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COGNITIVE PROFILE OF SUBJECT 1 ABOUT PHILOSOPHY, PRINCIPLES AND CHARACTERISTICS OF REALISTIC MATHEMATICS EDUCATION BEFORE AND AFTER STUDYING THE REALISTIC MATHEMATICS EDUCATION LEARNING RESOURCE

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Abstract

The purpose of this study to create cognitive profiles of elementary school teachers who have been and have not been following the PMRI workshop, before and after they learning about the realistic mathematics education learning resource in understanding about philosophy, principles, and characteristics of realistic mathematics approach. The type of research used in this study is a combination of qualitative research and developmental research. The developmental research is used to construct a realistic mathematics education learning resource. The analysis steps of qualitative data which was built by Miles and Huberman (1994) is used to create cognitive profiles of teachers who become the subject research. The triangulation process of data used in this study is the triangulation of method. The results presented in this paper are the cognitive profile of one subject who is a PGSD student. Research subjects involved in the trial for the first task, the learning resource, and second task are six persons, which consists of three PGSD students who are working on the final project, and three elementary school teachers.

Key Words: cognitive profile, realistic mathematics education, the realistic mathematics education learning resource, design research, and qualitative research.

INTRODUCTION

Realistic Mathematics Education Indonesia (PMRI) is an implementation of realistic mathematics approach in Indonesia, which began in 2001. PMRI movement is a movement to apply a realistic mathematical approach in teaching and learning process in mathematics. The aim of this movement is to improve the quality of teaching and learning process in mathematics. The implementation of PMRI started from primary level, and was started by 4 LPTK (Institute of Teacher Training). In the initial implementation, the 4 LPTK collaborated with 12 elementary/MIN. The implementation process always started with a workshop for school teachers who want to implement PMRI. There are two levels of the workshop held by the PRI team, namely local workshops and national workshops (Suryanto et al., 2010).

According the researcher, there is a quite fundamental weakness of the workshop, namely that the material given in the workshop was not illustrate how a teacher do the progressive mathematization process. The materials given in the workshop were about contextual issues that can be used by teachers to teach a mathematical concept, and models of solution that may be made by the student to solve the contextual issues (models of), but the next steps that need to be

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done to help the students to achieve a model for and finally a formal mathematical knowledge were almost never given. Consequently, the understanding of teachers who attended workshops on progressive mathematization process is not complete.

This conjecture is supported by the findings that were founded by the researcher when the researcher observed on the teaching and learning process undertaken by teachers who attended the workshop PMRI when they are taught in class. The findings are teachers had difficulties to do the progressive mathematization process. One finding was discovered by the researcher when the researcher observed in grade two on September 30 and October 1, 2010. The teaching and learning process already begins by providing contextual issues that can be used by students in the phenomenological exploration, but in the next step the teacher did not give a series of problems associated with the given problem in the beginning so that the process of progressive mathematization may occur.

Base on some input from some teachers who attended the workshop PMRI that give to the researcher, the researcher knew that there were teachers who did not understand about the philosophy, principles, and characteristics of realistic mathematics approach and they had a desire to learn about realistic mathematics approach from various references, but in the process of learning they are often hampered by the language factor. Because it is for now, the realistic mathematics approach references are more in English than in the Indonesian language. According to researcher, if the teacher can learn from a reliable reference about the philosophy, principles, and characteristics of realistic mathematics approach by themselves, the teacher will also be able to construct an understanding of the philosophy, principles, and characteristics of realistic mathematics approach. Therefore, in this study, the researcher want to know about the understanding of teachers who have and have not participated in the PMRI workshop about the philosophy, principles, and characteristics of realistic mathematics approach before and after they learned the realistic mathematics approach learning resource by themselves. In other words, by doing this research, the researcher would like to get an answer for the question of how cognitive profiles of teachers who have and have not participated in the PMRI workshop before and after studied the RME learning resource compiled by the researcher.

Research Questions

From the introduction that was outlined by the author, the author noticed that there are problems that need to look for the answer sought through a process of research, namely:

1. How are the cognitive profiles about the philosophy, principles, and characteristics of realistic mathematics approach of elementary school teachers who have and have not been following the PMRI workshop before they study the RME learning source?
2. How are the cognitive profiles about the philosophy, principles, and characteristics of realistic mathematics approach of elementary school teachers who have and have not been following the PMRI workshop after they study the RME learning source?

