COGNITIVE PROFILE OF SUBJECT ABOUT PHILOSOPHY, PRINCIPLES AND CHARACTERISTICS OFREALISTIC MATHEMATICS EDUCATION BEFORE AND AFTERSTUDYING THE REALISTIC MATHEMATICS EDUCATION LEARNING RESOURCE

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Abstract

This study aim to create cognitive profiles of elementary school teachers who have been and have not been following the workshop PMRI, before and after they learning about the realistic mathematics education learning resource in understanding about philosophy, principles, and characteristics of realistic mathematics approach. This 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 shown in this paper is the cognitive profile of one subject who is a private elementary school teacher. 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. The learning source that made by the researcher about thephilosophy, principles, and characteristics of RME can help the research subject to have the cognitive profiles inter-alia about (1) the RME philosophy, (2) progressive mathematizing, (3) the didactical phenomenology principle, and (4) the subject 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.

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

Introduction

Pendidikan Matematika Realistik 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 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.

Based 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?

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 which 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

Table 1 The component of RME and the element of each component of RME

Component of RME	The elementof each component of RME
Philosophy	Mathematics as a human activity.
Meaningofmathematicsas ahuman activity	1. Mathematicsis constructedfromhumanactivities. 2. Mathematicscan be implemented inhuman activities.
Principles	There arethreeprincipleRME, namely: 1. Guided reinvention and progressive mathematizing. 2. Didactical phenemenology. 3. Self developed models.
Principle 1a: guided reinvention.	1. The reinvention process ofthe conceptsandprocedures of mathematicsis doneby thestudents themselves. 2. There is the guidance processin the reinvention process ofthe conceptsandprocedures of mathematicsbystudents.
Principle 1b: progressive mathematizing	1. Mathematizing process. 2. Horizontal mathematizing process. 3. Vertical mathematizing process. 4. Progressive mathematizing.
Principle 2: didactical phenomenology	There is aphenomenaor a contextualproblemexplored bystudents.
Principle 3: self	1. There are modelsthatare builtas aresultof

developed models	themathematizing process. 2. A model isa mathematics representation form of the problem and the solution of the problem in the problem solving process. 3. There are four levelsin the model, i.e. situationalmodel, model of, modelfor, andformalmodel.
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 arephenomenathatcan beexplored by students to bringthemto mathematizing, horizontal mathematizing, vertical mathematizing, and progressive mathematizing. 2. There arephenomenathatcan beexplored by students to makethemto a situationalmodel, a model of, a modelfor, and a formalmodel. 3. At the end, the phenomenaexploredbystudents canbringthemto the reinvention process ofthe conceptandprocedure of mathematics. 4. The firstroleof the contextualprobleminrealistic mathematicsapproach is toestablishthe mathematics conceptandprocedure, and the second role is to implementthe conceptandprocedure of mathematicsthat has been ownedbythe student. 5. Definitionofa contextual problem.
Characteristic 2: bridging by vertical instruments	1. The definition of mathematizing. 2. The fourstages of the problem solving process are (1) the presentation ofthe problem, (2) write the problemin the language ofmathematics, (3) solve the problemmathematically, and (4) translatethe solutiontothe 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. Studentscontribute tomathematizing, horizontal mathematizing, vertical mathematizing, and progressive mathematizing. 3. Studentscontribute toasituationalmodel, a model of, a modelfor, and a formalmodel. 4. At the end, the studentscontribute tothe reinvention process.
Characteristic 4: interactivity	1. Studentsreceive the guidancefrom the"adult" in the mathematizing, horizontal mathematizing, vertical mathematizing, and progressive mathematizing. 2. Studentsreceive the guidancefrom the"adult" in the constructing process of a situationalmodel, a model of, a

	modelfor, and a formalmodel. 3. At the end, the guidanceof the"adults" can bringstudentsto the reinvention process. 4. A negotiation process occursbetween thestudents in the mathematizing, horizontal mathematizing, vertical mathematizing, and progressive mathematizing. 5. A negotiation process occursbetween thestudents in the constructing process of a situationalmodel, a model of, a modelfor, and a formalmodel. 6. At the end, a negotiation process occursbetween thestudents bringthem to reinvention process ofthe concepts and procedures mathematics.
Characteristic 5: intertwining.	In order toset upa comprehensive formalmathematicalknowledge, it isinthe constructing process of a formalmathematicalknowledge, studentsneed toget achanceto makethe fabric between theknowledgewhichthey already have andthe new knowledge.

DataCollection Method

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.

Cognitive Profiles

In this part, the researcher provides the cognitive profilesof research subject2aboutthe philosophy, principles, andcharacteristics ofrealistic mathematicseducationbefore and after the subject research studied thelearning resource.

Table2 Cognitive profiles of subject research 2about thephilosophy, principles, andcharacteristics ofrealistic mathematicseducationbefore and after the research subject studiedthelearning resource.

