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Adaptive Reasoning, Mathematical Problem Solving and Cognitive Styles

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ABSTRACT

The purpose of this research finds a link between adaptive reasoning, mathematical problem solving, and cognitive style. This research is a literature study. This paper showed the relationship between adaptive reasoning, mathematical problem solving, and cognitive styles. In particular, field-independent (FI) and field-dependent (FD) cognitive styles. Adaptive reasoning in mathematical problems is the legitimacy of problem strategies. Whereas the cognitive style provides opportunities for students to give reasonable arguments according to the tendency of the cognitive style. Mathematical problem-solving in the FI and the FD can vary according to students' cognitive styles. It was found that adaptive reasoning, mathematical problems, cognitive styles (FI, FD) have a strong stylistic relationship where adaptive reasoning will be able to give direction to students in solving math problems. Therefore, the basis for researching the adaptive reasoning profile of students in solving mathematical problems in terms of FI and FD cognitive styles is our understanding of the relationship between adaptive reasoning, mathematical problem solving, and cognitive style.

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A. INTRODUCTION

There are several competencies that students mastered as reasoning (inductive, deductive and intuitive), processing, and presenting (Ansari et al., 2020). Reasoning standard becomes important in mathematics learning, many concepts in mathematical reasoning are to formal proof and other forms of deductive reasoning(McCrory & Stylianides, 2014; Mellone et al., 2020). Adaptive reasoning indicators in previous studies include using six adaptive reasoning indicators (Yudhanegara & Lestari, 2017), using four adaptive reasoning indicators (Yanti et al., 2020), using three adaptive reasoning indicators (Syukriani et al., 2017). From the number of adaptive reasoning indicators, this paper uses two adaptive reasoning indicators namely (1) logical thinking, (2) the relationship between concepts and situations. These two adaptive reasoning indicators simplify the adaptive reasoning indicators found in previous research. The first indicator of adaptive reasoning is logical thinking. This indicator includes making assumptions, providing reasons. The second indicator, namely the relationship between concepts and situations, this indicator includes making patterns,

checking the correctness of answers, and concluding. By using these two adaptive reasoning indicators, it will be easier to see the adaptive reasoning carried out by students.

Problem-solving is the process of applying someone's knowledge to solve problems in new or specific situations (Öztürk et al., 2020). Problem-solving refers to active efforts to find what must be goals that are not easily achieved (Weiten, 2017). The ability to solve problems as an individual means to use knowledge and ability. It has previously to synthesized and applied to new and different situations (Custers, 2019; Sidenvall, 2019). The mathematical problem are problems that have a mathematical relationship that meets the following requirements: (1) can be understood and are challenging solving, (2) cannot be solved with routine procedures that have been mastered by students, and (3) involves mathematical ideas (Harianja et al., 2020). These three conditions require challenging, irregular ways of solving math problems.

Each person has a different way of knowing, seeing, and organizing information and processing information in response to mathematical problem-solving. The cognitive style is a personal character and approach to organization information and processing information. Based on the kind of cognitive style, it consists of field-independent (FI) and field-dependent (FD) cognitive styles where students who have the FI cognitive style tend to perceive separate parts of a pattern according to its components. Students who have the FD cognitive style tend to perceive patterns, and it difficult to focus attention on one aspect of a kind pattern various (Nicolaou & Xistouri, 2011; Yanti et al., 2020).

The teacher must know the kind of students' reasoning before they make plan and optimal learning. In other words, adaptive reasoning, problem-solving, and cognitive styles are interrelated. The aim shows as (1) know the relationship of adaptive reasoning to mathematical problem-solving, (2) know the relationship of adaptive reasoning to FI and FD cognitive styles, (3) know the relationship of mathematical problem solving to FI and FD cognitive styles, (4) know the relationship between adaptive reasoning, mathematical problem solving, and FI and FD cognitive styles.

B. METHODS

This research is a type of literature study research by looking for theoretical references that are relevant to the cases or problems found (Creswell, 2014). The theoretical references obtained by means of literature study research serve as the basic foundation and the main tool in formulating the notion of adaptive reasoning, solving mathematical problems and cognitive styles, and determining their relationship.

C. RESULT AND DISCUSSION

1. The Relationship between Adaptive Reasoning and Mathematical Problem Solving

Adaptive reasoning is closely related to Mathematical problem solving because it acts as a determinant of the legitimacy of problem-solving strategies (Evans et al., 2020; Öztürk et al., 2020; Yanti et al., 2020; Yazgan & Busra Sahin, 2018). In other words, mathematical solving-problems are an effort that involves thinking and reasoning skills to get a solution. Adaptive reasoning interacts with several other mathematical skills, especially mathematical problem-solving. Students demonstrate strategic competence to formulate and present a problem,

using their heuristic approaches that give a resolution strategy. But adaptive reasoning plays a role when determining the legitimacy of a selected way to solve (Khalifaeva et al., 2020; Mawardi et al., 2020; Mousavi et al., 2012; Nugroho et al., 2020; Yanti et al., 2020).

