Student's Behavior Base Cognitive Style In Outdoor Learning-Mathematiacal Modelling

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Abstract: The purpose of this research is to investigate students' cognitive and learning behavior such as Field Independent (FI) and Field Dependent (FD) in outdoor learning mathematical modelling. Students' learning behavior is constructed based on the cognitive activity through the cycle route of mathematical modelling in outdoor learning activities. The type of research used was qualitative with grounded theory approach. Data were obtained from 175 students and 3 teachers through students' task, observation, and deep interview. The research results show that: (1) FI students in identifying the problem are more insterested in facts, collecting information on real word problem. All FI students in building the mental of mathematical model tend to modify the scheme Extra-Mathematical Knowledge (EMK) in oder to adjust with the problem context, (2) FD students in identifying the problem tend to remember back, classifying the mental experience and then adjusted it with the problem context. FD students tend to follow the Mathematical model normatively and tend to be difficult in shifting to the next step on the transition of Real Model to Mathematical Model. FD students build the mental of Mathematics Model tend to not modifying the EMK Scheme towards the adjustment of the problem context. The results of the study suggested to teachers pay attention to students characteristics (Cognitive Style) in teaching and learning mathematical modelling

Index Terms: Cognitive Style, Field Independent, Field Dependent, Mathematical modelling, Outdoor learning.

1. INTRODUCTION

Program for International Student Assessment (PISA) is used to measure how effective is a country in preparing their students to understand and use Mathematics on each aspect of daily life [15]. The results of the study by PISA in the last ten years [28]; [29]; [30] show that Mathematical literacy ability of Junior High School Students in Indonesia is at questions level 4-6 experiencing problem, in which almost zero percent student can achieve it. The competence needed on that level is started from using Mathematics model explicitly, until building, and create the mathematics model from problem situation. This fact is supported by a study conducted by [23]; [3];[1];[37] at some schools in Indonesia found out that Junior High School students and the teacher encounter problem in Mathematical literacy ability or more specifically in modelling daily problems into Mathematics model. Mathematical Modelling and its implementation in education is relatively new in the research field either internationally [9] or in Indonesia. Many research report that through Mathematical Modelling, we can create meaningful learning [24]; [22]. Beside that, it can be said that almost all students' motivation in learning Mathematics increase when they see the relevance between what they learn and the world outside the class and other subjects [32]; [41]. The world outside class can bring the context of solving the real life problem into the construction of students' Mathematics understanding towards Mathematics relevance to real life problem [38]; [33]; [33]. Basically outdoor learning process can be done through many ways and its more flexible depending on the context and learning purpose [10]. One kind of outdoor learning approach Mathematical Modelling approach also had been developed by [35]. Outdoor Mathematical learning in Indonesia nowadays has been done and given positive impact towards learning achievement, motivation, and students' involvement in the process of learning activities [12]; [13]; [14]. Motivation and students' involvement in learning activities are one form of behavior change. According to Behavioristic Theory, learning is the change in behavior as the cause of interaction between stimulus and responses. Stimulus given by the teacher in learning is written in learning activity design. Students' characteristics in learning give effect in learning activity [34]. Likewise in learning through Mathematical Modelling apprach. The research results by Borromeo [9] explain that cognitive style (visual and analytic thinker) influence the tendency of learning styles in mathematical modelling activity. The results of those research become the foundation of this research which is how is the students' tendency behavior in outdoor learning through Mathematical approach on other cognitive styles such as Field Independent and Field Independent [39]. The specific way of a student in processing the information and domination of using brain will enable someone to describe various thinking strategies to overcome problem with the best solution, making decision and conceptualizing it. Through the preferred condition, the students will think through the best way, until by recognizing students' thinking process based on the difference in their cognitive style in constructing a mathematical concept which in this case mathematics modelling, it is expected that it then can design an effective learning strategy and can motivate the students with all potentials they have.