Research Methodology

Broadly, the steps are carried out by the researcher in building cognitive profiles above are as follows:

1. Making an observation sheet, a worksheet 1 and 2, an interview sheet, student learning materials, and teacher guides.
2. Validating an observation sheet, an interview sheet, student learning materials, and teacher guides.
3. Implement student learning materials and teacher guides, and make a recording of the implementation process of student learning materials and teacher guides. The results of the

implementation of the two become examples to explain about the philosophy, principles, and characteristics of realistic mathematics education in the learning resource.

4. Building the learning resource for teachers that contains: a description of the philosophy, principles, and characteristics of realistic mathematics approach with simple language that needs to be understood by research subjects. The steps used to build the learning resource followed the developmental research steps.
5. Trying out of the worksheet 1 and 2, the interview sheet, and the learning resource to 3 PGSD students , and 3 elementary school teachers.
6. Making cognitive profiles of research subjects involved in the trial.

Design Research

According Akker, Gravemeijer, McKeney, and Nieveen (in Akker, Gravemeijer, McKeney, and Nieveen, 2006), design research can be characterized as:

1. Interventionist: the research leading to the design of an intervention in the real world.
2. Iterative: the research incorporates a cyclic approach to the design, evaluation, and revision.
3. Process-oriented: a model of research that avoids the measurement of inputs and outputs, focus on understanding and improving interventions.
4. Oriented to usability: the benefits of design is measured by looking at the practicality of the design for the user in reality.
5. Oriented to the theory: design (at least partially) made by theories that already exist, and field testing of the design contribute to the development of the theory.

According Gravemeijer and Cobb (in Akker, Gravemeijer, McKeney, and Nieveen, 2006) there are three phases in the design research, namely

1. The first phase: preparation of trial design.
2. Second phase: trial design.
3. The third phase: a retrospective analysis.

Qualitative Research

According to Denzin and Lincoln (in Merriam, 2009), qualitative research is an activity that puts the observer in the world. According to Denzin and Lincoln (in Merriam, 2009), a qualitative researcher studies things in their natural situation, try to consider, or interpret the phenomena. Van Manen (in Merriam , 2009) says that qualitative research is an umbrella term that covers an unity of interpretation techniques that try to describe, encode, translate, and interpret naturally occurring phenomena in the social world .

According to Merriam (2009), there are four characteristics of the qualitative research, namely:

1. Focus on meaning and understanding.

   Qualitative researchers are interested in how people interpret their experiences, how they construct their world, and what meaning they attribute to their experiences. Overall, the goals of qualitative research are to achieve an understanding of how people make sense of their lives, to describe the interpretation process, and to describe how people interpret their experiences.
2. The researchers are the main instrument for data collection and analysis.
3. An inductive process.

   Other important characteristic of the qualitative research is an inductive process, which the

researchers collected data to build concepts, hypotheses, or theories.

4. The results of qualitative research are a rich description

According to Miles and Huberman (1994), there are three stages in the analysis of the qualitative data, namely:

1. Data reduction.
   The process of data reduction is related with the electoral process, centralization, simplification, abstraction, and transformation of data obtained from the script and transcription from the research field. Data reduction occurs continuously throughout the qualitative research conducted. Data reduction can be initiated before the data is actually collected (anticipatory data reduction).
2. Presentation of data.
   Presentation of data is the organized information is and do not contain things that are not relevant which allows making conclusions and actions.
3. Making conclusions and verification
   Making conclusions and verification are a process to record the regularities, patterns, explanations, links between one part and other part, causality, and statements that can be inferred from the existing data. A skilled researcher do not view these conclusions as something that is final, maintaining an openness and skepticism attitude, though the conclusions of global first and blurred, then rise and fundamental explicitly. Final conclusions will not appear until the collection data process is completed.

