilation learning styles were capable of solving problems up to the devising a planning stage. Students with divergent, assimilation, convergent, and accommodation style learning were unlikely to reach the stage of looking back. Students with divergent and assimilation learning styles appeared to be better at solving problems up to the looking back stage.



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