1.1 Litelature Review

1.1.2 Mathematical Modelling

[25] have categorized modelling in various perspectives such as realistic modelling, contextual modelling, educational modelling, socio-critical modelling, epistemological modelling, and in addition the so-called "meta-perspective" of cognitive modelling. This research uses cognitive modelling approach. This is based on the research purpose in which according to [25] the purpose of research from cognitive modelling is to describe the cognitive process during the modelling activities. Mathematical modelling can be defined as certain work or cognitive activity in the form of internal conceptual system plus external representation in the form of self interpretation from the real world problem into the form of Mathematics model in digging and understanding the real complex problem situation [15]; [20]. The identification of students learning activity in Mathematical modelling in this research used the cycle of Mathematical modelling. Basically there are many versions of Mathematical Modelling cycle [8], however in this research a cycle according to [6]; [7] was used. The usage of this cycle is based on the consideration that the research focuses on the cognitive activity expressed through verbal activities [9]. A series of cognitive activities in mathematics modelling according to [6]; [7], is illustrated in Figure 1 as follows.

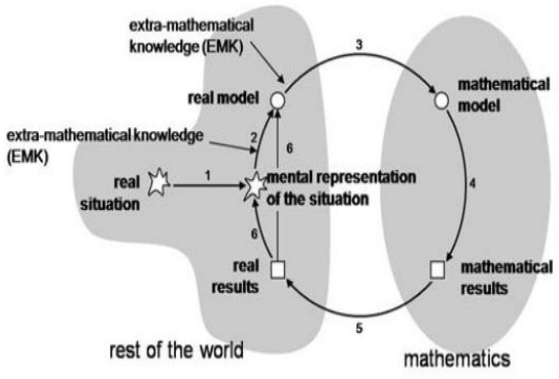

***Figure 1**. The Cycle of Mathematial Modelling in Cognitive Perspective*

Information of Figure 1:
1. Understanding the tasks;
2. Simplifying/Structuring the tasks; using/need of (EMK) depends on the tasks,
3. Mathematesizing; EMK is needed here strongly
4. Working mathematically, using individual mathematical competencies
5. Interpreting
6. Validating

The six cognitive activities obtained in figure 1 above are normative stages of someone in solving problem with Mathematics Modelling. That diagram only shows the ideal illustration of the theory of problem solving process modelling in which its normal process on someone enable to not to be linear [9]; [19]. According to [9] cognitive style has role in determining the students' characteristics on problem solving Mathematematics Modelling. The created characteristics are in the form of modelling stages route experienced by the students.

1.1.2 Cognitive Style

Cognitive style is a typical way of someone in processing the information, observing, thinking, solving the problem, and remembering [26]. Some decades ago, [39] had founded that individual's difference in visual effect is not only the mistake from the method, but also at a high consistence level on the test which generates a perception [16]. There are many interpretation relted to cognitive style, one of them is by [37] who categorizes two functions of congitive such as Field Independent and Field Dependent which are marked analytically and globally in solving various cognitive questions in the formo f Embedded Figures Test. FD and FI style are the type of cognitive style which reflects analysis way of someone in interacting with their environment. [37] explains that FI cognitive style is a cognitive style which tends to not influenced by manipulation of spieler elements in the context and able analytically to determine simple and separated parts from the real context. While FD cognitive is the cognitive style that tends to be difficult to determine simple part from its real context and easy to be influenced by manipulation of spieler elements in the context because of its global view.

2. METHODS

2.1 Research Method

This research constructed students' cognitive process during outdoor learning activities-Mathematical Modelling. The observation of cognitive process was conducted through direct observation based on emerged verbal activities and students' answer responses from the solution they offer. Therefore, this research used qualitative paradigm with Grounded Theory Approach [36]; [9].

2.2 Research Design

This research was conducted at Grade X of Junior High School in Jambi Province, Indonesia. The subject were taken from 175 students and 3 teachers. Firstly, identification on students' FI and FD cognitive style was conducted by giving GEFT test to 175 students. Based on the test results, in each class each cognitive style was represented by 4 students and then given code FI1 (FI first subject), FI2 (FI second subject), and so on. Then, each class of students given outdoor Mathematics modelling task such as "Basket Ball Field". In each that would be observed, it was conditioned by placing students with certain cognitive style by not mixing dominant FI and FD cognitive style on the group. This aimed to give chance to the students with more active cognitive style and data taken were not bias because affected by learning ways on students' dominant cognitive style. Learning implementation was conducted outside the class with the selection of place had been determined and adjusted with the task such as the parking lot and basket ball field. The learning activity was conducted for 90 minutes and all students' activities represented each cognitive style became the focus to be recorded.