Component of RME	Cognitive profiles before the subject research studied thelearning resource	Cognitive profiles after the subject research studied thelearning resource
Philosophy	The subject can not mention the philosophy of RME.	The subject can mention the philosophy of RME.
Meaningofmathematicsas ahuman activity	• The subject does not have the understanding about the component 1 of the meaning of RME philosophy. • The subject already hasthe understanding and be able to provide examples about the component 2 of the meaning of RME philosophy.	• The subject' understanding about the meaning of RME philosophy not evolves from the previous understanding.
Principles	The subjectcan not mention about how many and what are the principles of RME.	The subject can not mention about how many and what are the principles of RME.
Principle 1a: guided reinvention.	The subject already hasthe understanding about the component 1 and 2 of the guided reinvention principle, but the subject understanding aboutcomponent 1 has not been fully. Because students are not only expected to only be able to find the formula/procedure, but students are expected to find a concept as well in the reinvention process.	The subject already has fully understanding aboutcomponent 1 and 2 of the guided reinvention principle.
Principle 1b: progressive mathematizing	The subject does not have the understanding about the progressive mathematizing principle.	The subject already has the understanding about the progressive mathematizing principle, though not yet complete. What is understood by the subject are about mathematizing, vertical mathematizing, and progressive mathematizing. The subject understanding has not been touched on horizontal mathematizing and sustainability in horizontal mathematizing.
Principle 2: didactical phenomenology	The subject does not have the understanding about the	The subject has the understanding about the

	didactical phenomenology principle.	didactical phenomenology principle.
Principle 3: self developed models	The subject does not have the understanding about the self developed models principle.	The subject does not have the understanding about the element 1, 2, and 3 of the self developed models principle.
Characteristics	The subjects can not mention how many and what are the RME characteristics.	The subjects can mention how many and what are the RME characteristics.
Characteristic 1: phenomenological exploration	• The subject does not havethe understanding of the element 1-3 of the phenomenological exploration characteristic. • The subject does not have the understanding about the roles of the contextual problem. • The subject understanding about the contextual problem is limited to problem in daily life.	• The subject does not have the understanding of the element 1-3 of the phenomenological exploration characteristic, but not yet complete. Because the subject can not explain that the existence of the phenomenon of exploration will bring students to the mathematizing and will help students to construct models. • The subject already has the understanding about the roles of the contextual problem. • The subject's understanding about the contextual problem not evolves previous understanding.
Characteristic 2: bridging by vertical instruments	The subject does not have the understanding about mathematizing , the stages of the problem solving, horizontal and vertical mathematizing, and progressive mathematizing.	The subject has the understanding about mathematizing , the stages of the problem solving, horizontal and vertical mathematizing, and progressive mathematizing.
Characteristic 3: student contributions	• The subject has not been able to explain the definition of the model. • The subject has the understanding about the element 2 and 3 of the student contributions characteristic, but does not have the understanding about element 4 of the student contributions	• The subject can explain the definition of the model. • The subject has the understanding about the element 2 – 4 of the student contributions characteristic.

	characteristic.	
Characteristic 4: interactivity	• The subject does not have the understanding about the element 1-5 of the interactivity characteristic. • The subject has the understanding about the element 6 of the interactivity characteristic.	• The subject has the understanding about the element 1, 3, and 6 of the interactivity characteristic. • The subject does not have the understanding about the element 2, 4, and 5 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 understands 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 thephilosophy, principles, andcharacteristics of RMEcan help the research subjecttohavethe cognitive profiles about

1. The philosophy of RME.
2. How many and what are the RME principles.
3. Element 1 of the guided reinvention principle.
4. Mathematizing, horizontal and vertical mathematizing, and progressive mathematizing.
5. The didactical phenomenology principle.
6. Element 1-3 of the self developed models principle.
7. How many and what are the RME characteristics.
8. Element1-3 of the phenomenological exploration characteristic.
9. The roles of thecontextual problem.
10. The problem solving stages.
11. The definition of model.
12. Elements 4 of the student contributions characteristic.
13. Element 1 and 6 of the interactivity characteristic.
14. The subject 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.

REFERENCES

Akker, Jan Van Den, Gravemeijer K., McKenney S., dan Nieveen N.. 2006. *Educational Design Research.* New York: Taylor and Francis Group.

Fosnot C. T. and Dolk Maarten. 2002. *Young Mathematicians at Work: Constructing Fractions, Decimal, and Percents*. Portsmouth: Heinemann.

Gravemeijer, K.P. E. 1994. *Developing Realistic Mathematics Education*. Utrecht: CD-β.

Miles, M. B. dan Huberman, A. M. 1994. *Qualitative Data Analysis*. London: Sage Publications

Merriam, S. B. 2009. *Qualitative Research: A Guide to Design and Implementation*. San Francisco: Jossey Bass A Wiley Imprint.

Plomp, Tjeerd. *Development Research in/on Education and Training***.** Makalah disajikan pada Seminar Nasional Pendidikan Matematika Realistik Indonesia yang diadakan oleh Universitas Sanata Darma pada tanggal 14-15 November 2001 di Yogyakarta.

Suryanto, dkk. 2010. *Sejarah Pendidikan Matematika Realistik Indonesia (PMRI)*. Bandung: IP-PMRI.

Widjaja W., Dolk M, dan Fauzan A. 2010. *The Role of Contexts and Teacher's Questioning to Enhance Students' Thinking*. Dalam Journal of Science and Mathematics Education in Southeast Asia, Volume 33, No. 2, halaman 168 – 186.