Adaptive reasoning is the capacity to think logically, think reflectively, give explanations, and provide justification. It is a critical thinking skill in finding a solution to a problem. It easy to solve the problem and is related to problem-solving because it plays a role when determining the legitimacy of the problem-solving strategy used (Villeneuve et al., 2019). Based on(Khalifaeva et al., 2020; Mousavi et al., 2012; Yanti et al., 2020), students who have adaptive reasoning abilities easily find out the correct answer they get by justifying the steps they used to get the solution.

Students will solve problems quickly, accurately and students will build their minds to master mathematical concepts for now, later and become the basis for students to act logically in mathematical activities or their daily activities. We can hope that students can be responsible for their thinking and can solve new problems using guesswork or analytically. Through adaptive reasoning, it keeps students from just memorizing concepts, but it is further from that. The relationship between adaptive reasoning and problems in mathematics is presented in Table 1.

Table 1. Relationship of Adaptive Reasoning and Mathematical Problem Solving

Stages	**Adaptive Reasoning**	**Adaptive Reasoning Problems in Mathematics**	**Code**
Understanding the problem	Think logically about the relationships between concepts and situations	1. Students mention things they know and why.	UA_1
		2. Students find the relationship between concepts and things that are known.	UA_2
		3. Students mention something asked along with the reasons.	UA_3
		4. Students find the relationship between the concepts and the things being asked.	UA_4
		5. Students find the relationship between things that are known and things that are asked.	UA_5
Devising a plan		Students formulate plans to complete plans	
		1. Making models	PA_1
		a. Plans in relating situations to concepts	$PA_{1.1}$
		b. Plans to relate the situation to the situation	$PA_{1.2}$
		c. Plans in linking concepts to concepts	$PA_{1.3}$
		2. Plans in completing the model:	PA_2
		a. Plans in linking concepts to concepts	$PA_{2.1}$
Carrrying out the plan		Students apply the plans that have been made:	
		1. Carry out the plan in making the model:	IA_1
		a. Using the link between situations and concepts	$IA_{1.1}$
		b. Using the relationship of situation to situation	$IA_{1.2}$
		c. Using concept-concept linkages	$IA_{1.3}$
		2. Carry out the plan for completing the model:	IA_2
		a. Using concept-concept linkages	$IA_{2.1}$
		3. Computing	IA_3
Looking back		Checking the validity of the relationships made in making conclusions.	L

Based on Table 1, adaptive reasoning in solving mathematical problems is the ability to think logically about the relationship between concepts and situations to find a problem solution by using problem-solving steps (Pratikno & Retnowati, 2018).

2. The Relationship between Adaptive Reasoning and Cognitive Style

Mathematical abilities are related to a person's potential includes knowledge and skills in carrying out various activities such as thinking, reasoning, mathematical problem-solving. FI and FD cognitive styles have a relationship with adaptive-reasoning (Eggen & Kauchak, 2015). Each person will choose the preferred way of processing and organizing information in response to environmental stimuli(Kusuma Dewi et al., 2020).

There are differences between FI and FD cognitive styles, where students who have a FI cognitive style tend to perceive separate parts of a pattern according to its components. Students who have an FD cognitive style tend to perceive a scheme, and it difficult to focus their attention on one aspect of the situation or analyzation a pattern into various kinds (Yanti et al., 2020). In mathematical problem-solving, students who have a FI cognitive style use their perceptions and analytics, systematically using several processes and strategies. Meanwhile, students who have an FD cognitive style are intuitive in mathematical problem-solving steps, not systematic. They were hard to develop ways to solve the problems. The characteristics inherent are thinking, remembering, solving problems, and making decisions. It shows a different way when viewed from the cognitive style of FI and FD where adaptive reasoning in solving problems of students with the FI cognitive style tends to be better than students with the FD cognitive style. Arguing that FI is superior to FD. It is certainly interesting to study more deeply how the differences occur. Adaptive reasoning is reasoning that provides opportunities for students to give reasonable arguments based on mathematical properties when looking for relationships between concepts and situations. Students have different strategic characteristics in understanding, choosing strategies, making conclusions, and providing.

3. The Relationship between Mathematical Problem-Solving and Cognitive Style

According to (Kusuma Dewi et al., 2020) students are faced with a problem. An individual has a different way of dealing with the situation because each student has not the same characteristic, one of which is cognitive style (Purwaningsih et al., 2019; Udil et al., 2017). Therefore, the way a student behaves and assesses are different. It says as cognitive style. Psychologists have seen that differences in the way people process and utilize their environment can have an effect on student learning outcomes to school. Teachers and students have their preferred strategy of structuring what they see, remember, and think. Individual differences that persist in compiling and processing information and experiences are known as cognitive styles.