2.3 Method of Data Collection

To construct the cognitive process through Mathematical Modelling Route in outdoor learning, the first step conducted was by identifying FI and FD students' cognitive style using GEFT adopted from [2] At the second stage, conducted the model of data collection Embedding the stimulated recall in a three-step design [11] such as: (1) conducting direct observation through students activity observation sheet and recorded the video of outdoor learning process, (2) This activity observation only focused on how was the students' interaction among them in the group and between the students and teachers, (3) conducting confirmation through deep interview to the students related to how was their typical way and opinion of learning mathematics on outdoor learning using real life problem context. Data collection in this research used task instrument Outdoor Mathematical Modelling as follows.

Basketball Court

Your school keeper will repaint three point area with only one color. The price of 1 Liter Paint Brand A with red color is IDR 42.000,- having spread reach 5 m^2/L with 1 painting layer to obtain maximum result, while the price of 1 Liter paint Brand B with blue color is IDR 38.000 having spread reach 10 m^2/L with two layers painting to obtain the maximum results. What paint must be bought by the school keeper to save the budget? Give the reason of your question by using many ways of different problem solving! Observe the basketball court at your school and then write down the information needed.

2.4 Data Analysis

Data the result of learning records, wide observation, and the interview, the analysis of task answer, then transcription and reduction were conducted, followed by coding in which the procedure of coding in this research used coding techniques by [36]. In this research used two code classification, they were: (1) structural code taken from the individual's learning activities towards the teacher and the group friends, task analysis modelling, (2) theoretical code taken from the cycle rout of Mathematical Modelling, FI and FD cognitive styles, and discussion themes among the students and the teacher. The construction of transition process of students' activity was based on the cycle of Mathematical Modelling [21]; [9]. The following Table 1 explains some examples of coding based on Mathematical Modelling activity, in which each identification wold appear or at least in the learning

Table 1. Classification of Coding based on Mathematical Modelling Activities

No	Route of Mathematical Modelling	Activities of Mathematical Modelling	Yes	No
1	Real Situation	Identification of Real Situation Problem	√	
	Mental Representation Of Situation	Understanding and recognizing Mathematical Problem		√
2	Real Model	Assuming the problem	√	
		Recognizing Mathematical Background needed	√	
	Mathematical Model	Estimating variables and determining relevant variables	√	

3. RESULTS AND DISCUSSIONS

3.1 Cognitive Field Independent and Field Dependent Style

Cognitive style classification is obtained through GEFT test on 175 students. The research results show that 25 students have FI cognitive style, 54 FD cognitive style, and 96 with intermediate category. Through the consideration of purposive sampling, then chosen 4 highest scores for FD students with score range 17 – 18 on FD students chosen with score range 1 to 4. The consideration of this selection is meant to see the tendency of so that the researcher can easily see the characteristics of each constructive style.

3.3 Learning Activity of Outdoor Mathematical Modelling

The learning was conducted by following the learning stages of outdoor Mathematical Modelling [35], they are; (1) Students' orientation towards the contextual problem, (2) collecting the data, (3) making plan for problem solving, (4) conducting experiment, and (5) presenting the result and reflection.

Figure 1 *Students' activities in collecting data in the form of outdoor learning*

3.4 Learning Activities of FI students in Outdoor Learning Mathematical Modelling

Based on data analysis according to the cycle of Mathematical Modelling, then obtained construction route of Mathematical Modelling of FI students as follows:

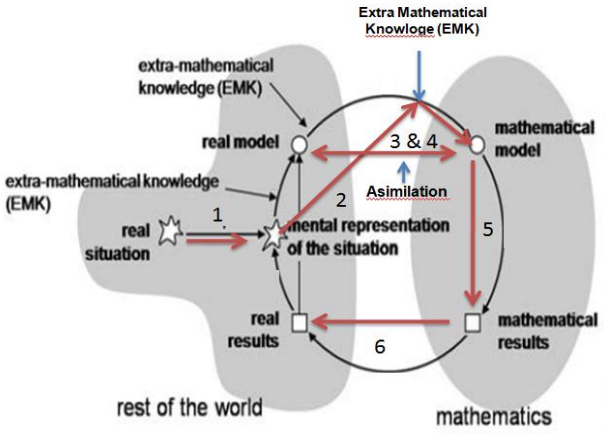

Figure 2 *The route of Mathematical Modelling FIS tudents*

Information of Figure 2:

1. Problem understanding
2. Building Mathematical Model
3. Simplifying the problem
4. Building Mathematical Model
5. Finding Mathematical solution
6. Result interpretation

The thinking process of obtaining mental understanding on Mathematical Model of FI students in Figure 1 is constructed based on the results of itnerview, video of students' activity observation and the results of students task problem solving result.