Denzin (1978 in Merriam, 2009) proposes four types of triangulation, namely: (1) method triangulation, (2) triangulation of data sources, (3) researcher triangulation, and (4) theory triangulation. In the method triangulation, qualitative researchers use a variety of methods to approximate the data. For example, data obtained from interviews with research subjects is cross-checked with data obtained from observation and reading documents. If it is done by qualitative researchers, it can be said that the researchers used the method triangulation and the method used to approximate the data is by interview, observation, and reading documents (Merriam, 2009).

Realistic Mathematics Education

Tabel 1. The component of RME and the element of each component of RME

Component of RME	The element of each component of RME
Philosophy	Mathematics as a human activity.
Meaning of mathematics as a human activity	1. Mathematics is constructed from human activities. 2. Mathematics can be implemented in human activities.
Principles	There are three principle PMR, namely: 1. Guided reinvention and progressive mathematizing. 2. Didactical phenemenology. 3. Self developed models.
Principle 1a: guided reinvention.	1. The reinvention process of the concepts and procedures of mathematics is done by the students themselves. 2. There is the guidance process in the reinvention process of the concepts and procedures of mathematics by students.
Principle 1b: progressive mathematizing	1. Mathematizing process. 2. Horizontal mathematizing process. 3. Vertical mathematizing process. 4. Progressive mathematizing.
Principle 2: didactical phenomenology	There is a phenomena or a contextual problem explored by students.

Principle 3: self developed models	1. There are models that are built as a result of the mathematizing process. 2. A model is a mathematics representation form of the problem and the solution of the problem in the problem solving process. 3. The are four levels in the model, i.e. situational model, model of, model for, and formal model.
Characteristics	Five characteristics of RME are 1. phenomenological exploration; 2. bridging by vertical instruments; 3. student contributions; 4. interactivity; 5. intertwining.
Characteristic 1: phenomenological exploration	1. There are phenomena that can be explored by students to bring them to mathematizing, horizontal mathematizing, vertical mathematizing, and progressive mathematizing. 2. There are phenomena that can be explored by students to make them to a situational model, a model of, a model for, and a formal model. 3. At the end, the phenomena explored by students can bring them to the reinvention process of the concept and procedure of mathematics. 4. The first role of the contextual problem in realistic mathematics approach is to establish the mathematics concept and procedure, and the second role is to implement the concept and procedure of mathematics that has been owned by the student. 5. Definition of a contextual problem.
Characteristic 2: bridging by vertical instruments	1. The definition of mathematizing. 2. The four stages of the problem solving process are (1) the presentation of the problem, (2) write the problem in the language of mathematics, (3) solve the problem mathematically, and (4) translate the solution to the context. 3. The definition of horizontal mathematizing. 4. The definition of vertical mathematizing. 5. The definition of progressive mathematizing.
Characteristic 3: student contributions	1. The definition of of models. 2. Students contribute to mathematizing, horizontal mathematizing, vertical mathematizing, and progressive mathematizing. 3. Students contribute to a situational model, a model of, a model for, and a formal model. 4. At the end, the students contribute to the reinvention process.
Characteristic 4: interactivity	1. Students receive the guidance from the "adult" in the mathematizing, horizontal mathematizing, vertical mathematizing, and progressive mathematizing. 2. Students receive the guidance from the "adult" in the

	constructing process of a situational model, a model of, a model for, and a formal model. 3. At the end, the guidance of the "adults" can bring students to the reinvention process. 4. A negotiation process occurs between the students in the mathematizing, horizontal mathematizing, vertical mathematizing, and progressive mathematizing. 5. A negotiation process occurs between the students in the constructing process of a situational model, a model of, a model for, and a formal model. 6. At the end, a negotiation process occurs between the students bring them to reinvention process of the concepts and procedures mathematics.
Characteristic 5: intertwining.	In order to set up a comprehensive formal mathematical knowledge, it is in the constructing process of the formal mathematical knowledge, students need to get a chance to make the fabric between the knowledge which they already have and the new knowledge.

Cognitive Profiles

In this part, the researcher provides the cognitive profiles of research subject 1 about the philosophy, principles, and characteristics of realistic mathematics education before and after the subject research studied the learning resource.

Table 2. Cognitive profiles of subject research 1 about the philosophy, principles, and characteristics of realistic mathematics education before and after the research subject studied the learning resource.