Each individual has a different way of knowing, seeing, and organizing information and choosing their preferred for organization and processing information in response to environmental stimuli. Meanwhile, according to (Yanti et al., 2020), that cognitive style is an individual character and a consistent approach in organizing and processing information. So,

the cognitive style is the individual character of how these individuals think, remember, process, and solve problems and make decisions.

4. The Relationship Adaptive Reasoning, Mathematical Problem Solving and Cognitive Style

There is an effect on students' adaptive reasoning to solve mathematical problem-solving and gives direction to students in finding mathematic problem-solving (Mawardi et al., 2020; Yanti et al., 2020). Thus, it can say part of problem-solving. Meanwhile, students' problem-solving abilities in mathematics can influence several factors where these factors arise because everyone has differences. As in (Mousavi et al., 2012; Nugroho et al., 2020), states that the dimensions of different include intelligence, logical thinking skills, creativity, cognitive style, personality, values, attitudes, and interests. Problem-solving is related to the cognitive style and also involves a mental activity which is reflected in the cognitive style to receive and process information requiring knowledge and experience to have a habitual impact on students' propensity to process information. Students' cognitive style has a strong relationship with students' mathematics performance (refers to the individual's capacity to deal with changing job needs and new or unusual situations) of students' mathematics (Mousavi et al., 2012; Nugroho et al., 2020). It is not surprising that researchers around the world are very interested in examining the relationship between cognitive style dimensions and mathematical problem-solving abilities. Mathematical problem-solving of students depend on cognitive styles where the higher level of students' cognitive styles, the higher students' mathematical problem-solving (Kusuma Dewi et al., 2020).

Different cognitive styles of students can affect students' ability to think, reason, and use information in solving problems. As in (Harris, 2019; Joyce et al., 2017) it said that cognitive style is one of the learning conditions which one of the considerations in designing learning. Cognitive style sees as a determining variable on students' ability to solve story problems. In other words, the student who has the same cognitive style may not necessarily have the same. Moreover, if the person's cognitive style is different, the tendency for differences in their abilities is greater. Cognitive style shows variations between one student and another in terms of mathematical problem-solving. It not a certain level of intelligence of an individual.

Furthermore, the role of cognitive style in the learning process refers to the views of experts on the dimensions of cognitive style. The student who has a cognitive style FD, global perceptual feels a heavy burden, has difficulty and is easy to perceive when information is according to the context. Someone who has a cognitive style, a psychological differentiation, articulation will perceive it analytically. He will be able to separate the stimuli in the context, but his perception is weak when the context changes. However, psychological differences can improve through a variety of situations. FI students usually use internal factors as directions in processing information, work out of order, and feel efficient working alone. FI students are generally not easily distracted and are not easily confused, so they have good problem-solving skills. FI students in identifying problems tended to make fewer mistakes and read or find problems than FD students. FI students tend to have the best adaptive reasoning (Collins et al., 2018; Kuo et al., 2012; Matsuo & Tsukube, 2020). They showed higher results compared to FD students in solving complex word problems because of analytical in connecting concepts

to problem situations, is easy to focus in problem situations, and are not affected by the distracting components in problem situations (Purwaningsih et al., 2019). FD students tend to deal with problems globally, passively, and influenced by external factors. Furthermore, to find the relationship between concepts, representations, formulations, and very limited in choosing the right strategy.

D. CONCLUSION AND SUGGESTIONS

Based on the discussion, it can be concluded that the relation of adaptive reasoning, Mathematical problem solving, and cognitive style (FI, FD) is as follows: (a) The relationship between adaptive reasoning and mathematical problem solving are determinant of the legitimacy of problem-solving strategies; (b) The relation between adaptive reasoning cognitive style (FI, FD) provides opportunities for students to give reasonable arguments based on mathematical properties when looking for linkages between students' concepts and situations based on student tendencies with FI and FD cognitive styles; (c) The relation between mathematical problem-solving and cognitive style (FI,FD) is everyone has a different way of dealing with problems according to characteristics based on FI and FD cognitive styles; (d) The relation of adaptive reasoning, mathematical problem solving, and cognitive style (FI, FD) is give direction to students in mathematical problem-solving and students' problem-solving abilities are influenced by FI and FD cognitive styles.

Further research, we can study the other cognitive styles such as impulsive, reflexive, perceptive, receptive, visualizer, verbalizer, and other aspects such as learning styles or emotional intelligence or mathematical dispositions or other cognitive aspects.

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