Theacher: First step, what do you do? How do you answer it?

FI1 01: I had just seen the court, Mam, the three point area consists of two cycles and rectangle, thus it looks like using the concept of the wide of area to determine the usage of paint (Real Situation ➔ Mental Representation Situation ➔ Mathematics Model).

FI2 02 : I find out what is known to determine how to solve it, Sir.

The results of interview on FI01 student proposing a Mathematical concept which is the area of rectangle, this means the FI students need Extra Mathematical Knowledge

(EMK) before making a Mathematical Modelling at the initial stage. EMK is defined as on of Mathematical knowledge needed to solve the problem [7]. It can be seen that FI did understanding on the problem context from outdoor environment and FI2 also had seen directly determining his Mathematical Modelling. Then FI students already can determine Mathematical solution to solve the problem although it is not correct yet (Real Situation ➔Mental Representation Situation ➔ Model Mathematics).
The process of students' activity continued. FI students need structuralization problem for making the right Mathematical Modelling. After the students measure three point area in the court.

Student 01: What structures are in these?
FI103: Let's just draw the court (student FI01 drew the court and wrote the problem variables on problem in Figure 3).

Seemed there was conversation between FI01. FI students need Real Model stage in which beforehand FI was already at Model Mathematics stage which was imperfect yet (Real Model ← Model Mathematics).

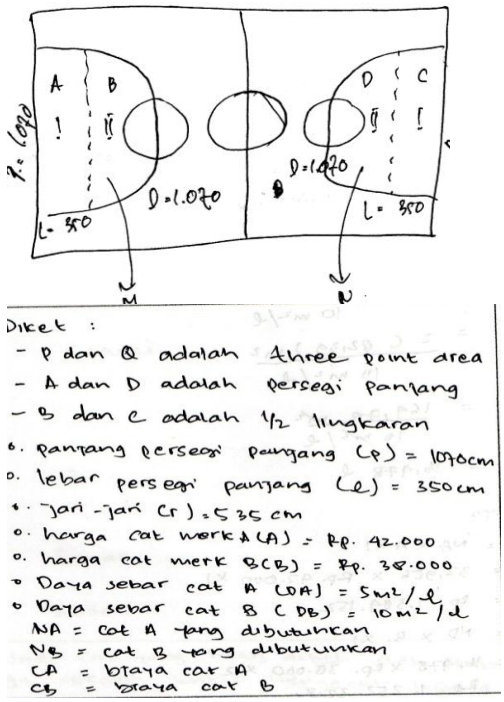

Figure 3. *The representation of FI students to bulid Real Model*

In figure 3 above, it can be seen that FI students are more detailed in organizing the facts obtained in the problem. This is also confirmed through the answer from FI2 02 student. The tendency of FI students for directly aiming for the Mathematics Model stage with the imperfect scheme will make the condition in which FI students will be back to the stage of problem model marked with the activity of simplifying/structurizing the problem details. This activity gives the scheme for then FI students determine and estimate the variable and build the mathematics model which comprehensively can be used to solve the problem. After obtaining more detail description from the structuralization of the problem, FI students get back to Model Mathematics stage.

FI1 04: We add the area of half circle with the area of rectangle, then we divide with the power of absorption of the paint then multipled with the paint price.