Components of RME	**Cognitive profiles before the subject research studied the learning resource**	**Cognitive profiles after the subject research studied the learning resource**
Philosophy	The subject could not mention the philosophy of RME.	The subject could not mention the philosophy of RME.
Meaning of mathematics as a human activity	The subject just has the understanding about element 2 of the meaning of the philosophy of RME.	The subject already has the understanding about element 1 and 2 of the meaning of the philosophy of RME.
Principles	The subject can not mention three principles of RME.	The subject can not mention three principles RME.
Principle 1a: guided reinvention.	The subject already has the understanding about the element 1 of the guided reinvention principle.	The subject already has the understanding about the element 1 and 2 of the guided reinvention principle, although the understanding of the subject about element 1 is not yet complete.
Principle 1b: progressive mathematizing	The subject has the understanding about element 1 of the progressive mathematizing principle, but not deep.	The subject has the understanding about element 1 of the progressive mathematizing principle, but not deep and not evolve from the previous understanding.
Principle 2: didactical phenomenology	The subject already has the understanding of the didactical phenomenology principle, but the understanding about the phenomenon	The subject understanding about the didactical phenomenology principle is not evolve from the previous understanding.

	is still limited to the experiences of everyday life.	
Principle 3: self developed models	The subject has the understanding about element 1 of the self developed models principle.	The subject has the understanding about element 1 of the self developed models principle, but the subject understanding more explicit.
Characteristics	The subject mentioned two characteristics of RME, namely the phenomenological exploration, and the student contributions.	The subject mentioned seven characteristics of RME.
Characteristic 1: phenomenological exploration	• The subject does not have the understanding about the elements 1-3 of the phenomenological exploration characteristic. • The subject does not have the understanding about roles of contextual problem. • The subject understanding about the contextual problem is limited on the daily life problem.	• The subject has the understanding about the elements 1-3 of the phenomenological exploration characteristic, but not yet complete. Because the subject can't explain that the students can construct the mathematics concepts and procedures pass through the phenomena exploration activity. • The subject already has the understanding about the first role of the contextual problem. • The subject understanding about the contextual problem is limited on the daily life problem.
Characteristic 2: bridging by vertical instruments	• The subject already has the understanding about the mathematizing, but not complete. Because the subject did not explain about the results of mathematizing. • The subject does not provide an explanation about the problem solving stages, horizontal mathematizing, vertical mathematizing, and progressive mathematizing.	• The subject already has the understanding about the mathematizing. • The subject doesn't have an idea about how many, and what are the stages of problem solving. • The subject already has the understanding about horizontal mathematizing, but not yet complete. Because the subject has not been explained on the results of the horizontal mathematizing. • The subject already has the understanding about vertical mathematizing, but not yet complete. Because the subject doesn't fully explain about the process that occurs in the vertical mathematizing. • The subject already has the understanding about progressive mathematizing.
Characteristic 3: student contributions	• The subject does not have the understanding about the definition of the model. • The subject does not have the understanding about the element 2 and 4 of the student contributions	• The subject does not have the understanding about the definition of the model. • The subject has the understanding about the element 2 - 4 of the student contributions characteristic

	characteristic, and the subject already has the idea about the element 3 of the student contributions characteristic.	
Characteristic 4: interactivity	• The subject has the understanding about the element 6 of the interactivity characteristic.	• The subject has the understanding about the element 6 of the interactivity characteristic.
Characteristic 5: intertwining.	The subject does not understand that the teacher need to help students to make the fabric of students' knowledge, and why the teacher need to help students to make the fabric of students' knowledge.	The subject does not understand that the teacher need to help students to make the fabric of students' knowledge, and why the teacher need to help students to make the fabric of students' knowledge.

CONCLUSIONS

The learning source that made by the researcher about the philosophy, principles, and characteristics of RME can help the research subject to have the cognitive profiles about

1. Element 1 of the meaning of RME philosophy.
2. Element 2 of the guided reinvention principle.
3. Characteristic of RME.
4. Element 1 – 3 of the phenomenological exploration characteristic.
5. The first role of the contextual problem.
6. Horizontal and vertical mathematizing, though not yet complete.
7. Element 2 – 4 of the student contributions characteristic.

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