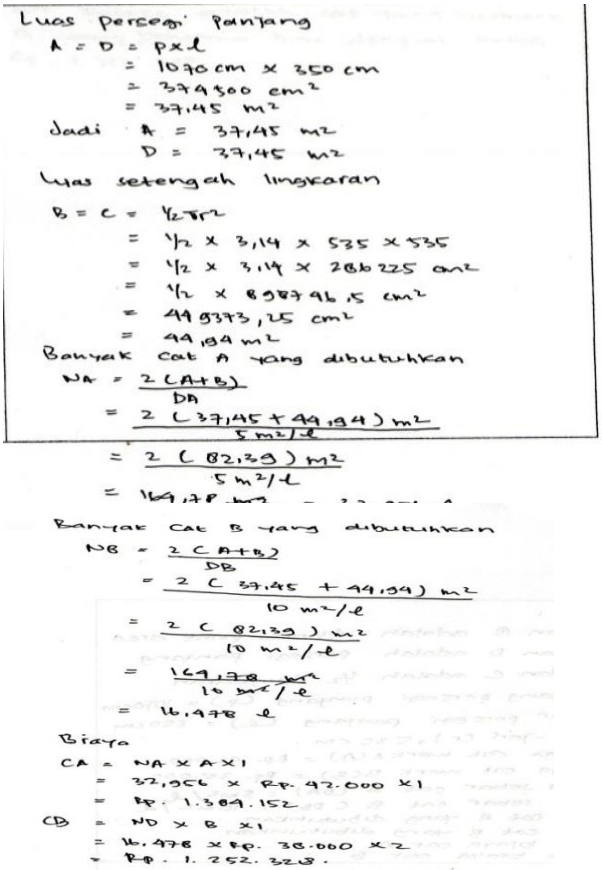

Figure 4. *The Result of Problem Solving by FI Students*

FI1 04 conversation and the student's figure make a Mathematics Model for determining the cost of buying the paint (Real Model ➔ Model Mathematics). The acquisition of the understanding on the Mathematics Model Mental departs from the context of the real problem, then FI students conducted the activity of problem comprehension (identification, recognizing the Mathematical problem), through the mental information scheme owned by FI students, then interpreted, integrated with the problem context, until it becomes the problem comprehension (MRS) from the real situation. FI students tend to head for Mathematic model stage. FI students' tendency to head for Mathematics model after MRS stage is in line with and strengthened by the research results by [9] on students with analytical cognitive style. This is because on one of the students' characteristics, FI students have analytical style, until this enables them to have relatively the same tendency which have analytical cognitive style in the context of Mathematics modelling. The mental structure of FI students in understanding the problem context tend to be faster if compared to FD students. This is because FI students can and not easily tricked by irrelevant components in the problem context and can analytically determine the simple parts separated from its real context [39].

Another factor which supports the characteristics of FI students to be faster in mental structure of problem understanding is that the ability of structuralizing, organizing objects that are not organized by FI students yet. Phifer in [27] argues that FI students more tend to remember the information significantly on Mathematics/Scientific parts. This statement can explain the research results that why FI students tend to be interested in the question facts in the activity of problem comprehension. It can be understood too that by remembering the facts of information in the question, FI students try to do understanding through the ways they like. FI students through the memory schemes at the second stage (FI104), will be accomodated, modified to create Mathematics model which is suitable with the problem context. Accomodation is the process of integrating the new stimulus indirectly, and occurs modification of schemes and create the new schemes (Suherman et. al., 2003). The students can modify the scheme they already have from problem identification activity and EMK becomes the new scheme in the form of Mathematics model in line with the problem context. At the stage of position 3 and 4 certainly become the important parts to be considered in learning delivery because it is possible that FI students experience failure in determining the problem details until the model being built becomes less correct. This occurs on some FI students which can be observed based on the the answers (FI3 student) who is already able to recognize the background of Mathematical needed suitable with the context. However in the next model stage, FI students cannot connect the model scheme being built beforehand.

3.5 Mathematical Learning Activities of FD Students on Mathematical Outdoor Learning

The route of Mathematics Modelling of FD students based on the analysis of the interview results task-based are illustrated in Figure 5 as follows:

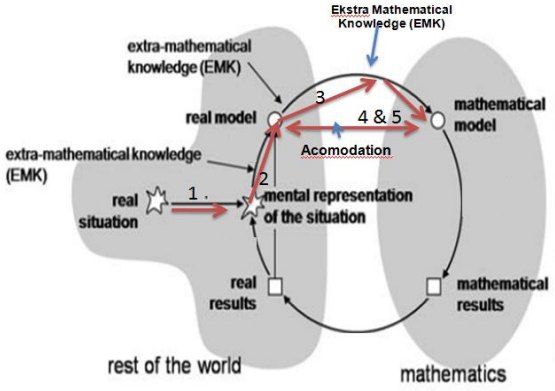

Figure 5. *The Route of Mathematical Modelling of FD Students*

Information of Figure 5:

1. Problem understanding
2. Simplifying the problem
3. Building Mathematics Model
4. Simplifying the problem
5. Building Mathematics Model

The same thing is done to FD students as the process which has been done on FI students. Students' activity is started with understanding the problem on the context of real problem, the understanding of Mathematics model mental of FD students is obtained through the activity of understanding the problem (identification, recognizing Mathematical problem).

Teacher: What is the first step that you will do? How will you answer it?
FD1 01 : Yes, first I pay attention on the questions and the form of the basketball court, if from the question, it seems like paint A needs to be bought first, Sir.
Teacher: How could it be like that?
FD1 02 : Because paint A just needs once to paint and no need twice, then paint B needs twice sir. Usually, if I paint my home twice like that it will need much paint.
Teacher: Do you know what Mathematical concept that you will use to solve this question?
FD1 02 : Not yet, Sir. I will understand it first.

After the initial discussion with the teacher, the students with their group make problem structuralization like in Figure 6 below:

Figure 9 *The representation of FD students to bulid Mathematical model*

The initial activity of Mathematical modelling by FD students tend to reremember, group the mental experience then compared with the problem context, this activity takes FD students at MRS stage (Real Situation ➔ Mental Representation Situation ➔Real Model). This result is in line with Phifer opinion in [27] that FD students more remembering the parts with social orientation, in which students' experiences are part of social life. In the context of problem of Mathematics modelling which its context comes from daily life enables FD students to use their characteristics in understanding the problem which is remembering the experience they have beforehand. After at Real Model stage, FD students work with their group to make their Mathematics Modelling (Real Model ➔ Mathematical Model).

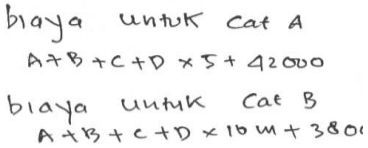

Figure 8. *The representation of FD students to bulid Mathematical model*

Teacher : Try to explain your answer, how to determine the paint that must be bought?
FD2 04 : First I find the area of the circle and the rectangle, after that I multiple with the absorption power and the price of the paint.

The formed memory scheme from MRS is recalled and integrated with the problem context until it creates new scheme in the form of problem understanding in simple form of problem. Through EMK owned by FD students then integrated with the scheme of problem simplifying, FD students start to try to know the Mathematical knowledge needed to solve the problem (the concept of rectangle and circle). The research results show the scheme integration and EMK to form suitable Mathematics model with the problem of the question is not running well (Figure 8 and FD 04). FD students tend to assimilate the stimulus from the scheme owned beforehand, until Mathematics model formed tend to be not suitable yet with the problem solving. The results of this research strengthened more what has been explained by [21] and [31] that individual knowledge, related to the comprehension of certain problem situation causes varied model of mental formed and individual's construction until this determines the representation of the individual themselves. To form the suitable Mathematics model with the problem solving, FD students did again problem simplification, and in this stage the cycle occurs, the research results show that FD students get confused, doubt in determining the problem and the suitable solving, until they try to understand again the problem in the question. It becomes clear that the construction of students' modelling route which is viewed from FI cognitive style is not linear with the cycle of modelling normatively. This can be different on other cognitive styles. [9] proves that there is effect of cognitive styles (analytic and visual) towards the learning activities of students' Mathematics Modelling. Based on the results of this research, this strengthened more the statements that cognitive style creates special characteristics on each individual in the process of Mathematics Modelling.

4 CONCLUSIONS

The process of thinking FI and FD students constructed based on the route of Mathematics Modelling show particular characteristics when solving the problem of modelling in each cognitive style. FI students tend to be able to conduct the whole process of modelling well and not follow the cycle route of modelling normatively. FI students can build the mental of Mathematics model which is suitable with the problem context. FD students tend to follow the cycle of Mathematics model normatively and frequently trapped in the model of Mathematics Problem-model, and mental model built has no modification scheme in adjusting with the problem context

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